GSAS-II Developers Documentation

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CONTENTS

CHAPTER

ONE

GSAS-II MAIN MODULE

Main routines for the GSAS-II program

class `GSASII.`**`GSASII`**`(`*parent*`)`

Define the main GSAS-II frame and its associated menu items

`Bind``(`*eventtype*, *handler*, **args*, ***kwargs*`)`

Override the Bind function so that we can wrap calls that will be logged.

N.B. This is a bit kludgy. Menu bindings with an id are wrapped and menu bindings with an object and no id are not.

`CheckNotebook``()`

Make sure the data tree has the minimally expected controls. (BHT) correct?

class **`CopyDialog`**`(`*parent*, *title*, *text*, *data*`)`

Creates a dialog for copying control settings between data tree items

`GSASII.`**`EnableSeqRefineMenu`**`()`

Enable or disable the sequential refinement menu items based on the contents of the Controls 'Seq Data' item (if present)

`GSASII.`**`ErrorDialog`**`(`*title*, *message*, *parent=None*, *wtype=4*`)`

Display an error message

`GSASII.`**`ExitMain`**`(`*event*`)`

Called if the main window is closed

`GSASII.`**`FillMainMenu`**`(`*menubar*`)`

Define contents of the main GSAS-II menu for the (main) data tree window. For the mac, this is also called for the data item windows as well so that the main menu items are data menu as well.

`GSASII.`**`GetFileList`**`(`*fileType*, *skip=None*`)`

Appears unused. Note routine of same name in GSASIIpwdGUI

`GSASII.`**`GetHKLFdatafromTree`**`(`*HKLFname*`)`

Returns single crystal data from GSASII tree

Parameters **HKLFname** (*str*) – a single crystal histogram name as obtained from `GSASIIstruct.GetHistogramNames()`

Returns HKLFdata = single crystal data list of reflections

`GSASII.`**`GetHistogramNames`**`(`*hType*`)`

Returns a list of histogram names found in the GSASII data tree Note routine `GSASIIstrIO.GetHistogramNames()` also exists to get same info from GPX file.

Parameters **hType** (*str*) – list of histogram types

Returns list of histogram names

`GSASII.`**`GetImportFile`**`(`*message*, *defaultDir=''*, *defaultFile=''*, *style=1*, **args*, ***kwargs*`)`

Defines a customized dialog that gets gets files from the appropriate Import directory (unless overridden with defaultDir). The default import directory is found in self.ImportDir, which will be set to the location of the (first) file entered in this dialog.

Returns a list of files or an empty list

`GSASII.`**`GetPWDRdatafromTree`**`(`*PWDRname*`)`

Returns powder data from GSASII tree

Parameters PWDRname (*str*) – a powder histogram name as obtained from `GSASIIstruct.GetHistogramNames()`

Returns PWDRdata = powder data dictionary with Powder data arrays, Limits, Instrument Parameters, Sample Parameters

`GSASII.`**`GetPhaseData`**`()`

Returns a dict with defined phases. Note routine `GSASIIstrIO.GetPhaseData()` also exists to get same info from GPX file.

`GSASII.`**`GetPhaseInfofromTree`**`()`

Get the phase names and their rId values, also the histograms used in each phase.

Returns

(phaseRIdList, usedHistograms) where

- phaseRIdList is a list of random Id values for each phase
- usedHistograms is a dict where the keys are the phase names and the values for each key are a list of the histogram names used in each phase.

`GSASII.`**`GetPhaseNames`**`()`

Returns a list of defined phases. Note routine `GSASIIstrIO.GetPhaseNames()` also exists to get same info from GPX file.

`GSASII.`**`GetPowderIparm`**`(`*rd*, *prevIparm*, *lastIparmfile*, *lastdatafile*`)`

Open and read an instrument parameter file for a data file Returns the list of parameters used in the data tree

Parameters

- **rd** (*obj*) – the raw data (histogram) data object.
- **prevIparm** (*str*) – not used
- **lastIparmfile** (*str*) – Name of last instrument parameter file that was read, or a empty string.
- **lastdatafile** (*str*) – Name of last data file that was read.

Returns a list of two dicts, the first containing instrument parameters and the second used for TOf lookup tables for profile coeff.

`GSASII.`**`GetUsedHistogramsAndPhasesfromTree`**`()`

Returns all histograms that are found in any phase and any phase that uses a histogram. This also assigns numbers to used phases and histograms by the order they appear in the file. Note routine `GSASIIstrIO.GetUsedHistogramsAndPhasesfromTree()` also exists to get same info from GPX file.

Returns

(Histograms,Phases)

- Histograms = dictionary of histograms as {name:data,...}

- Phases = dictionary of phases that use histograms

`GSASII.`**`MakeLSParmDict`**`()`

Load all parameters used for computation from the tree into a dict of paired values [value, refine flag]. Note that this is different than the parmDict used in the refinement, which only has values.

Note that similar things are done in `GSASIIIO.ExportBaseclass.loadParmDict()` (from the tree) and `GSASIIstrMain.Refine()` and `GSASIIstrMain.SeqRefine()` (from a GPX file).

Returns

(parmDict,varyList) where:

- parmDict is a dict with values and refinement flags for each parameter and
- varyList is a list of variables (refined parameters).

`GSASII.`**`MenuBinding`**`(`*event*`)`

Called when a menu is clicked upon; looks up the binding in table

`GSASII.`**`OnAddPhase`**`(`*event*`)`

Add a new, empty phase to the tree. Called by Data/Add Phase menu

`GSASII.`**`OnDataDelete`**`(`*event*`)`

Delete one or more histograms from data tree. Called by the Data/DeleteData menu

`GSASII.`**`OnDeletePhase`**`(`*event*`)`

Delete a phase from the tree. Called by Data/Delete Phase menu

`GSASII.`**`OnDummyPowder`**`(`*event*`)`

Called in response to Import/Powder Data/Simulate menu item to create a Dummy powder diffraction data set.

Reads an instrument parameter file and then gets input from the user

`GSASII.`**`OnFileClose`**`(`*event*`)`

Clears the data tree in response to the File/New Project menu button. User is given option to save the project.

`GSASII.`**`OnFileExit`**`(`*event*`)`

Called in response to the File/Quit menu button

`GSASII.`**`OnFileOpen`**`(`*event*, *filename=None*`)`

Gets a GSAS-II .gpx project file in response to the File/Open Project menu button

`GSASII.`**`OnFileSave`**`(`*event*`)`

Save the current project in response to the File/Save Project menu button

`GSASII.`**`OnFileSaveas`**`(`*event*`)`

Save the current project in response to the File/Save as menu button

`GSASII.`**`OnImageRead`**`(`*event*`)`

Called to read in an image in any known format

`GSASII.`**`OnImageSum`**`(`*event*`)`

Sum together image data(?)

`GSASII.`**`OnImportGeneric`**`(`*reader*, *readerlist*, *label*, *multiple=False*, *usedRanIdList=[ ]*`)`

Used to import Phases, powder dataset or single crystal datasets (structure factor tables) using reader objects subclassed from `GSASIIIO.ImportPhase`, `GSASIIIO.ImportStructFactor` or `GSASIIIO.ImportPowderData`. If a reader is specified, only that will be attempted, but if no reader is specified, every one that is potentially compatible (by file extension) will be tried on the selected file(s).

Parameters

- **reader** (*readerobject*) – This will be a reference to a particular object to be used to read a file or None, if every appropriate reader should be used.
- **readerlist** (*list*) – a list of reader objects appropriate for the current read attempt. At present, this will be either self.ImportPhaseReaderlist, self.ImportSfactReaderlist or self.ImportPowderReaderlist (defined in _init_Imports from the files found in the path), but in theory this list could be tailored. Used only when reader is None.
- **label** (*str*) – string to place on the open file dialog: Open *label* input file
- **multiple** (*bool*) – True if multiple files can be selected in the file dialog. False is default. At present True is used only for reading of powder data.
- **usedRanIdList** (*list*) – an optional list of random Ids that have been used and should not be reused

Returns a list of reader objects (rd_list) that were able to read the specified file(s). This list may be empty.

`GSASII.`**`OnImportPhase`**`(`*event*`)`

Called in response to an Import/Phase/... menu item to read phase information. dict self.ImportMenuId is used to look up the specific reader item associated with the menu item, which will be None for the last menu item, which is the “guess” option where all appropriate formats will be tried.

`GSASII.`**`OnImportPowder`**`(`*event*`)`

Called in response to an Import/Powder Data/... menu item to read a powder diffraction data set. dict self.ImportMenuId is used to look up the specific reader item associated with the menu item, which will be None for the last menu item, which is the “guess” option where all appropriate formats will be tried.

Also reads an instrument parameter file for each dataset.

`GSASII.`**`OnImportSfact`**`(`*event*`)`

Called in response to an Import/Structure Factor/... menu item to read single crystal datasets. dict self.ImportMenuId is used to look up the specific reader item associated with the menu item, which will be None for the last menu item, which is the “guess” option where all appropriate formats will be tried.

`GSASII.`**`OnImportSmallAngle`**`(`*event*`)`

Called in response to an Import/Small Angle Data/... menu item to read a small angle diffraction data set. dict self.ImportMenuId is used to look up the specific reader item associated with the menu item, which will be None for the last menu item, which is the “guess” option where all appropriate formats will be tried.

`GSASII.`**`OnMacroRecordStatus`**`(`*event*, *setvalue=None*`)`

Called when the record macro menu item is used which toggles the value. Alternately a value to be set can be provided. Note that this routine is made more complex because on the Mac there are lots of menu items (listed in self.MacroStatusList) and this loops over all of them.

`GSASII.`**`OnMakePDFs`**`(`*event*`)`

Calculates PDFs

`GSASII.`**`OnPatternTreeItemActivated`**`(`*event*`)`

Called when a tree item is activated

`GSASII.`**`OnPatternTreeItemCollapsed`**`(`*event*`)`

Called when a tree item is collapsed - all children will be collapsed

`GSASII.`**`OnPatternTreeItemDelete`**`(`*event*`)`

Called when a tree item is deleted – not sure what this does

`GSASII.`**`OnPatternTreeItemExpanded`**`(`*event*`)`

Called when a tree item is expanded

GSASII.**OnPatternTreeKeyDown**(*event*)
Allows stepping through the tree with the up/down arrow keys

GSASII.**OnPatternTreeSelChanged**(*event*)
Called when a data tree item is selected

GSASII.**OnPwdrSum**(*event*)
Sum together powder data(?)

GSASII.**OnReadPowderPeaks**(*event*)
Bound to menu Data/Read Powder Peaks

GSASII.**OnRefine**(*event*)
Perform a refinement. Called from the Calculate/Refine menu.

GSASII.**OnRenameData**(*event*)
Renames an existing phase. Called by Data/Rename Phase menu

GSASII.**OnSeqRefine**(*event*)
Perform a sequential refinement. Called from the Calculate/Sequential refine menu.

GSASII.**OnSize**(*event*)
Called when the main window is resized. Not sure why

GSASII.**OpenPowderInstprm**(*instfile*)
Read a GSAS-II (new) instrument parameter file

Parameters **instfile** (*str*) – name of instrument parameter file

GSASII.**ReadPowderInstprm**(*instLines*)
Read lines from a GSAS-II (new) instrument parameter file

Parameters **instLines** (*list*) – strings from GSAS-II parameter file; can be concatenated with ';'

GSASII.**ReadPowderIparm**(*instfile*, *bank*, *databanks*, *rd*)
Read a GSAS (old) instrument parameter file

Parameters

- **instfile** (*str*) – name of instrument parameter file
- **bank** (*int*) – the bank number read in the raw data file
- **databanks** (*int*) – the number of banks in the raw data file. If the number of banks in the data and instrument parameter files agree, then the sets of banks are assumed to match up and bank is used to select the instrument parameter file. If not, the user is asked to make a selection.
- **rd** (*obj*) – the raw data (histogram) data object. This sets rd.instbank.

GSASII.**ShowLSParms**(*event*)
Displays a window showing all parameters in the refinement. Called from the Calculate/View LS Parms menu.

GSASII.**StartProject**()
Opens a GSAS-II project file & selects the 1st available data set to display (PWDR, HKLF or SASD)

class GSASII.**SumDialog**(*parent*, *title*, *text*, *dataType*, *data*)
Allows user to supply scale factor(s) when summing data

class GSASII.**GSASIImain**(*redirect=False*, *filename=None*, *useBestVisual=False*, *clearSigInt=True*)
Defines a wxApp for GSAS-II

Creates a wx frame (self.main) which contains the display of the data tree.

OnInit()

Called automatically when the app is created.

GSASII.**main**()

Start up the GSAS-II application

CHAPTER

TWO

GSASIIOBJ: DATA OBJECTS

This module defines and/or documents the data structures used in GSAS-II, as well as provides misc. support routines.

2.1 Constraints Tree Item

Constraints are stored in a dict, separated into groups. Note that parameter are named in the following pattern, p:h:<var>:n, where p is the phase number, h is the histogram number <var> is a variable name and n is the parameter number. If a parameter does not depend on a histogram or phase or is unnumbered, that number is omitted. Note that the contents of each dict item is a List where each element in the list is a *constraint definition objects*. The constraints in this form are converted in `GSASIIstrIO.ProcessConstraints()` to the form used in `GSASIImapvars`

The keys in the Constraints dict are:

key	explanation
Hist	This specifies a list of constraints on histogram-related parameters, which will be of form :h:<var>:n.
HAP	This specifies a list of constraints on parameters that are defined for every histogram in each phase and are of form p:h:<var>:n.
Phase	This specifies a list of constraints on phase parameters, which will be of form p::<var>:n.
Global	This specifies a list of constraints on parameters that are not tied to a histogram or phase and are of form ::<var>:n

Each constraint is defined as an item in a list. Each constraint is of form:

```
[[<mult1>, <var1>], [<mult2>, <var2>],..., <fixedval>, <varyflag>, <constype>]
```

Where the variable pair list item containing two values [<mult>, <var>], where:

- <mult> is a multiplier for the constraint (float)
- **<var> a `G2VarObj` object (previously a str variable name of form** 'p:h:name[:at]')

Note that the last three items in the list play a special role:

- <fixedval> is the fixed value for a *constant equation* (`constype=c`) constraint or is None. For a *New variable* (`constype=f`) constraint, a variable name can be specified as a str (used for externally generated constraints)
- <varyflag> is True or False for *New variable* (`constype=f`) constraints or is None. This will be implemented in the future to indicate if these variables should be refined.
- <constype> is one of four letters, 'e', 'c', 'h', 'f' that determines the type of constraint:
  - 'e' defines a set of equivalent variables. Only the first variable is refined (if the appropriate refine flag is set) and and all other equivalent variables in the list are generated from that variable, using the appropriate multipliers.

- 'c' defines a constraint equation of form, $m_1 \times var_1 + m_2 \times var_2 + ... = c$
- 'h' defines a variable to hold (not vary). Any variable on this list is not varied, even if its refinement flag is set. Only one [mult,var] pair is allowed in a hold constraint and the mult value is ignored. This is of particular value when needing to hold one or more variables where a single flag controls a set of variables such as, coordinates, the reciprocal metric tensor or anisotropic displacement parameter.
- 'f' defines a new variable (function) according to relationship $newvar = m_1 \times var_1 + m_2 \times var_2 + ...$

2.2 Covariance Tree Item

The Covariance tree item has results from the last least-squares run. They are stored in a dict with these keys:

key	sub-key	explanation
newCellDict		dict with lattice parameters computed by `GSASIIstrMath.GetNewCellParms()` (dict)
title		Name of gpx file(?) (str)
variables		Values for all N refined variables (list of float values, length N, ordered to match varyList)
sig		Uncertainty values for all N refined variables (list of float values, length N, ordered to match varyList)
varyList		List of directly refined variables (list of str values, length N)
newAtomDict		dict with atom position values computed in `GSASIIstrMath.ApplyXYZshifts()` (dict)
Rvals		R-factors, GOF, Marquardt value for last refinement cycle (dict)
	Nobs	Number of observed data points (int)
	Rwp	overall weighted profile R-factor (%, float)
	chisq	sum[w*(Iobs-Icalc)**2] for all data note this is not the reduced chi squared (float)
	lamMax	Marquardt value applied to Hessian diagonal (float)
	GOF	The goodness-of-fit, aka square root of the reduced chi squared. (float)
covMatrix		The (NxN) covVariance matrix (np.array)

2.3 Phase Tree Items

Phase information is stored in the GSAS-II data tree as children of the Phases item in a dict with keys:

key	sub-key	explanation
General		Overall information for the phase (dict)
	AtomPtrs	list of four locations to use to pull info from the atom records (list)
	F000X	x-ray F(000) intensity (float)
	F000N	neutron F(000) intensity (float)
	Mydir	directory of current .gpx file (str)
	MCSA controls	Monte Carlo-Simulated Annealing controls (dict)
	Cell	List with 8 items: cell refinement flag (bool) a, b, c, (Angstrom, float) alpha, beta & gamma (degrees, float) volume (A^3, float)
	Type	'nuclear' or 'macromolecular' for now (str)
	Map	dict of map parameters
	SH Texture	dict of spherical harmonic preferred orientation parameters
	Isotope	dict of isotopes for each atom type

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key	sub-key	explanation
	Isotopes	dict of scattering lengths for each isotope combination for each element in phase
	Name	phase name (str)
	SGData	Space group details as a *space group (SGData) object* as defined in `GSASIIspc.SpcGroup()`.
	Pawley neg wt	Restraint value for negative Pawley intensities (float)
	Flip	dict of Charge flip controls
	Data plot type	data plot type ('Mustrain', 'Size' or 'Preferred orientation') for powder data (str)
	Mass	Mass of unit cell contents in g/mol
	POhkl	March-Dollase preferred orientation direction
	Z	dict of atomic numbers for each atom type
	vdWRadii	dict of van der Waals radii for each atom type
	Color	Colors for atoms (list of (r,b,g) triplets)
	AtomTypes	List of atom types
	AtomMass	List of masses for atoms
	doPawley	Flag for Pawley intensity extraction (bool)
	NoAtoms	Number of atoms per unit cell of each type (dict)
	Pawley dmin	maximum Q (as d-space) to use for Pawley extraction (float)
	BondRadii	Default radius for each atom used to compute interatomic distances (list of floats)
	AngleRadii	Default radius for each atom used to compute interatomic angles (list of floats)
	DisAglCtls	Dict with distance/angle search controls, which has keys 'Name', 'AtomTypes', 'BondRadii', 'AngleRadii' which are as above except are possibly edited. Also contains 'Factors', which is a 2 element list with a multiplier for bond and angle search range [typically (0.85,0.85)].
ranId		unique random number Id for phase (int)
pId		Phase Id number for current project (int).
Atoms		Atoms in phase as a list of lists. The outer list is for each atom, the inner list contains varying items depending on the type of phase, see the *Atom Records* description. (list of lists)
Drawing		Display parameters (dict)
	ballScale	Size of spheres in ball-and-stick display (float)
	bondList	dict with bonds
	contourLevel	map contour level in e/A^3 (float)
	showABC	Flag to show view point triplet (bool). True=show.
	viewDir	cartesian viewing direction (np.array with three elements)
	Zclip	clipping distance in A (float)
	backColor	background for plot as and R,G,B triplet (default = [0, 0, 0], black). (list with three atoms)
	selectedAtoms	List of selected atoms (list of int values)
	showRigidBodies	Flag to highlight rigid body placement
	sizeH	Size ratio for H atoms (float)
	bondRadius	Size of binds in A (float)
	atomPtrs	positions of x, type, site sym, ADP flag in Draw Atoms (list)
	viewPoint	list of lists. First item in list is [x,y,z] in fractional coordinates for the center of the plot. Second item list of previous & current atom number viewed (may be [0,0])
	showHydrogen	Flag to control plotting of H atoms.
	unitCellBox	Flag to control display of the unit cell.

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key	sub-key	explanation
	ellipseProb	Probability limit for display of thermal ellipsoids in % (float).
	vdwScale	Multiplier of van der Waals radius for display of vdW spheres.
	Atoms	A list of lists with an entry for each atom that is plotted.
	Zstep	Step to de/increase Z-clip (float)
	Quaternion	Viewing quaternion (4 element np.array)
	radiusFactor	Distance ratio for searching for bonds. ? Bonds are located that are within r(Ra+Rb) and (Ra+Rb)/r where Ra and Rb are the atomic radii.
	oldxy	previous view point (list with two floats)
	cameraPos	Viewing position in A for plot (float)
	depthFog	True if use depthFog on plot - set currently as False (bool)
RBModels		Rigid body assignments (note Rigid body definitions are stored in their own main top-level tree entry.)
Pawley ref		Pawley reflections
Histograms		A dict of dicts. The key for the outer dict is the histograms tied to this phase. The inner dict contains the combined phase/histogram parameters for items such as scale factors, size and strain parameters. (dict)
MCSA		Monte-Carlo simulated annealing parameters (dict)

2.4 Rigid Body Objects

Rigid body descriptions are available for two types of rigid bodies: 'Vector' and 'Residue'. Vector rigid bodies are developed by a sequence of translations each with a refinable magnitude and Residue rigid bodies are described as Cartesian coordinates with defined refinable torsion angles.

key	sub-key	explanation
Vector	RBId	vector rigid bodies (dict of dict)
	AtInfo	Drad, Color: atom drawing radius & color for each atom type (dict)
	RBname	Name assigned by user to rigid body (str)
	VectMag	vector magnitudes in A (list)
	rbXYZ	Cartesian coordinates for Vector rigid body (list of 3 float)
	rbRef	3 assigned reference atom nos. in rigid body for origin definition, use center of atoms flag (list of 3 int & 1 bool)
	VectRef	refinement flags for VectMag values (list of bool)
	rbTypes	Atom types for each atom in rigid body (list of str)
	rbVect	Cartesian vectors for each translation used to build rigid body (list of lists)
	useCount	Number of times rigid body is used in any structure (int)
Residue	RBId	residue rigid bodies (dict of dict)
	AtInfo	Drad, Color: atom drawing radius & color for each atom type(dict)
	RBname	Name assigned by user to rigid body (str)
	rbXYZ	Cartesian coordinates for Residue rigid body (list of 3 float)
	rbTypes	Atom types for each atom in rigid body (list of str)
	atNames	Names of each atom in rigid body (e.g. C1,N2...) (list of str)
	rbRef	3 assigned reference atom nos. in rigid body for origin definition, use center of atoms flag (list of 3 int & 1 bool)
	rbSeq	Orig,Piv,angle,Riding (list): definition of internal rigid body torsion; origin atom (int), pivot atom (int), torsion angle (float), riding atoms (list of int)
	SelSeq	[int,int] used by SeqSizer to identify objects
	useCount	Number of times rigid body is used in any structure (int)
RBIds		unique Ids generated upon creation of each rigid body (dict)
	Vector	Ids for each Vector rigid body (list)
	Residue	Ids for each Residue rigid body (list)

2.5 Space Group Objects

Space groups are interpreted by `GSASIIspc.SpcGroup()` and the information is placed in a SGdata object which is a dict with these keys:

key	explanation
SpGrp	space group symbol (str)
Laue	one of the following 14 Laue classes: -1, 2/m, mmm, 4/m, 4/mmm, 3R, 3mR, 3, 3m1, 31m, 6/m, 6/mmm, m3, m3m (str)
SGInv	True if centrosymmetric, False if not (bool)
SGLatt	Lattice centering type. Will be one of P, A, B, C, I, F, R (str)
SGUniq	unique axis if monoclinic. Will be a, b, or c for monoclinic space groups. Will be blank for non-monoclinic. (str)
SGCen	Symmetry cell centering vectors. A (n,3) np.array of centers. Will always have at least one row: `np.array([[0, 0, 0]])`
SGOps	symmetry operations as a list of form `[[M1,T1], [M2,T2],...]` where M_n is a 3x3 np.array and T_n is a length 3 np.array. Atom coordinates are transformed where the Asymmetric unit coordinates [X is (x,y,z)] are transformed using $X' = M_n * X + T_n$
SGSys	symmetry unit cell: type one of 'triclinic', 'monoclinic', 'orthorhombic', 'tetragonal', 'rhombohedral', 'trigonal', 'hexagonal', 'cubic' (str)
SGPolax	Axes for space group polarity. Will be one of '', 'x', 'y', 'x y', 'z', 'x z', 'y z', 'xyz'. In the case where axes are arbitrary '111' is used (P 1, and ?).

Space groups are interpreted by `GSASIIspc.SSpcGroup()` and the information is placed in a SSGdata object which is a dict with these keys:

key	explanation
SSpGrp	superspace group symbol extension to space group symbol, accidental spaces removed
SSGCen	4D cell centering vectors [0,0,0,0] at least
SSGOps	4D symmetry operations as [M,T] so that M*x+T = x'

2.6 Atom Records

If `phasedict` points to the phase information in the data tree, then atoms are contained in a list of atom records (list) in `phasedict['Atoms']`. Also needed to read atom information are four pointers, `cx,ct,cs,cia = phasedict['General']['atomPtrs']`, which define locations in the atom record, as shown below. Items shown are always present; additional ones for macromolecular phases are marked 'mm'

location	explanation
ct-4	mm - residue number (str)
ct-3	mm - residue name (e.g. ALA) (str)
ct-2	mm - chain label (str)
ct-1	atom label (str)
ct	atom type (str)
ct+1	refinement flags; combination of 'F', 'X', 'U' (str)
cx,cx+1,cx+2	the x,y and z coordinates (3 floats)
cs	site symmetry (str)
cs+1	site multiplicity (int)
cia	ADP flag: Isotropic ('I') or Anisotropic ('A')
cia+1	Uiso (float)
cia+2...cia+7	U11, U22, U33, U12, U13, U23 (6 floats)
atom[cia+8]	unique atom identifier (int)

2.7 Drawing Atom Records

If `phasedict` points to the phase information in the data tree, then drawing atoms are contained in a list of drawing atom records (list) in `phasedict['Drawing']['Atoms']`. Also needed to read atom information are four pointers, `cx,ct,cs,ci = phasedict['Drawing']['AtomPtrs']`, which define locations in the atom record, as shown below. Items shown are always present; additional ones for macromolecular phases are marked 'mm'

location	explanation
ct-4	mm - residue number (str)
ct-3	mm - residue name (e.g. ALA) (str)
ct-2	mm - chain label (str)
ct-1	atom label (str)
ct	atom type (str)
cx,cx+1,cx+2	the x,y and z coordinates (3 floats)
cs-1	Sym Op symbol; sym. op number + unit cell id (e.g. '1,0,-1') (str)
cs	atom drawing style; e.g. 'balls & sticks' (str)
cs+1	atom label style (e.g. 'name') (str)
cs+2	atom color (RBG triplet) (int)
cs+3	ADP flag: Isotropic ('I') or Anisotropic ('A')
cs+4	Uiso (float)
cs+5...cs+11	U11, U22, U33, U12, U13, U23 (6 floats)
ci	unique atom identifier; matches source atom Id in Atom Records (int)

2.8 Powder Diffraction Tree Items

Every powder diffraction histogram is stored in the GSAS-II data tree with a top-level entry named beginning with the string "PWDR ". The diffraction data for that information are directly associated with that tree item and there are a series of children to that item. The routines `GSASII.GSASII.GetUsedHistogramsAndPhasesfromTree()` and `GSASIIstrIO.GetUsedHistogramsAndPhases()` will load this information into a dictionary where the child tree name is used as a key, and the information in the main entry is assigned a key of `Data`, as outlined below.

key	sub-key	explanation
Comments		Text strings extracted from the original powder data heade be changed by the user; it may be empty.
Limits		A list of two two element lists, as [[Ld,Hd],[L,H]] whe the current and default lowest two-theta value to be use and Hd are the current and default highest two-theta valu
Reflection Lists		A dict with an entry for each phase in the histogram. each dict item is a dict containing reflections, as describe *Reflections* description.
Instrument Parameters		A list containing two dicts where the possible keys in eac below. The value for each item is a list containing three v value, the current value and a refinement flag which can True, False or 0 where 0 indicates a value that cannot first and second values are floats unless otherwise note first dict are noted as [1]
	Lam	Specifies a wavelength in Angstroms [1]
	Lam1	Specifies the primary wavelength in Angstrom, when ar source is used [1]
	Lam2 I(L2)/I(L1)	Specifies the secondary wavelength in Angstrom, when ar source is used [1] Ratio of Lam2 to Lam1 [1]
	Type	**Histogram type (str) [1]:** • 'PXC' for constant wavelength x-ray • 'PNC' for constant wavelength neutron • 'PNT' for time of flight neutron
	Zero	Two-theta zero correction in *degrees* [1]

Continued

Table 2.2 – continued from previous page

key	sub-key	explanation
	Azimuth	Azimuthal setting angle for data recorded with differin [1]
	U, V, W	Cagliotti profile coefficients for Gaussian instrumen where the FWHM goes as $U\tan^2\theta + V\tan\theta + W$ [1]
	X, Y	Cauchy (Lorentzian) instrumental broadening coefficient
	SH/L	Variant of the Finger-Cox-Jephcoat asymmetric peak b Note that this is the average between S/L and H/L wh height, H is the slit height and L is the goniometer diame
	Polariz.	Polarization coefficient. [1]
wtFactor		A weighting factor to increase or decrease the leverage o togram (float). A value of 1.0 weights the data with their tainties and a larger value increases the weighting of the to decreasing the uncertainties).
Sample Parameters		Specifies a dict with parameters that describe how the lected, as listed below. Refinable parameters are a list c and a bool, where the second value specifies if the value erwise the value is a float unless otherwise noted.
	Scale	The histogram scale factor (refinable)
	Absorption	The sample absorption coefficient as μr where r is the ra Only valid for Debye-Scherrer geometry.
	SurfaceRoughA	Surface roughness parameter A as defined by Surotti, 5,325-331, 1972.(refinable - only valid for Bragg-Brenta
	SurfaceRoughB	Surface roughness parameter B (refinable - only v Brentano geometry)
	DisplaceX, DisplaceY	Sample displacement from goniometer center where Y is direction and X is perpendicular. Units are μm (refinabl
	Phi, Chi, Omega	Goniometer sample setting angles, in degrees.
	Gonio. radius	Radius of the diffractometer in mm
	InstrName	A name for the instrument, used in preparing a CIF (str).
	Force, Temperature, Humidity, Pressure, Voltage	Variables that describe how the measurement was perfo directly in any computations.
	ranId	The random-number Id for the histogram (same value as key is ranId)
	Type	Type of diffraction data, may be 'Debye-Scherrer' or 'E (str).
	Diffuse	not in use?
hId		The number assigned to the histogram when the proje edited (can change)
ranId		A random number id for the histogram that does not cha
Background		The background is stored as a list with where the first is list and the second item is a dict. The list contains function and its coefficients; the dict contains Debye di background peaks. (TODO: this needs to be expanded.)
Data		The data consist of a list of 6 np.arrays containing in ord 0. the x-postions (two-theta in degrees), 1. the intensity values (Yobs), 2. the weights for each Yobs value 3. the computed intensity values (Ycalc) 4. the background values 5. Yobs-Ycalc

2.9 Powder Reflection Data Structure

For every phase in a histogram, the `Reflection Lists` value is a dict one element of which is *'RefList'*, which is a np.array containing reflections. The columns in that array are documented below.

index	explanation
0,1,2	h,k,l (float)
3	multiplicity
4	d-space, Angstrom
5	pos, two-theta
6	sig, Gaussian width
7	gam, Lorenzian width
8	F^2_{obs}
9	F^2_{calc}
10	reflection phase, in degrees
11	intensity correction for reflection, this times F^2_{obs} or F^2_{calc} gives Iobs or Icalc

2.10 Single Crystal Tree Items

Every single crystal diffraction histogram is stored in the GSAS-II data tree with a top-level entry named beginning with the string "HKLF ". The diffraction data for that information are directly associated with that tree item and there are a series of children to that item. The routines `GSASII.GSASII.GetUsedHistogramsAndPhasesfromTree()` and `GSASIIstrIO.GetUsedHistogramsAndPhases()` will load this information into a dictionary where the child tree name is used as a key, and the information in the main entry is assigned a key of `Data`, as outlined below.

key	sub-key	explanation
Data		A dict that contains the reflection table, as described in the *Single Crystal Reflections* description.
Instrument Parameters		A list containing two dicts where the possible keys in each dict are listed below. The value for most items is a list containing two values: the initial value, the current value. The first and second values are floats unless otherwise noted.
	Lam	Specifies a wavelength in Angstroms (two floats)
	Type	**Histogram type (two str values):** • 'SXC' for constant wavelength x-ray • 'SNC' for constant wavelength neutron • 'SNT' for time of flight neutron
	InstrName	A name for the instrument, used in preparing a CIF (str).
wtFactor		A weighting factor to increase or decrease the leverage of data in the histogram (float). A value of 1.0 weights the data with their standard uncertainties and a larger value increases the weighting of the data (equivalent to decreasing the uncertainties).
hId		The number assigned to the histogram when the project is loaded or edited (can change)
ranId		A random number id for the histogram that does not change

2.11 Single Crystal Reflection Data Structure

For every single crystal a histogram, the `'Data'` item contains the structure factors as an np.array in item *'RefList'*. The columns in that array are documented below.

index	explanation
0,1,2	h,k,l (float)
3	multiplicity
4	d-space, Angstrom
5	F^2_{obs}
6	$\sigma(F^2_{obs})$
7	F^2_{calc}
8	$F^2_{obs}T$
9	$F^2_{calc}T$
10	reflection phase, in degrees
11	intensity correction for reflection, this times F^2_{obs} or F^2_{calc} gives Iobs or Icalc

2.12 Image Data Structure

Every 2-dimensional image is stored in the GSAS-II data tree with a top-level entry named beginning with the string "IMG ". The image data are directly associated with that tree item and there are a series of children to that item. The routines `GSASII.GSASII.GetUsedHistogramsAndPhasesfromTree()` and `GSASIIstrIO.GetUsedHistogramsAndPhases()` will load this information into a dictionary where the child tree name is used as a key, and the information in the main entry is assigned a key of `Data`, as outlined below.

key	sub-key	explanation
Comments		Text strings extracted from the original image data header or a metafile. These cannot be changed by the user; it may be empty.
Image Controls	azmthOff	(float) The offset to be applied to an azimuthal value. Accomodates detector orientations other than with the detector X-axis horizontal.
	background image	(list:str,float) The name of a tree item ("IMG ...") that is to be subtracted during image integration multiplied by value. It must have the same size/shape as the integrated image. NB: value < 0 for subtraction.
	calibrant	(str) The material used for determining the position/orientation of the image. The data is obtained from `ImageCalibrants()` and UserCalibrants.py (supplied by user).
	calibdmin	(float) The minimum d-spacing used during the last calibration run.
	calibskip	(int) The number of expected diffraction lines skipped during the last calibration run.
	center	(list:floats) The [X,Y] point in detector coordinates (mm) where the direct beam strikes the detector plane as determined by calibration. This point does not have to be within the limits of the detector boundaries.
	centerAzm	(bool) If True then the azimuth reported for the integrated slice of the image is at the center line otherwise it is at the leading edge.
	color	(str) The name of the colormap used to display the image. Default = 'Paired'.
	cutoff	(float) The minimum value of I/Ib for a point selected in a diffraction ring for calibration calculations. See pixLimit for details as how point is found.

Continued on next page

Table 2.3 – continued from previous page

key	sub-key	explanation
	DetDepth	(float) Coefficient for penetration correction to distance; accounts for diffraction ring offset at higher angles. Optionally determined by calibration.
	DetDepthRef	(bool) If True then refine DetDepth during calibration/recalibration calculation.
	distance	(float) The distance (mm) from sample to detector plane.
	ellipses	(list:lists) Each object in ellipses is a list [center,phi,radii,color] where center (list) is location (mm) of the ellipse center on the detector plane, phi is the rotation of the ellipse minor axis from the x-axis, and radii are the minor & major radii of the ellipse. If radii[0] is negative then parameters describe a hyperbola. Color is the selected drawing color (one of 'b', 'g' ,'r') for the ellipse/hyperbola.
	edgemin	(float) Not used; parameter in EdgeFinder code.
	fullIntegrate	(bool) If True then integrate over full 360 deg azimuthal range.
	GonioAngles	(list:floats) The 'Omega','Chi','Phi' goniometer angles used for this image. Required for texture calculations.
	invert_x	(bool) If True display the image with the x-axis inverted.
	invert_y	(bool) If True display the image with the y-axis inverted.
	IOtth	(list:floats) The minimum and maximum 2-theta values to be used for integration.
	LRazimuth	(list:floats) The minimum and maximum azimuth values to be used for integration.
	Oblique	(list:float,bool) If True apply a detector absorption correction using the value to the intensities obtained during integration.
	outAzimuths	(int) The number of azimuth pie slices.
	outChannels	(int) The number of 2-theta steps.
	pixelSize	(list:ints) The X,Y dimensions (microns) of each pixel.
	pixLimit	(int) A box in the image with 2*pixLimit+1 edges is searched to find the maximum. This value (I) along with the minimum (Ib) in the box is reported by `GSASIIimage.ImageLocalMax()` and subject to cutoff in `GSASIIimage.makeRing()`. Locations are used to construct rings of points for calibration calcualtions.
	PolaVal	(list:float,bool) If type='SASD' and if True, apply polarization correction to intensities from integration using value.
	rings	(list:lists) Each entry is [X,Y,dsp] where X & Y are lists of x,y coordinates around a diffraction ring with the same d-spacing (dsp)
	ring	(list) The x,y coordinates of the >5 points on an inner ring selected by the user,
	Range	(list) The minimum & maximum values of the image
	rotation	(float) The angle between the x-axis and the vector about which the detector is tilted. Constrained to -180 to 180 deg.
	SampleShape	(str) Currently only 'Cylinder'. Sample shape for Debye-Scherrer experiments; used for absorption calculations.
	SampleAbs	(list: float,bool) Value of absorption coefficient for Debye-Scherrer experimnents, flag if True to cause correction to be applied.
	setDefault	(bool) If True the use the image controls values for all new images to be read. (might be removed)
	setRings	(bool) If True then display all the selected x,y ring positions (vida supra rings) used in the calibration.
	showLines	(bool) If True then isplay the integration limits to be used.
	size	(list:int) The number of pixels on the image x & y axes

Continued on next page

Table 2.3 – continued from previous page

key	sub-key	explanation
	type	(str) One of 'PWDR', 'SASD' or 'REFL' for powder, small angle or reflectometry data, respectively.
	tilt	(float) The angle the detector normal makes with the incident beam; range -90 to 90.
	wavelength	(float) Tha radiation wavelength (Angstroms) as entered by the user (or someday obtained from the image header).
Masks	Arcs	(list: lists) Each entry [2-theta,[azimuth[0],azimuth[1]],thickness] describes an arc mask to be excluded from integration
	Frames	(list:lists) Each entry describes the x,y points (3 or more - mm) that describe a frame outside of which is excluded from recalibration and integration. Only one frame is allowed.
	Points	(list:lists) Each entry [x,y,radius] (mm) describes an excluded spot on the image to be excluded from integration.
	Polygons	(list:lists) Each entry is a list of 3+ [x,y] points (mm) that describe a polygon on the image to be excluded from integration.
	Rings	(list: lists) Each entry [2-theta,thickness] describes a ring mask to be excluded from integration.
	Thresholds	(list:[tuple,list]) [(Imin,Imax),[Imin,Imax]] This gives lower and upper limits for points on the image to be included in integrsation. The tuple is the image intensity limits and the list are those set by the user.
Stress/Strain	Sample phi	(float) Sample rotation about vertical axis.
	Sample z	(float) Sample translation from the calibration sample position (for Sample phi = 0) These will be restricted by space group symmetry; result of strain fit refinement.
	Type	(str) 'True' or 'Conventional': The strain model used for the calculation.
	d-zero	(list:dict) Each item is for a diffraction ring on the image; all items are from the same phase and are used to determine the strain tensor. The dictionary items are: 'Dset': (float) True d-spacing for the diffraction ring; entered by the user. 'Dcalc': (float) Average calculated d-spacing determined from strain coeff. 'Emat': (list: float) The strain tensor elements e11, e12 & e22 (e21=e12, rest are 0) 'Esig': (list: float) Esds for Emat from fitting. 'pixLimit': (int) Search range to find highest point on ring for each data point 'cutoff': (float) I/Ib cutoff for searching. 'ImxyObs': (list: lists) [[X],[Y]] observed points to be used for strain calculations. 'ImtaObs': (list: lists) [[d],[azm]] transformed via detector calibration from ImxyObs. 'ImtaCalc': (list: lists [[d],[azm]] calculated d-spacing & azimuth from fit.

2.13 Parameter Dictionary

The parameter dictionary contains all of the variable parameters for the refinement. The dictionary keys are the name of the parameter (<phase>:<hist>:<name>:<atom>). It is prepared in two ways. When loaded from the tree (in `GSASII.GSASII.MakeLSParmDict()` and `GSASIIIO.ExportBaseclass.loadParmDict()`), the values are lists with two elements: `[value, refine flag]`

When loaded from the GPX file (in `GSASIIstrMain.Refine()` and `GSASIIstrMain.SeqRefine()`), the value in the dict is the actual parameter value (usually a float, but sometimes a letter or string flag value (such as I or A for iso/anisotropic).

2.14 *Classes and routines*

`GSASIIobj.`**`AtomIdLookup`** = {}
dict listing for each phase index as a str, the atom label and atom random Id, keyed by atom sequential index as a str; best to access this using `LookupAtomLabel()`

`GSASIIobj.`**`AtomRanIdLookup`** = {}
dict listing for each phase the atom sequential index keyed by atom random Id; best to access this using `LookupAtomId()`

`GSASIIobj.`**`CompileVarDesc`**`()`
Set the values in the variable description lookup table (`VarDesc`) into `reVarDesc`. This is called in `getDescr()` so the initialization is always done before use.

Note that keys may contain regular expressions, where '[xyz]' matches 'x' 'y' or 'z' (equivalently '[x-z]' describes this as range of values). '.*' matches any string. For example:

```
'AUiso':'Atomic isotropic displacement parameter',
```

will match variable `'p::AUiso:a'`. If parentheses are used in the key, the contents of those parentheses can be used in the value, such as:

```
'AU([123][123])':'Atomic anisotropic displacement parameter U\1',
```

will match `AU11`, `AU23`,.. and *U11*, *U23* etc will be displayed in the value when used.

`GSASIIobj.`**`DefaultControls`** = **{'Author': 'no name', 'SeqParFitEqList': [], 'shift factor': 1.0, 'deriv type': 'analytic Hes**
Values to be used as defaults for the initial contents of the `Controls` data tree item.

class `GSASIIobj.`**`ExpressionCalcObj`**`(`*exprObj*`)`
An object used to evaluate an expression from a `ExpressionObj` object.

Parameters **exprObj** (*ExpressionObj*) – a `ExpressionObj` expression object with an expression string and mappings for the parameter labels in that object.

`EvalExpression``()`
Evaluate an expression. Note that the expression and mapping are taken from the `ExpressionObj` expression object and the parameter values were specified in `SetupCalc()`. :returns: a single value for the expression. If parameter values are arrays (for example, from wild-carded variable names), the sum of the resulting expression is returned.

For example, if the expression is `'A*B'`, where A is 2.0 and B maps to `'1::Afrac:*'`, which evaluates to:

```
[0.5, 1, 0.5]
```

then the result will be `4.0`.

`SetupCalc``(`*parmDict*`)`
Do all preparations to use the expression for computation. Adds the free parameter values to the parameter dict (parmDict).

`UpdateDict``(`*parmDict*`)`
Update the dict for the expression with values in a dict :param list parmDict: a dict of values some of which may be in use here

`UpdateVars``(`*varList*, *valList*`)`
Update the dict for the expression with a set of values :param list varList: a list of variable names :param list valList: a list of corresponding values

compiledExpr = None
The expression as compiled byte-code

eObj = None
The expression and mappings; a `ExpressionObj` object

exprDict = None
dict that defines values for labels used in expression and packages referenced by functions

fxnpkgdict = None
a dict with references to packages needed to find functions referenced in the expression.

lblLookup = None
Lookup table that specifies the expression label name that is tied to a particular GSAS-II parameters in the parmDict.

varLookup = None
Lookup table that specifies the GSAS-II variable(s) indexed by the expression label name. (Used for only for diagnostics not evaluation of expression.)

class GSASIIobj.**ExpressionObj**
Defines an object with a user-defined expression, to be used for secondary fits or restraints. Object is created null, but is changed using `LoadExpression()`. This contains only the minimum information that needs to be stored to save and load the expression and how it is mapped to GSAS-II variables.

CheckVars()
Check that the expression can be parsed, all functions are defined and that input loaded into the object is internally consistent. If not an Exception is raised.

Returns a dict with references to packages needed to find functions referenced in the expression.

EditExpression(*exprVarLst*, *varSelect*, *varName*, *varValue*, *varRefflag*)
Load the expression and associated settings from the object into arrays used for editing.

Parameters

- **exprVarLst** (*list*) – parameter labels found in the expression
- **varSelect** (*dict*) – this will be 0 for Free parameters and non-zero for expression labels linked to G2 variables.
- **varName** (*dict*) – Defines a name (str) associated with each free parameter
- **varValue** (*dict*) – Defines a value (float) associated with each free parameter
- **varRefflag** (*dict*) – Defines a refinement flag (bool) associated with each free parameter

Returns the expression as a str

GetDepVar()
return the dependent variable, or None

GetIndependentVars()
Returns the names of the required independent parameters used in expression

GetVaried()
Returns the names of the free parameters that will be refined

GetVariedVarVal()
Returns the names and values of the free parameters that will be refined

LoadExpression(*expr*, *exprVarLst*, *varSelect*, *varName*, *varValue*, *varRefflag*)
Load the expression and associated settings into the object. Raises an exception if the expression is not parsed, if not all functions are defined or if not all needed parameter labels in the expression are defined.

This will not test if the variable referenced in these definitions are actually in the parameter dictionary. This is checked when the computation for the expression is done in `SetupCalc()`.

Parameters

- **expr** (*str*) – the expression
- **exprVarLst** (*list*) – parameter labels found in the expression
- **varSelect** (*dict*) – this will be 0 for Free parameters and non-zero for expression labels linked to G2 variables.
- **varName** (*dict*) – Defines a name (str) associated with each free parameter
- **varValue** (*dict*) – Defines a value (float) associated with each free parameter
- **varRefflag** (*dict*) – Defines a refinement flag (bool) associated with each free parameter

`ParseExpression`(*expr*)

Parse an expression and return a dict of called functions and the variables used in the expression. Returns None in case an error is encountered. If packages are referenced in functions, they are loaded and the functions are looked up into the modules global workspace.

Note that no changes are made to the object other than saving an error message, so that this can be used for testing prior to the save.

Returns a list of used variables

`SetDepVar`(*var*)

Set the dependent variable, if used

`UpdateVariedVars`(*varyList*, *values*)

Updates values for the free parameters (after a refinement); only updates refined vars

`assgnVars` **= None**

A dict where keys are label names in the expression mapping to a GSAS-II variable. The value a G2 variable name. Note that the G2 variable name may contain a wild-card and correspond to multiple values.

`expression` **= None**

The expression as a text string

`freeVars` **= None**

A dict where keys are label names in the expression mapping to a free parameter. The value is a list with:

- a name assigned to the parameter
- a value for to the parameter and
- a flag to determine if the variable is refined.

`lastError` **= None**

Shows last encountered error in processing expression (list of 1-3 str values)

class `GSASIIobj.`**`G2VarObj`**(**args*)

Defines a GSAS-II variable either using the phase/atom/histogram unique Id numbers or using a character string that specifies variables by phase/atom/histogram number (which can change). Note that `LoadID()` should be used to (re)load the current Ids before creating or later using the G2VarObj object.

This can store rigid body variables, but does not translate the residue # and body # to/from random Ids

A `G2VarObj` object can be created with a single parameter:

Parameters **varname** (*str/tuple*) –

a single value can be used to create a `G2VarObj` object. If a string, it must be of form "p:h:var" or "p:h:var:a", where

- p is the phase number (which may be left blank or may be '*' to indicate all phases);
- h is the histogram number (which may be left blank or may be '*' to indicate all histograms);
- a is the atom number (which may be left blank in which case the third colon is omitted). The atom number can be specified as '*' if a phase number is specified (not as '*'). For rigid body variables, specify a will be a string of form "residue:body#"

  Alternately a single tuple of form (Phase,Histogram,VarName,AtomID) can be used, where Phase, Histogram, and AtomID are None or are ranId values (or one can be '*') and VarName is a string. Note that if Phase is '*' then the AtomID is an atom number. For a rigid body variables, AtomID is a string of form "residue:body#".

If four positional arguments are supplied, they are:

Parameters

- **phasenum** (*str/int*) – The number for the phase (or None or '*')
- **histnum** (*str/int*) – The number for the histogram (or None or '*')
- **varname** (*str*) – a single value can be used to create a `G2VarObj`
- **atomnum** (*str/int*) – The number for the atom (or None or '*')

`varname``()`

Formats the GSAS-II variable name as a "traditional" GSAS-II variable string (p:h:<var>:a) or (p:h:<var>)

Returns the variable name as a str

`GSASIIobj.`**`GenWildCard`**`(`*varlist*`)`

Generate wildcard versions of G2 variables. These introduce '*' for a phase, histogram or atom number (but only for one of these fields) but only when there is more than one matching variable in the input variable list. So if the input is this:

```
varlist = ['0::AUiso:0', '0::AUiso:1', '1::AUiso:0']
```

then the output will be this:

```
wildList = ['*::AUiso:0', '0::AUiso:*']
```

Parameters **varlist** (*list*) – an input list of GSAS-II variable names (such as 0::AUiso:0)

Returns wildList, the generated list of wild card variable names.

`GSASIIobj.`**`HistIdLookup`** **= {}**

dict listing histogram name and random Id, keyed by sequential histogram index as a str; best to access this using `LookupHistName()`

`GSASIIobj.`**`HistRanIdLookup`** **= {}**

dict listing histogram sequential index keyed by histogram random Id; best to access this using `LookupHistId()`

`GSASIIobj.`**`IndexAllIds`**`(`*Histograms*, *Phases*`)`

Scan through the used phases & histograms and create an index to the random numbers of phases, histograms and atoms. While doing this, confirm that assigned random numbers are unique – just in case lightning strikes twice in the same place.

Note: this code assumes that the atom random Id (ranId) is the last element each atom record.

This is called in three places (only): `GSASIIstrIO.GetUsedHistogramsAndPhases()` (which loads the histograms and phases from a GPX file), `GetUsedHistogramsAndPhasesfromTree()` (which loads the histograms and phases from the data tree.) and `GSASIIconstrGUI.UpdateConstraints()` (which displays & edits the constraints in a GUI)

TODO: do we need a lookup for rigid body variables?

`GSASIIobj.`**`LookupAtomId`**`(`*pId*, *ranId*`)`
Get the atom number from a phase and atom random Id

Parameters

- **pId** (*int/str*) – the sequential number of the phase
- **ranId** (*int*) – the random Id assigned to an atom

Returns the index number of the atom (str)

`GSASIIobj.`**`LookupAtomLabel`**`(`*pId*, *index*`)`
Get the atom label from a phase and atom index number

Parameters

- **pId** (*int/str*) – the sequential number of the phase
- **index** (*int*) – the index of the atom in the list of atoms

Returns the label for the atom (str) and the random Id of the atom (int)

`GSASIIobj.`**`LookupHistId`**`(`*ranId*`)`
Get the histogram number and name from a histogram random Id

Parameters **ranId** (*int*) – the random Id assigned to a histogram

Returns the sequential Id (hId) number for the histogram (str)

`GSASIIobj.`**`LookupHistName`**`(`*hId*`)`
Get the histogram number and name from a histogram Id

Parameters **hId** (*int/str*) – the sequential assigned to a histogram

Returns (hist,ranId) where hist is the name of the histogram (str) and ranId is the random # id for the histogram (int)

`GSASIIobj.`**`LookupPhaseId`**`(`*ranId*`)`
Get the phase number and name from a phase random Id

Parameters **ranId** (*int*) – the random Id assigned to a phase

Returns the sequential Id (pId) number for the phase (str)

`GSASIIobj.`**`LookupPhaseName`**`(`*pId*`)`
Get the phase number and name from a phase Id

Parameters **pId** (*int/str*) – the sequential assigned to a phase

Returns (phase,ranId) where phase is the name of the phase (str) and ranId is the random # id for the phase (int)

`GSASIIobj.`**`LookupWildCard`**`(`*varname*, *varlist*`)`
returns a list of variable names from list varname that match wildcard name in varname

Parameters

- **varname** (*str*) – a G2 variable name containing a wildcard (such as *::var)
- **varlist** (*list*) – the list of all variable names used in the current project

Returns a list of matching GSAS-II variables (may be empty)

`GSASIIobj.`**`MakeUniqueLabel`**`(`*lbl*, *labellist*`)`
Make sure that every a label is unique against a list by adding digits at the end until it is not found in list.

Parameters

- **lbl** (*str*) – the input label
- **labellist** (*list*) – the labels that have already been encountered

Returns lbl if not found in labellist or lbl with `_1-9` (or `_10-99`, etc.) appended at the end

`GSASIIobj.`**`PhaseIdLookup`** **= {}**
dict listing phase name and random Id keyed by sequential phase index as a str; best to access this using `LookupPhaseName()`

`GSASIIobj.`**`PhaseRanIdLookup`** **= {}**
dict listing phase sequential index keyed by phase random Id; best to access this using `LookupPhaseId()`

`GSASIIobj.`**`ShortHistNames`** **= {}**
a dict containing a possibly shortened and when non-unique numbered version of the histogram name. Keyed by the histogram sequential index.

`GSASIIobj.`**`ShortPhaseNames`** **= {}**
a dict containing a possibly shortened and when non-unique numbered version of the phase name. Keyed by the phase sequential index.

`GSASIIobj.`**`VarDesc`** **= {}**
This dictionary lists descriptions for GSAS-II variables, as set in `CompileVarDesc()`. See that function for a description for how keys and values are written.

`GSASIIobj.`**`VarDescr`**`(`*varname*`)`
Return two strings with a more complete description for a GSAS-II variable

Parameters **name** (*str*) – A full G2 variable name with 2 or 3 or 4 colons (<p>:<h>:name[:<a>] or <p>::RBname:<r>:<t>])

Returns (loc,meaning) where loc describes what item the variable is mapped (phase, histogram, etc.) and meaning describes what the variable does.

`GSASIIobj.`**`fmtVarDescr`**`(`*varname*`)`
Return a string with a more complete description for a GSAS-II variable

Parameters **varname** (*str*) – A full G2 variable name with 2 or 3 or 4 colons (<p>:<h>:name[:<a>] or <p>::RBname:<r>:<t>])

Returns a string with the description

`GSASIIobj.`**`getDescr`**`(`*name*`)`
Return a short description for a GSAS-II variable

Parameters **name** (*str*) – The descriptive part of the variable name without colons (:)

Returns a short description or None if not found

`GSASIIobj.`**`getVarDescr`**`(`*varname*`)`
Return a short description for a GSAS-II variable

Parameters **name** (*str*) – A full G2 variable name with 2 or 3 or 4 colons (<p>:<h>:name[:<a1>][:<a2>])

Returns a six element list as [*p*,‘h‘,‘name‘,‘a1‘,‘a2‘,‘description‘], where *p*, *h*, *a1*, *a2* are str values or *None*, for the phase number, the histogram number and the atom number; *name* will always be a str; and *description* is str or *None*. If the variable name is incorrectly formed (for example, wrong number of colons), *None* is returned instead of a list.

`GSASIIobj.`**`reVarDesc`** **= {}**

This dictionary lists descriptions for GSAS-II variables with the same values as `VarDesc` except that keys have been compiled as regular expressions. Initialized in `CompileVarDesc()`.

CHAPTER

THREE

GSAS-II UTILITY MODULES

3.1 *GSASIIdata: Data for computations*

At present this module defines one dict, `ramachandranDist`, which contains arrays for All and specific amino acids

3.2 *GSASIIpath: locations & updates*

Routines for dealing with file locations, etc.

Determines the location of the compiled (.pyd or .so) libraries.

Interfaces with subversion (svn): Determine the subversion release number by determining the highest version number where `SetVersionNumber()` is called (best done in every GSASII file). Other routines will update GSASII from the subversion server if svn can be found.

Accesses configuration options, as defined in config.py

`GSASIIpath.`**`DoNothing`**`()`

A routine that does nothing. This is called in place of IPyBreak and pdbBreak except when the debug option is set True in config.py

`GSASIIpath.`**`GetConfigValue`**`(`*key*, *default=None*`)`

Return the configuration file value for key or a default value if not present

Parameters

- **key** (*str*) – a value to be found in the configuration (config.py) file
- **default** – a value to be supplied is none is in the config file or the config file is not found. Defaults to None

Returns the value found or the default.

`GSASIIpath.`**`GetVersionNumber`**`()`

Return the maximum version number seen in `SetVersionNumber()`

`GSASIIpath.`**`IPyBreak`**`()`

A routine that does nothing. This is called in place of IPyBreak and pdbBreak except when the debug option is set True in config.py

`GSASIIpath.`**`IPyBreak_base`**`()`

A routine that invokes an IPython session at the calling location This routine is only used when debug=True is set in config.py

`GSASIIpath.`**`InvokeDebugOpts`**`()`
Called in GSASII.py to set up debug options

`GSASIIpath.`**`LoadConfigFile`**`(`*filename*`)`
Read a GSAS-II configuration file. Comments (starting with "%") are removed, as are empty lines

Parameters **filename** (*str*) – base file name (such as 'file.dat'). Files with this name are located from the path and the contents of each are concatenated.

Returns a list containing each non-empty (after removal of comments) line found in every matching config file.

`GSASIIpath.`**`SetVersionNumber`**`(`*RevString*`)`
Set the subversion version number

Parameters **RevString** (*str*) – something like "$Revision: 1729 $" that is set by subversion when the file is retrieved from subversion.

Place `GSASIIpath.SetVersionNumber("$Revision: 1729 $")` in every python file.

`GSASIIpath.`**`exceptHook`**`(`**args*`)`
A routine to be called when an exception occurs. It prints the traceback with fancy formatting and then calls an IPython shell with the environment of the exception location.

This routine is only used when debug=True is set in config.py

`GSASIIpath.`**`pdbBreak`**`()`
A routine that does nothing. This is called in place of IPyBreak and pdbBreak except when the debug option is set True in config.py

`GSASIIpath.`**`svnFindLocalChanges`**`(`*fpath='/Users/toby/software/G2/GSASII'*`)`

Returns a list of files that were changed locally. If no files are changed, the list has length 0

Parameters **fpath** – path to repository dictionary, defaults to directory where the current file is located

Returns None if there is a subversion error (likely because the path is not a repository or svn is not found)

`GSASIIpath.`**`svnGetLog`**`(`*fpath='/Users/toby/software/G2/GSASII'*, *version=None*`)`
Get the revision log information for a specific version of the specified package

Parameters

- **fpath** (*str*) – path to repository dictionary, defaults to directory where the current file is located.
- **version** (*int*) – the version number to be looked up or None (default) for the latest version.

Returns a dictionary with keys (one hopes) 'author', 'date', 'msg', and 'revision'

`GSASIIpath.`**`svnGetRev`**`(`*fpath='/Users/toby/software/G2/GSASII'*, *local=True*`)`
Obtain the version number for the either the last update of the local version or contacts the subversion server to get the latest update version (# of Head).

Parameters

- **fpath** (*str*) – path to repository dictionary, defaults to directory where the current file is located
- **local** (*bool*) – determines the type of version number, where True (default): returns the latest installed update False: returns the version number of Head on the server

Returns the version number as an str or None if there is a subversion error (likely because the path is not a repository or svn is not found)

`GSASIIpath.`**`svnInstallDir`**`(`*URL*, *loadpath*`)`

Load a subversion tree into a specified directory

Parameters

- **rpath** (*str*) – path to locate files, relative to the GSAS-II installation path (defaults to path2GSAS2)
- **URL** (*str*) – the repository URL

`GSASIIpath.`**`svnSwitchDir`**`(`*rpath*, *filename*, *baseURL*, *loadpath=None*`)`

This performs a switch command to move files between subversion trees.

This is currently used for moving tutorial web pages and demo files into the GSAS-II source tree. Note that if the files were previously downloaded the switch command will update the files to the newest version.

Parameters

- **rpath** (*str*) – path to locate files, relative to the GSAS-II installation path (defaults to path2GSAS2)
- **URL** (*str*) – the repository URL
- **loadpath** (*str*) – the prefix for the path, if specified. Defaults to path2GSAS2

`GSASIIpath.`**`svnUpdateDir`**`(`*fpath='/Users/toby/software/G2/GSASII'*, *version=None*`)`

This performs an update of the files in a local directory from a server.

Parameters

- **fpath** (*str*) – path to repository dictionary, defaults to directory where the current file is located
- **version** – the number of the version to be loaded. Used only cast as a string, but should be an integer or something that corresponds to a string representation of an integer value when cast. A value of None (default) causes the latest version on the server to be used.

`GSASIIpath.`**`svnUpdateProcess`**`(`*version=None*, *projectfile=None*`)`

perform an update of GSAS-II in a separate python process

`GSASIIpath.`**`svnUpgrade`**`(`*fpath='/Users/toby/software/G2/GSASII'*`)`

This reformats subversion files, which may be needed if an upgrade of subversion is done.

Parameters **fpath** (*str*) – path to repository dictionary, defaults to directory where the current file is located

`GSASIIpath.`**`svnVersion`**`()`

Get the version number of the current subversion executable

Returns a string with a version number such as “1.6.6” or None if subversion is not found.

`GSASIIpath.`**`svnVersionNumber`**`()`

Get the version number of the current subversion executable

Returns a fractional version number such as 1.6 or None if subversion is not found.

`GSASIIpath.`**`whichsvn`**`()`

Returns a path to the subversion exe file, if any is found. Searches the current path as well as subdirectory “svn” and “svn/bin” in the location of the GSASII source files.

Returns None if svn is not found or an absolute path to the subversion executable file.

3.3 *GSASIIlog: Logging of "Actions"*

Module to provide logging services, e.g. track and replay "actions" such as menu item, tree item, button press, value change and so on.

`GSASIIlog.`**`ButtonBindingLookup`** **= {}**

Lookup table for button objects

class `GSASIIlog.`**`ButtonLogEntry`**`(`*locationcode*, *label*`)`

Object to track button press

`GSASIIlog.`**`G2logList`** **= [None]**

Contains a list of logged actions; first item is ignored

`GSASIIlog.`**`InvokeMenuCommand`**`(`*id*, *G2frame*, *event*`)`

Called when a menu item is used to log the action as well as call the routine "bind"ed to that menu item

class `GSASIIlog.`**`LogEntry`**

Base class to define logging objects. These store information on events in a manner that can be pickled and saved – direct references to wx objects is not allowed.

Each object must define:

- __init__: stores the information needed to log & later recreate the action
- __str__ : shows a nice ASCII string for each action
- Replay: recreates the action when the log is played

optional:

- Repaint: redisplays the current window

`GSASIIlog.`**`LogInfo`** **= {'Tree': None, 'Logging': False, 'LastPaintAction': None}**

Contains values that are needed in the module for past actions & object location

`GSASIIlog.`**`LogOff`**`()`

Turn Off logging of actions

`GSASIIlog.`**`LogOn`**`()`

Turn On logging of actions

`GSASIIlog.`**`LogVarChange`**`(`*result*, *key*`)`

Called when a variable is changed to log that action

`GSASIIlog.`**`MakeButtonLog`**`(`*locationcode*, *label*`)`

Create a ButtonLogEntry action log

`GSASIIlog.`**`MakeTabLog`**`(`*title*, *tabname*`)`

Create a TabLogEntry action log

`GSASIIlog.`**`MakeTreeLog`**`(`*textlist*`)`

Create a TreeLogEntry action log

`GSASIIlog.`**`MenuBindingLookup`** **= {}**

Lookup table for Menu buttons

class `GSASIIlog.`**`MenuLogEntry`**`(`*menulabellist*`)`

object that tracks when a menu command is executed

`Replay``()`

Perform a Menu item action when read from the log

`GSASIIlog.`**`OnReplayPress`**`(`*event*`)`
execute one or more commands when the replay button is pressed

`GSASIIlog.`**`ReplayLog`**`(`*event*`)`
replay the logged actions

`GSASIIlog.`**`SaveMenuCommand`**`(`*id*, *G2frame*, *handler*`)`
Creates a table of menu items and their pseudo-bindings

`GSASIIlog.`**`ShowLogStatus`**`()`
Return the logging status

class `GSASIIlog.`**`TabLogEntry`**`(`*title*, *tabname*`)`
Object to track when tabs are pressed in the DataFrame window

`Repaint``()`
Used to redraw a window created in response to a Tab press

`Replay``()`
Perform a Tab press action when read from the log

class `GSASIIlog.`**`TreeLogEntry`**`(`*itemlist*`)`
Object to track when tree items are pressed in the main window

`Repaint``()`
Used to redraw a window created in response to a click on a data tree item

`Replay``()`
Perform a Tree press action when read from the log

class `GSASIIlog.`**`VarLogEntry`**`(`*treeRefs*, *indexRefs*, *value*`)`
object that tracks changes to a variable

`Replay``()`
Perform a Variable Change action, when read from the log

class `GSASIIlog.`**`dictLogged`**`(`*obj*, *treeRefs*, *indexRefs=[ ]*`)`
A version of a dict object that tracks the source of the object back to the location on the G2 tree. If a list (tuple) or dict are pulled from inside this object the source information is appended to the provinance tracking lists.

tuples are converted to lists.

class `GSASIIlog.`**`listLogged`**`(`*obj*, *treeRefs*, *indexRefs=[ ]*`)`
A version of a list object that tracks the source of the object back to the location on the G2 tree. If a list (tuple) or dict are pulled from inside this object the source information is appended to the provinance tracking lists.

tuples are converted to lists.

3.4 *config.py: Configuration options*

This file contains optional configuration options for GSAS-II. Note that this file is not required to be present and code should be written to provide the default behavior if the file is not present or if any configuration variable is not set, but please do place a docstring here for every used config variable explaining what it does. Access these variables using `GSASIIpath.GetConfigValue()`.

`config_example.`**`Enable_logging`** **= False**
Set to True to enable use of command logging

`config_example.`**`Help_mode`** **= None**
Set to “internal” to use a Python-based web viewer rather than a web browser

config_example.**Import_directory** = **None**

Specifies a default location for starting GSAS-II

config_example.**Starting_directory** = **None**

Specifies a default location for starting GSAS-II

config_example.**Tutorial_location** = **None**

Change this to place tutorials by in a different spot. If None, this defaults to ~/My Documents/G2tutorials (on windows) or ~/G2tutorials. If you want to use a different location (such as to use the GSASII installation directory), this can be set here. As an example, to always use ~/G2tutorials do this:

```
import os.path
Tutorial_location = os.path.join(os.path.expanduser('~'),'G2tutorials')
```

To install into the location where GSAS-II is installed, use this:

```
import GSASIIpath
Tutorial_location = GSASIIpath.path2GSAS2
```

config_example.**debug** = **False**

Set to True to turn on debugging mode. This enables use of IPython on exceptions and on calls to `GSASIIpath.IPyBreak()`. Calls to `GSASIIpath.pdbBreak()` will invoke pdb at that location. If debug is false calls to `GSASIIpath.IPyBreak()` and `GSASIIpath.pdbBreak()` are ignored.

config_example.**logging_debug** = **False**

Set to True to enable debug for logging

config_example.**wxInspector** = **None**

If set to True, the wxInspector widget is displayed

3.5 *GSASIIElem: functions for element types*

GSASIIElem.**CheckElement**(*El*)

Check if element El is in the periodic table

Parameters **El** (*str*) – One or two letter element symbol, capitaliztion ignored

Returns True if the element is found

GSASIIElem.**ComptonFac**(*El*, *SQ*)

compute Compton scattering factor

Parameters

- **El** – element dictionary
- **SQ** – (sin-theta/lambda)**2

Returns compton scattering factor

GSASIIElem.**FPcalc**(*Orbs*, *KEv*)

Compute real & imaginary resonant X-ray scattering factors

Parameters

- **Orbs** – list of orbital dictionaries as defined in GetXsectionCoeff
- **KEv** – x-ray energy in keV

Returns C: (f',f",mu): real, imaginary parts of resonant scattering & atomic absorption coeff.

`GSASIIElem.`**`FixValence`**`(`*El*`)`

Returns the element symbol, even when a valence is present

`GSASIIElem.`**`GetAtomInfo`**`(`*El*`)`

reads element information from atmdata.py

`GSASIIElem.`**`GetBLtable`**`(`*General*`)`

returns a dictionary of neutron scattering length data for atom types & isotopes found in General

Parameters **General** (*dict*) – dictionary of phase info.; includes AtomTypes & Isotopes

Returns BLtable, dictionary of scattering length data; key is atom type

`GSASIIElem.`**`GetFFC5`**`(`*ElSym*`)`

Get 5 term form factor and Compton scattering data

Parameters **ElSym** – str(1-2 character element symbol with proper case);

Return El dictionary with 5 term form factor & compton coefficients

`GSASIIElem.`**`GetFFtable`**`(`*atomTypes*`)`

returns a dictionary of form factor data for atom types found in atomTypes

Parameters **atomTypes** (*list*) – list of atom types

Returns FFtable, dictionary of form factor data; key is atom type

`GSASIIElem.`**`GetFormFactorCoeff`**`(`*El*`)`

Read X-ray form factor coefficients from *atomdata.py* file

Parameters **El** (*str*) – element 1-2 character symbol, case irrevelant

Returns *FormFactors*: list of form factor dictionaries

Each X-ray form factor dictionary is:

- *Symbol*: 4 character element symbol with valence (e.g. 'NI+2')
- *Z*: atomic number
- *fa*: 4 A coefficients
- *fb*: 4 B coefficients
- *fc*: C coefficient

`GSASIIElem.`**`GetMagFormFacCoeff`**`(`*El*`)`

Read magnetic form factor data from atomdata.asc file

Parameters **El** – 2 character element symbol

Returns MagFormFactors: list of all magnetic form factors dictionaries for element El.

each dictionary contains:

- 'Symbol':Symbol
- 'Z':Z
- 'mfa': 4 MA coefficients
- 'nfa': 4 NA coefficients
- 'mfb': 4 MB coefficients
- 'nfb': 4 NB coefficients
- 'mfc': MC coefficient

- 'nfc': NC coefficient

GSASIIElem.**GetXsectionCoeff**(*El*)

Read atom orbital scattering cross sections for fprime calculations via Cromer-Lieberman algorithm

Parameters **El** – 2 character element symbol

Returns Orbs: list of orbitals each a dictionary with detailed orbital information used by FPcalc

each dictionary is:

- 'OrbName': Orbital name read from file
- 'IfBe' 0/2 depending on orbital
- 'BindEn': binding energy
- 'BB': BindEn/0.02721
- 'XSectIP': 5 cross section inflection points
- 'ElEterm': energy correction term
- 'SEdge': absorption edge for orbital
- 'Nval': 10/11 depending on IfBe
- 'LEner': 10/11 values of log(energy)
- 'LXSect': 10/11 values of log(cross section)

GSASIIElem.**ScatFac**(*El*, *SQ*)

compute value of form factor

Parameters

- **El** – element dictionary defined in GetFormFactorCoeff
- **SQ** – (sin-theta/lambda)**2

Returns real part of form factor

GSASIIElem.**getBLvalues**(*BLtables*, *ifList=False*)

Needs a doc string

GSASIIElem.**getFFvalues**(*FFtables*, *SQ*, *ifList=False*)

Needs a doc string

3.6 *GSASIIlattice: Unit cells*

Perform lattice-related computations

Note that g is the reciprocal lattice tensor, and G is its inverse, $G = g^{-1}$, where

$$G = \begin{pmatrix} a^2 & ab\cos\gamma & ac\cos\beta \\ ab\cos\gamma & b^2 & bc\cos\alpha \\ ac\cos\beta & bc\cos\alpha & c^2 \end{pmatrix}$$

The "A tensor" terms are defined as $A = (G_{11} \quad G_{22} \quad G_{33} \quad 2G_{12} \quad 2G_{13} \quad 2G_{23})$ and A can be used in this fashion: $d^* = \sqrt{A_1h^2 + A_2k^2 + A_3l^2 + A_4hk + A_5hl + A_6kl}$, where d is the d-spacing, and d^* is the reciprocal lattice spacing, $Q = 2\pi d^* = 2\pi/d$

`GSASIIlattice.`**`A2Gmat`**`(`*A*, *inverse=True*`)`

Fill real & reciprocal metric tensor (G) from A.

Parameters

- **A** – reciprocal metric tensor elements as [G11,G22,G33,2*G12,2*G13,2*G23]
- **inverse** (*bool*) – if True return both G and g; else just G

Returns reciprocal (G) & real (g) metric tensors (list of two numpy 3x3 arrays)

`GSASIIlattice.`**`A2cell`**`(`*A*`)`

Compute unit cell constants from A

Parameters **A** – [G11,G22,G33,2*G12,2*G13,2*G23] G - reciprocal metric tensor

Returns a,b,c,alpha, beta, gamma (degrees) - lattice parameters

`GSASIIlattice.`**`A2invcell`**`(`*A*`)`

Compute reciprocal unit cell constants from A returns tuple with a*,b*,c*,alpha*, beta*, gamma* (degrees)

`GSASIIlattice.`**`CellAbsorption`**`(`*ElList*, *Volume*`)`

Compute unit cell absorption

Parameters

- **ElList** (*dict*) – dictionary of element contents including mu and number of atoms be cell
- **Volume** (*float*) – unit cell volume

Returns mu-total/Volume

`GSASIIlattice.`**`CellBlock`**`(`*nCells*`)`

Generate block of unit cells n*n*n on a side; [0,0,0] centered, n = 2*nCells+1 currently only works for nCells = 0 or 1 (not >1)

`GSASIIlattice.`**`CentCheck`**`(`*Cent*, *H*`)`

needs doc string

`GSASIIlattice.`**`CosAngle`**`(`*U*, *V*, *G*`)`

calculate cos of angle between U & V in generalized coordinates defined by metric tensor G

Parameters

- **U** – 3-vectors assume numpy arrays, can be multiple reflections as (N,3) array
- **V** – 3-vectors assume numpy arrays, only as (3) vector
- **G** – metric tensor for U & V defined space assume numpy array

Returns cos(phi)

`GSASIIlattice.`**`CosSinAngle`**`(`*U*, *V*, *G*`)`

calculate sin & cos of angle between U & V in generalized coordinates defined by metric tensor G

Parameters

- **U** – 3-vectors assume numpy arrays
- **V** – 3-vectors assume numpy arrays
- **G** – metric tensor for U & V defined space assume numpy array

Returns cos(phi) & sin(phi)

`GSASIIlattice.`**`CrsAng`**`(`*H*, *cell*, *SGData*`)`

needs doc string

GSASIIlattice.**Dsp2pos**(*Inst*, *dsp*)
convert d-spacing to powder pattern position (2-theta or TOF, musec)

GSASIIlattice.**Flnh**(*Start*, *SHCoef*, *phi*, *beta*, *SGData*)
needs doc string

GSASIIlattice.**GenHBravais**(*dmin*, *Bravais*, *A*)
Generate the positionally unique powder diffraction reflections

Parameters

- **dmin** – minimum d-spacing in A
- **Bravais** – lattice type (see GetBraviasNum). Bravais is one of:: 0 F cubic 1 I cubic 2 P cubic 3 R hexagonal (trigonal not rhombohedral) 4 P hexagonal 5 I tetragonal 6 P tetragonal 7 F orthorhombic 8 I orthorhombic 9 C orthorhombic 10 P orthorhombic 11 C monoclinic 12 P monoclinic 13 P triclinic
- **A** – reciprocal metric tensor elements as [G11,G22,G33,2*G12,2*G13,2*G23]

Returns HKL unique d list of [h,k,l,d,-1] sorted with largest d first

GSASIIlattice.**GenHLaue**(*dmin*, *SGData*, *A*)
Generate the crystallographically unique powder diffraction reflections for a lattice and Bravais type

Parameters

- **dmin** – minimum d-spacing
- **SGData** – space group dictionary with at least
  - 'SGLaue': Laue group symbol: one of '-1','2/m','mmm','4/m','6/m','4/mmm','6/mmm', '3m1', '31m', '3', '3R', '3mR', 'm3', 'm3m'
  - 'SGLatt': lattice centering: one of 'P','A','B','C','I','F'
  - 'SGUniq': code for unique monoclinic axis one of 'a','b','c' (only if 'SGLaue' is '2/m') otherwise an empty string
- **A** – reciprocal metric tensor elements as [G11,G22,G33,2*G12,2*G13,2*G23]

Returns HKL = list of [h,k,l,d] sorted with largest d first and is unique part of reciprocal space ignoring anomalous dispersion

GSASIIlattice.**GenPfHKLs**(*nMax*, *SGData*, *A*)
Generate the unique pole figure reflections for a lattice and Bravais type. Min d-spacing=1.0A & no more than nMax returned

Parameters

- **nMax** – maximum number of hkls returned
- **SGData** – space group dictionary with at least
  - 'SGLaue': Laue group symbol: one of '-1','2/m','mmm','4/m','6/m','4/mmm','6/mmm', '3m1', '31m', '3', '3R', '3mR', 'm3', 'm3m'
  - 'SGLatt': lattice centering: one of 'P','A','B','C','I','F'
  - 'SGUniq': code for unique monoclinic axis one of 'a','b','c' (only if 'SGLaue' is '2/m') otherwise an empty string
- **A** – reciprocal metric tensor elements as [G11,G22,G33,2*G12,2*G13,2*G23]

Returns HKL = list of 'h k l' strings sorted with largest d first; no duplicate zones

`GSASIIlattice.`**`GenSHCoeff`**(*SGLaue*, *SamSym*, *L*, *IfLMN=True*)
needs doc string

`GSASIIlattice.`**`GenSSHLaue`**(*dmin*, *SGData*, *SSGData*, *Vec*, *maxH*, *A*)
needs a doc string

`GSASIIlattice.`**`GetBraviasNum`**(*center*, *system*)
Determine the Bravais lattice number, as used in GenHBravais

Parameters

- **center** – one of: 'P', 'C', 'I', 'F', 'R' (see SGLatt from GSASIIspc.SpcGroup)
- **system** – one of 'cubic', 'hexagonal', 'tetragonal', 'orthorhombic', 'trigonal' (for R) 'monoclinic', 'triclinic' (see SGSys from GSASIIspc.SpcGroup)

Returns a number between 0 and 13 or throws a ValueError exception if the combination of center, system is not found (i.e. non-standard)

`GSASIIlattice.`**`GetKcl`**(*L*, *N*, *SGLaue*, *phi*, *beta*)
needs doc string

`GSASIIlattice.`**`GetKclKsl`**(*L*, *N*, *SGLaue*, *psi*, *phi*, *beta*)

This is used for spherical harmonics description of preferred orientation; cylindrical symmetry only (M=0) and no sample angle derivatives returned

`GSASIIlattice.`**`GetKsl`**(*L*, *M*, *SamSym*, *psi*, *gam*)
needs doc string

`GSASIIlattice.`**`Glnh`**(*Start*, *SHCoef*, *psi*, *gam*, *SamSym*)
needs doc string

`GSASIIlattice.`**`Gmat2A`**(*G*)
Extract A from reciprocal metric tensor (G)

Parameters G – reciprocal maetric tensor (3x3 numpy array

Returns A = [G11,G22,G33,2*G12,2*G13,2*G23]

`GSASIIlattice.`**`Gmat2AB`**(*G*)
Computes orthogonalization matrix from reciprocal metric tensor G

Returns

tuple of two 3x3 numpy arrays (A,B)

- A for crystal to Cartesian transformations A*x = np.inner(A,x) = X
- B (= inverse of A) for Cartesian to crystal transformation B*X = np.inner(B,X) = x

`GSASIIlattice.`**`Gmat2cell`**(*g*)
Compute real/reciprocal lattice parameters from real/reciprocal metric tensor (g/G) The math works the same either way.

Parameters (or G) (*g*) – real (or reciprocal) metric tensor 3x3 array

Returns a,b,c,alpha, beta, gamma (degrees) (or a*,b*,c*,alpha*,beta*,gamma* degrees)

`GSASIIlattice.`**`Hx2Rh`**(*Hx*)
needs doc string

`GSASIIlattice.`**`MaxIndex`**(*dmin*, *A*)
needs doc string

`GSASIIlattice.`**`OdfChk`**`(`*SGLaue*, *L*, *M*`)`
needs doc string

`GSASIIlattice.`**`Pos2dsp`**`(`*Inst*, *pos*`)`
convert powder pattern position (2-theta or TOF, musec) to d-spacing

`GSASIIlattice.`**`Rh2Hx`**`(`*Rh*`)`
needs doc string

`GSASIIlattice.`**`SamAng`**`(`*Tth*, *Gangls*, *Sangl*, *IFCoup*`)`
Compute sample orientation angles vs laboratory coord. system

Parameters

- **Tth** – Signed theta
- **Gangls** – Sample goniometer angles phi,chi,omega,azmuth
- **Sangl** – Sample angle zeros om-0, chi-0, phi-0
- **IFCoup** – True if omega & 2-theta coupled in CW scan

Returns psi,gam: Sample odf angles dPSdA,dGMdA: Angle zero derivatives

`GSASIIlattice.`**`SwapIndx`**`(`*Axis*, *H*`)`
needs doc string

`GSASIIlattice.`**`TOF2dsp`**`(`*Inst*, *Pos*`)`
convert powder pattern TOF, musec to d-spacing by successive approximation Pos can be numpy array

`GSASIIlattice.`**`U6toUij`**`(`*U6*`)`
Fill matrix (Uij) from U6 = [U11,U22,U33,U12,U13,U23] NB: there is a non numpy version in GSASIIspc: U2Uij

Parameters **U6** (*list*) – 6 terms of u11,u22,...

Returns Uij - numpy [3][3] array of uij

`GSASIIlattice.`**`Uij2Ueqv`**`(`*Uij*, *GS*, *Amat*`)`
returns 1/3 trace of diagonalized U matrix

`GSASIIlattice.`**`Uij2betaij`**`(`*Uij*, *G*`)`
Convert Uij to beta-ij tensors – stub for eventual completion

Parameters

- **Uij** – numpy array [Uij]
- **G** – reciprocal metric tensor

Returns beta-ij - numpy array [beta-ij]

`GSASIIlattice.`**`UijtoU6`**`(`*U*`)`
Fill vector [U11,U22,U33,U12,U13,U23] from Uij NB: there is a non numpy version in GSASIIspc: Uij2U

`GSASIIlattice.`**`calc_V`**`(`*A*`)`
Compute the real lattice volume (V) from A

`GSASIIlattice.`**`calc_rDsq`**`(`*H*, *A*`)`
needs doc string

`GSASIIlattice.`**`calc_rDsq2`**`(`*H*, *G*`)`
needs doc string

`GSASIIlattice.`**`calc_rDsqSS`**`(`*H*, *A*, *vec*`)`
needs doc string

`GSASIIlattice.`**`calc_rDsqT`**(*H*, *A*, *Z*, *tof*, *difC*)
needs doc string

`GSASIIlattice.`**`calc_rDsqTSS`**(*H*, *A*, *vec*, *Z*, *tof*, *difC*)
needs doc string

`GSASIIlattice.`**`calc_rDsqZ`**(*H*, *A*, *Z*, *tth*, *lam*)
needs doc string

`GSASIIlattice.`**`calc_rDsqZSS`**(*H*, *A*, *vec*, *Z*, *tth*, *lam*)
needs doc string

`GSASIIlattice.`**`calc_rV`**(*A*)
Compute the reciprocal lattice volume (V*) from A

`GSASIIlattice.`**`calc_rVsq`**(*A*)
Compute the square of the reciprocal lattice volume (1/V**2) from A'

`GSASIIlattice.`**`cell2A`**(*cell*)
Obtain A = [G11,G22,G33,2*G12,2*G13,2*G23] from lattice parameters

Parameters **cell** – [a,b,c,alpha,beta,gamma] (degrees)

Returns G reciprocal metric tensor as 3x3 numpy array

`GSASIIlattice.`**`cell2AB`**(*cell*)
Computes orthogonalization matrix from unit cell constants

Parameters **cell** (*tuple*) – a,b,c, alpha, beta, gamma (degrees)

Returns tuple of two 3x3 numpy arrays (A,B) A for crystal to Cartesian transformations A*x = np.inner(A,x) = X B (= inverse of A) for Cartesian to crystal transformation B*X = np.inner(B,X) = x

`GSASIIlattice.`**`cell2GS`**(*cell*)
returns Uij to betaij conversion matrix

`GSASIIlattice.`**`cell2Gmat`**(*cell*)
Compute real and reciprocal lattice metric tensor from unit cell constants

Parameters **cell** – tuple with a,b,c,alpha, beta, gamma (degrees)

Returns reciprocal (G) & real (g) metric tensors (list of two numpy 3x3 arrays)

`GSASIIlattice.`**`combinations`**(*items*, *n*)
take n distinct items, order matters

`GSASIIlattice.`**`criticalEllipse`**(*prob*)
Calculate critical values for probability ellipsoids from probability

`GSASIIlattice.`**`fillgmat`**(*cell*)
Compute lattice metric tensor from unit cell constants

Parameters **cell** – tuple with a,b,c,alpha, beta, gamma (degrees)

Returns 3x3 numpy array

`GSASIIlattice.`**`getHKLmax`**(*dmin*, *SGData*, *A*)
finds maximum allowed hkl for given A within dmin

`GSASIIlattice.`**`getPeakPos`**(*dataType*, *parmdict*, *dsp*)
convert d-spacing to powder pattern position (2-theta or TOF, musec)

`GSASIIlattice.`**`invcell2Gmat`**(*invcell*)

Compute real and reciprocal lattice metric tensor from reciprocal unit cell constants

Parameters **invcell** – [a*,b*,c*,alpha*, beta*, gamma*] (degrees)

Returns reciprocal (G) & real (g) metric tensors (list of two 3x3 arrays)

`GSASIIlattice.`**`invpolfcal`**(*ODFln*, *SGData*, *phi*, *beta*)

needs doc string

`GSASIIlattice.`**`permutations`**(*items*)

take all items, order matters

`GSASIIlattice.`**`polfcal`**(*ODFln*, *SamSym*, *psi*, *gam*)

Perform a pole figure computation. Note that the the number of gam values must either be 1 or must match psi. Updated for numpy 1.8.0

`GSASIIlattice.`**`rotdMat`**(*angle*, *axis=0*)

Prepare rotation matrix for angle in degrees about axis(=0,1,2)

Parameters

- **angle** – angle in degrees
- **axis** – axis (0,1,2 = x,y,z) about which for the rotation

Returns rotation matrix - 3x3 numpy array

`GSASIIlattice.`**`rotdMat4`**(*angle*, *axis=0*)

Prepare rotation matrix for angle in degrees about axis(=0,1,2) with scaling for OpenGL

Parameters

- **angle** – angle in degrees
- **axis** – axis (0,1,2 = x,y,z) about which for the rotation

Returns rotation matrix - 4x4 numpy array (last row/column for openGL scaling)

`GSASIIlattice.`**`sec2HMS`**(*sec*)

Convert time in sec to H:M:S string

Parameters **sec** – time in seconds

Returns H:M:S string (to nearest 100th second)

`GSASIIlattice.`**`selections`**(*items*, *n*)

take n (not necessarily distinct) items, order matters

`GSASIIlattice.`**`selftestlist`** **= [<function test0 at 0x10ba89ed8>, <function test1 at 0x10ba89f50>, <function test2 at 0x**

Defines a list of self-tests

`GSASIIlattice.`**`sortHKLd`**(*HKLd*, *ifreverse*, *ifdup*, *ifSS=False*)

needs doc string

Parameters

- **HKLd** – a list of [h,k,l,d,...];
- **ifreverse** – True for largest d first
- **ifdup** – True if duplicate d-spacings allowed

`GSASIIlattice.`**`test1`**()

test cell2A and A2Gmat

`GSASIIlattice.`**`test2`**()

test Gmat2A, A2cell, A2Gmat, Gmat2cell

`GSASIIlattice.`**`test3`**`()`
test invcell2Gmat

`GSASIIlattice.`**`test4`**`()`
test calc_rVsq, calc_rV, calc_V

`GSASIIlattice.`**`test5`**`()`
test A2invcell

`GSASIIlattice.`**`test6`**`()`
test cell2AB

`GSASIIlattice.`**`test7`**`()`
test GetBraviasNum(...) and GenHBravais(...)

`GSASIIlattice.`**`test8`**`()`
test GenHLaue

`GSASIIlattice.`**`test9`**`()`
test GenHLaue

`GSASIIlattice.`**`textureIndex`**`(`*SHCoef*`)`
needs doc string

`GSASIIlattice.`**`uniqueCombinations`**`(`*items*, *n*`)`
take n distinct items, order is irrelevant

3.7 *GSASIIspc: Space group module*

Space group interpretation routines. Note that space group information is stored in a *Space Group (SGData)* object.

`GSASIIspc.`**`AllOps`**`(`*SGData*`)`
Returns a list of all operators for a space group, including those for centering and a center of symmetry

Parameters SGData – from `SpcGroup()`

Returns

(SGTextList,offsetList,symOpList,G2oprList) where

- SGTextList: a list of strings with formatted and normalized symmetry operators.
- offsetList: a tuple of (dx,dy,dz) offsets that relate the GSAS-II symmetry operation to the operator in SGTextList and symOpList. these dx (etc.) values are added to the GSAS-II generated positions to provide the positions that are generated by the normalized symmetry operators.
- symOpList: a list of tuples with the normalized symmetry operations as (M,T) values (see `SGOps` in the *Space Group object*)
- G2oprList: The GSAS-II operations for each symmetry operation as a tuple with (center,mult,opnum), where center is (0,0,0), (0.5,0,0), (0.5,0.5,0.5),...; where mult is 1 or -1 for the center of symmetry and opnum is the number for the symmetry operation, in `SGOps` (starting with 0).

`GSASIIspc.`**`ApplyStringOps`**`(`*A*, *SGData*, *X*, *Uij=[]*`)`
Needs a doc string

`GSASIIspc.`**`ElemPosition`**`(`*SGData*`)`
Under development. Object here is to return a list of symmetry element types and locations suitable for say drawing them. So far I have the element type... getting all possible locations without lookup may be impossible!

GSASIIspc.**GenAtom**(*XYZ*, *SGData*, *All=False*, *Uij=[ ]*, *Move=True*)
Generates the equivalent positions for a specified coordinate and space group

Parameters

- **XYZ** – an array, tuple or list containing 3 elements: x, y & z
- **SGData** – from SpcGroup()
- **All** – True return all equivalent positions including duplicates; False return only unique positions
- **Uij** – [U11,U22,U33,U12,U13,U23] or [] if no Uij
- **Move** – True move generated atom positions to be inside cell False do not move atoms

Returns

[[XYZEquiv],Idup,[UijEquiv]]

- [XYZEquiv] is list of equivalent positions (XYZ is first entry)
- Idup = [-][C]SS where SS is the symmetry operator number (1-24), C (if not 0,0,0)
- is centering operator number (1-4) and - is for inversion Cell = unit cell translations needed to put new positions inside cell [UijEquiv] - equivalent Uij; absent if no Uij given

GSASIIspc.**GenHKLf**(*HKL*, *SGData*)
Uses old GSAS Fortran routine genhkl.for

Parameters

- **HKL** – [h,k,l] must be integral values for genhkl.for to work
- **SGData** – space group data obtained from SpcGroup

Returns

iabsnt,mulp,Uniq,phi

- iabsnt = True if reflection is forbidden by symmetry
- mulp = reflection multiplicity including Friedel pairs
- Uniq = numpy array of equivalent hkl in descending order of h,k,l
- phi = phase offset for each equivalent h,k,l

GSASIIspc.**GetCSuinel**(*siteSym*)
returns Uij terms, multipliers, GUI flags & Uiso2Uij multipliers

GSASIIspc.**GetCSxinel**(*siteSym*)
Needs a doc string

GSASIIspc.**GetKNsym**(*key*)
Needs a doc string

GSASIIspc.**GetNXUPQsym**(*siteSym*)
The codes XUPQ are for lookup of symmetry constraints for position(X), thermal parm(U) & magnetic moments (P&Q-not used in GSAS-II)

GSASIIspc.**GetOprPtrName**(*key*)
Needs a doc string

GSASIIspc.**HStrainNames**(*SGData*)
Needs a doc string

`GSASIIspc.`**`Latt2text`**`(`*Latt*`)`
From lattice type ('P',A', etc.) returns ';' delimited cell centering vectors

`GSASIIspc.`**`MT2text`**`(`*Opr*`)`
From space group matrix/translation operator returns text version

`GSASIIspc.`**`MoveToUnitCell`**`(`*xyz*`)`
Translates a set of coordinates so that all values are >=0 and < 1

Parameters **xyz** – a list or numpy array of fractional coordinates

Returns XYZ - numpy array of new coordinates now 0 or greater and less than 1

`GSASIIspc.`**`Muiso2Shkl`**`(`*muiso*, *SGData*, *cell*`)`
this is to convert isotropic mustrain to generalized Shkls

`GSASIIspc.`**`MustrainCoeff`**`(`*HKL*, *SGData*`)`
Needs a doc string

`GSASIIspc.`**`MustrainNames`**`(`*SGData*`)`
Needs a doc string

`GSASIIspc.`**`Opposite`**`(`*XYZ*, *toler=0.0002*`)`

Gives opposite corner, edge or face of unit cell for position within tolerance. Result may be just outside the cell within tolerance

Parameters

- **XYZ** – 0 >= np.array[x,y,z] > 1 as by MoveToUnitCell
- **toler** – unit cell fraction tolerance making opposite

Returns XYZ: array of opposite positions; always contains XYZ

`GSASIIspc.`**`SGErrors`**`(`*IErr*`)`
Interprets the error message code from SpcGroup. Used in SpaceGroup.

Parameters **IErr** – see SGError in `SpcGroup()`

Returns ErrString - a string with the error message or "Unknown error"

`GSASIIspc.`**`SGPrint`**`(`*SGData*`)`
Print the output of SpcGroup in a nicely formatted way. Used in SpaceGroup

Parameters **SGData** – from `SpcGroup()`

Returns SGText - list of strings with the space group details SGTable - list of strings for each of the operations

`GSASIIspc.`**`SGProd`**`(`*OpA*, *OpB*`)`

Form space group operator product. OpA & OpB are [M,V] pairs; both must be of same dimension (3 or 4). Returns [M,V] pair

`GSASIIspc.`**`SGPtGroup`**`(`*SGData*`)`
Determine point group of the space group - done after space group symbol has been evaluated by SpcGroup. Only short symbols are allowed

Parameters **SGData** – from :func SpcGroup

Returns SSGPtGrp & SSGKl (only defaults for Mono & Ortho)

`GSASIIspc.`**`SGpolar`**`(`*SGData*`)`
Determine identity of polar axes if any

GSASIIspc.**SSGModCheck**(*Vec*, *modSymb*)
Checks modulation vector compatibility with supersymmetry space group symbol. Superspace group symbol takes precidence & the vector will be modified accordingly

GSASIIspc.**SSGPrint**(*SGData*, *SSGData*)
Print the output of SSpcGroup in a nicely formatted way. Used in SSpaceGroup

Parameters

- **SGData** – space group data structure as defined in SpcGroup above.
- **SSGData** – from `SSpcGroup()`

Returns SSGText - list of strings with the superspace group details SGTable - list of strings for each of the operations

GSASIIspc.**SSLatt2text**(*SSGCen*)
Lattice centering vectors to text

GSASIIspc.**SSMT2text**(*Opr*)
From superspace group matrix/translation operator returns text version

GSASIIspc.**SSpaceGroup**(*SGSymbol*, *SSymbol*)
Print the output of SSpcGroup in a nicely formatted way.

Parameters

- **SGSymbol** – space group symbol with spaces between axial fields.
- **SSymbol** – superspace group symbol extension (string).

Returns nothing

GSASIIspc.**SSpcGroup**(*SGData*, *SSymbol*)
Determines supersymmetry information from superspace group name; currently only for (3+1) superlattices

Parameters

- **SGData** – space group data structure as defined in SpcGroup above (see *SGData*).
- **SSymbol** – superspace group symbol extension (string) defining modulation direction & generator info.

Returns

(SSGError,SSGData)

- SGError = 0 for no errors; >0 for errors (see SGErrors below for details)
- SSGData - is a dict (see *Superspace Group object*) with entries:
  - 'SSpGrp': superspace group symbol extension to space group symbol, accidental spaces removed
  - 'SSGCen': 4D cell centering vectors [0,0,0,0] at least
  - 'SSGOps': 4D symmetry operations as [M,T] so that M*x+T = x'

GSASIIspc.**SpaceGroup**(*SGSymbol*)
Print the output of SpcGroup in a nicely formatted way.

Parameters **SGSymbol** – space group symbol (string) with spaces between axial fields

Returns nothing

GSASIIspc.**SpcGroup**(*SGSymbol*)
Determines cell and symmetry information from a short H-M space group name

Parameters **SGSymbol** – space group symbol (string) with spaces between axial fields

Returns

(SGError,SGData)

- SGError = 0 for no errors; >0 for errors (see SGErrors below for details)
- SGData - is a dict (see *Space Group object*) with entries:
  - 'SpGrp': space group symbol, slightly cleaned up
  - 'SGLaue': one of '-1', '2/m', 'mmm', '4/m', '4/mmm', '3R', '3mR', '3', '3m1', '31m', '6/m', '6/mmm', 'm3', 'm3m'
  - 'SGInv': boolean; True if centrosymmetric, False if not
  - 'SGLatt': one of 'P', 'A', 'B', 'C', 'I', 'F', 'R'
  - 'SGUniq': one of 'a', 'b', 'c' if monoclinic, '' otherwise
  - 'SGCen': cell centering vectors [0,0,0] at least
  - 'SGOps': symmetry operations as [M,T] so that M*x+T = x'
  - 'SGSys': one of 'triclinic', 'monoclinic', 'orthorhombic', 'tetragonal', 'rhombohedral', 'trigonal', 'hexagonal', 'cubic'
  - 'SGPolax': one of ' ', 'x', 'y', 'x y', 'z', 'x z', 'y z', 'xyz', '111' for arbitrary axes
  - **'SGPtGrp': one of 32 point group symbols (with some permutations), which** is filled by SGPtGroup, is external (KE) part of supersymmetry point group
  - **'SSGKl': default internal (Kl) part of supersymmetry point group; modified** in supersymmetry stuff depending on chosen modulation vector for Mono & Ortho

GSASIIspc.**StandardizeSpcName**(*spcgroup*)

Accept a spacegroup name where spaces may have not been used in the names according to the GSAS convention (spaces between symmetry for each axis) and return the space group name as used in GSAS

GSASIIspc.**StringOpsProd**(*A*, *B*, *SGData*)

Find A*B where A & B are in strings '-' + '100*c+n' + '+ijk' where '-' indicates inversion, c(>0) is the cell centering operator, n is operator number from SgOps and ijk are unit cell translations (each may be <0). Should return resultant string - C. SGData - dictionary using entries:

- 'SGCen': cell centering vectors [0,0,0] at least
- 'SGOps': symmetry operations as [M,T] so that M*x+T = x'

GSASIIspc.**SytSym**(*XYZ*, *SGData*)

Generates the number of equivalent positions and a site symmetry code for a specified coordinate and space group

Parameters

- **XYZ** – an array, tuple or list containing 3 elements: x, y & z
- **SGData** – from SpcGroup

Returns a two element tuple:

- The 1st element is a code for the site symmetry (see GetKNsym)
- The 2nd element is the site multiplicity

GSASIIspc.**selftestlist = [<function test0 at 0x10baad758>, <function test1 at 0x10baad7d0>, <function test2 at 0x10ba**

Defines a list of self-tests

GSASIIspc.**spglist = {'P6/mmm': ('P 3', 'P 31', 'P 32', 'P -3', 'P 3 1 2', 'P 3 2 1', 'P 31 1 2', 'P 31 2 1', 'P 32 1 2', 'P 32 2 1'**

A dictionary of space groups as ordered and named in the pre-2002 International Tables Volume A, except that spaces are used following the GSAS convention to separate the different crystallographic directions. Note that the symmetry codes here will recognize many non-standard space group symbols with different settings. They are ordered by Laue group

GSASIIspc.**splitSSsym**(*SSymbol*)

Splits supersymmetry symbol into two lists of strings

GSASIIspc.**ssdict = {'F m 2 m': ['(0b0)', '(0b0)0ss', '(0b0)ss0', '(0b0)s0s', '(0b1)', '(0b1)s0s', '(0b1)0ss', '(1b0)', '(1b0)s0s',**

A dictionary of superspace group symbols allowed for each entry in spglist (except cubics). Monoclinics are all b-unique setting.

GSASIIspc.**test0**()

self-test #0: exercise MoveToUnitCell

GSASIIspc.**test1**()

self-test #1: SpcGroup against previous results

GSASIIspc.**test2**()

self-test #2: SpcGroup against cctbx (sgtbx) computations

GSASIIspc.**test3**()

self-test #3: exercise SytSym (includes GetOprPtrName, GenAtom, GetKNsym) for selected space groups against info in IT Volume A

3.8 *gltext: draw OpenGL text*

Routines that render text on OpenGL without use of GLUT.

Code written by Christian Brugger & Stefan Hacker and distributed under GNU General Public License.

class gltext.**Text**(*text='Text'*, *font=None*, *font_size=8*, *foreground=wx.Colour()*, *centered=False*)

A simple class for using System Fonts to display text in an OpenGL scene. The Text adds a global Cache of already created text elements to TextElement's base functionality so you can save some memory and increase speed

centered

Display the text centered

draw_text(*position=wx.Point(0, 0)*, *scale=1.0*, *rotation=0*)

position (wx.Point) - x/y Position to draw in scene scale (float) - Scale rotation (int) - Rotation in degree

Draws the text to the scene

font

Font of the object

font_size

Font size

foreground

Color/Overlay bitmap of the text

getTextElement()

Returns the text element bound to the Text class

getTexture()

Returns the texture of the bound TextElement

getTexture_size()
: Returns a texture size tuple

setCentered(*value*, *reinit=True*)
: value (bool) - New centered value reinit (bool) - Create a new texture

  Sets a new value for 'centered'

setFont(*value*, *reinit=True*)
: value (bool) - New Font reinit (bool) - Create a new texture

  Sets a new font

setFont_size(*value*, *reinit=True*)
: value (bool) - New font size reinit (bool) - Create a new texture

  Sets a new font size

setForeground(*value*, *reinit=True*)
: value (bool) - New centered value reinit (bool) - Create a new texture

  Sets a new value for 'centered'

setText(*value*, *reinit=True*)
: value (bool) - New Text reinit (bool) - Create a new texture

  Sets a new text

text
: Text of the object

text_element
: TextElement bound to this class

texture
: Texture of bound TextElement

texture_size
: Size of the used texture

class gltext.**TextElement**(*text=''*, *font=None*, *foreground=wx.Colour()*, *centered=False*)
: A simple class for using system Fonts to display text in an OpenGL scene

bind()
: Increase refcount

centered
: Is text centered

createTexture()
: Creates a texture from the settings saved in TextElement, to be able to use normal system fonts conviently a wx.MemoryDC is used to draw on a wx.Bitmap. As wxwidgets device contexts don't support alpha at all it is necessary to apply a little hack to preserve antialiasing without sticking to a fixed background color:

  We draw the bmp in b/w mode so we can use its data as a alpha channel for a solid color bitmap which after GL_ALPHA_TEST and GL_BLEND will show a nicely antialiased text on any surface.

  To access the raw pixel data the bmp gets converted to a wx.Image. Now we just have to merge our foreground color with the alpha data we just created and push it all into a OpenGL texture and we are DONE *inhalesdelpy*

  DRAWBACK of the whole conversion thing is a really long time for creating the texture. If you see any optimizations that could save time PLEASE CREATE A PATCH!!!

deleteTexture()
Deletes the OpenGL texture object

draw_text(*position=wx.Point(0, 0)*, *scale=1.0*, *rotation=0*)
position (wx.Point) - x/y Position to draw in scene scale (float) - Scale rotation (int) - Rotation in degree

Draws the text to the scene

font
Font of the object

foreground
Color of the text

isBound()
Return refcount

owner_cnt
Owner count

release()
Decrease refcount

text
Text of the object

texture
Used texture

texture_size
Size of the used texture

3.9 *ElementTable: Periodic Table Data*

Element table data for building periodic table with valences & JMOL colors. Need these in case we go back to this periodic table coloring scheme.

Defines list `ElTable` which contains all defined oxidation states for each element, the location in the table, an element name, a color, a size and a second color.

3.10 *FormFactors: Scattering Data*

Contains atomic scattering factors from "New Analytical Scattering Factor Functions for Free Atoms and Ions for Free Atoms and Ions", D. Waasmaier & A. Kirfel, *Acta Cryst.* **(1995).** A51, 416-413.

Also, tabulated coefficients for calculation of Compton Cross Section as a function of sin(theta)/lambda from "Analytic Approximations to Incoherently Scattered X-Ray Intensities", H. H. M. Balyuzi, *Acta Cryst.* **(1975).** A31, 600.

3.11 *ImageCalibrants: Calibration Standards*

GSASII powder calibrants as a dictionary `ImageCalibrants.Calibrants` with substances commonly used for powder calibrations for image data.

Each entry in `ImageCalibrants` consists of:

```
'key':([Bravais num,],[space group,],[(a,b,c,alpha,beta,gamma),],no. lines skipped,(dmin,pixLimit,cut
(The space group may be an empty string)
```

as an example:

```
'LaB6  SRM660a':([2,],['',][(4.1569162,4.1569162,4.1569162,90,90,90),],0,(1.0,10,10)),
```

or where "Bravais num" and "(a,b,...)" are repeated in the case of mixtures:

```
'LaB6 & CeO2':([2,0],['',''] [(4.1569,4.1569,4.1569,90,90,90),(5.4117,5.4117,5.4117,90,90,90)], 0,  (
```

To expand this list with locally needed additions, do not modify this file, because you may lose these changes during a software update. Instead duplicate the format of this file in a file named *UserCalibrants.py* and there define the material(s) you want:

```
Calibrants={
  'LaB6 skip 2 lines':([2,],['',],[(4.1569162,4.1569162,4.1569162,90,90,90),],2,(1.0,10,10)),
}
```

New key values will be added to the list of options. If a key is duplicated, the information in *UserCalibrants.py* will override the information in this file.

Note, some useful Bravais numbers are: F-cubic=0, I-cubic=1, P-cubic=2, R3/m (hex)=3, P6=4, P4mmm=6

3.12 *atmdata: Table of atomic data*

The entries here are:

XrayFF: a dict of form factor coefficients

AtmSize: atom Sizes, bond radii, angle radii, H-bond radii

AtmBlens: atom masses & neutron scattering length (b,b'), sig(incoh) @ 1A

MagFF: neutron magnetic form factor coeff: M for j<0> & N for j<2>

Sources:

Exponential scattering factor curve coeficients, Cromer and Waber(1971) Int. Tables Vol. IV. Delta f' and delta f" terms, Cromer(1971) Int. Tables Vol. IV Atomic weights from CRC 56th Edition.

Neutron scattering lengths & abs. cross sections from H. Rauch & W. Waschowski, Neutron Data Booklet, 2003. X-ray <j0> & <j2> coeff. from Intl. Tables for Cryst, Vol. C

Neutron anomalous coeff (LS) from fitting Lynn & Seeger, At. Data & Nuc. Data Tables, 44, 191-207(1990)

O2- x-ray scattering factor from Tokonami (1965) Acta Cryst 19, 486

At wts from 14th ed Nuclides & Isotopes, 1989 GE Co.

3.13 *defaultIparms: Table of atomic data*

Define some default instrument parameters: Format for each is a list of strings finished with a ' '. Begin with '#GSAS-II...' as the reader routine checks this. Each line can be comprised of a block of ';' delimited name:value pairs. All instrument parameters must be included; even those = 0. Use a GSAS-II instprm file as a source for the entries.

For a new entry:

Append a useful name to defaultIparms_lbl. Append the list of lines to defaultIparms.

defaultIparm_lbl: defines a list of labels

defaultIparms: defines a list of multiple strings with values for each set of defaults

CHAPTER

FOUR

GSAS-II GUI ROUTINES

4.1 *GSASIIctrls: Custom GUI controls*

A library of GUI controls for reuse throughout GSAS-II

(at present many are still in GSASIIgrid, but with time will be moved here)

class `GSASIIctrls.`**`ASCIIValidator`**(*result=None*, *key=None*)

A validator to be used with a TextCtrl to prevent entering characters other than ASCII characters.

The value is checked for validity after every keystroke If an invalid number is entered, the box is highlighted. If the number is valid, it is saved in result[key]

Parameters

- **result** (*dict/list*) – List or dict where value should be placed when valid
- **key** (*any*) – key to use for result (int for list)

`Clone`()

Create a copy of the validator, a strange, but required component

`OnChar`(*event*)

Called each type a key is pressed ignores keys that are not allowed for int and float types

`TestValid`(*tc*)

Check if the value is valid by casting the input string into ASCII.

Save it in the dict/list where the initial value was stored

Parameters **tc** (*wx.TextCtrl*) – A reference to the TextCtrl that the validator is associated with.

`TransferFromWindow`()

Needed by validator, strange, but required component

`TransferToWindow`()

Needed by validator, strange, but required component

class `GSASIIctrls.`**`AddHelp`**(*frame*, *helpType*, *helpLbl=None*, *title=''*)

For the Mac: creates an entry to the help menu of type ‘Help on <helpType>’: where helpType is a reference to an HTML page to be opened.

NOTE: when appending this menu (menu.Append) be sure to set the title to ‘&Help’ so that wx handles it correctly.

`OnHelpById`(*event*)

Called when Help on... is pressed in a menu. Brings up a web page for documentation.

GSASIIctrls.**CallScrolledMultiEditor**(*parent*, *dictlst*, *elemlst*, *prelbl=[ ]*, *postlbl=[ ]*, *title='Edit items'*, *header=''*, *size=(300, 250)*, *CopyButton=False*, ***kw*)

Shell routine to call a ScrolledMultiEditor dialog. See ScrolledMultiEditor for parameter definitions.

Returns True if the OK button is pressed; False if the window is closed with the system menu or the Cancel button.

class GSASIIctrls.**EnumSelector**(*parent*, *dct*, *item*, *choices*, *values=None*, ***kw*)

A customized `wxpython.ComboBox` that selects items from a list of choices, but sets a dict (list) entry to the corresponding entry from the input list of values.

Parameters

- **parent** (*wx.Panel*) – the parent to the `ComboBox` (usually a frame or panel)
- **dct** (*dict*) – a dict (or list) to contain the value set for the `ComboBox`.
- **item** – the dict key (or list index) where `dct[item]` will be set to the value selected in the `ComboBox`. Also, dct[item] contains the starting value shown in the widget. If the value does not match an entry in `values`, the first value in `choices` is used as the default, but `dct[item]` is not changed.
- **choices** (*list*) – a list of choices to be displayed to the user such as

  ```
  ["default","option 1","option 2",]
  ```

  Note that these options will correspond to the entries in `values` (if specified) item by item.
- **values** (*list*) – a list of values that correspond to the options in `choices`, such as

  ```
  [0,1,2]
  ```

  The default for `values` is to use the same list as specified for `choices`.
- **(other)** – additional keyword arguments accepted by `ComboBox` can be specified.

class GSASIIctrls.**G2CheckBox**(*parent*, *label*, *loc*, *key*)

A customized version of a CheckBox that automatically initializes the control to a supplied list or dict entry and updates that entry as the widget is used.

Parameters

- **parent** (*wx.Panel*) – name of panel or frame that will be the parent to the widget. Can be None.
- **label** (*str*) – text to put on check button
- **loc** (*dict/list*) – the dict or list with the initial value to be placed in the CheckBox.
- **key** (*int/str*) – the dict key or the list index for the value to be edited by the CheckBox. The `loc[key]` element must exist. The CheckBox will be initialized from this value. If the value is anything other that True (or 1), it will be taken as False.

class GSASIIctrls.**G2ChoiceButton**(*parent*, *choiceList*, *indLoc=None*, *indKey=None*, *strLoc=None*, *strKey=None*, *onChoice=None*, ***kwargs*)

A customized version of a wx.Choice that automatically initializes the control to match a supplied value and saves the choice directly into an array or list. Optionally a function can be called each time a choice is selected. The widget can be used with an array item that is set to to the choice by number (`indLoc[indKey]`) or by string value (`strLoc[strKey]`) or both. The initial value is taken from `indLoc[indKey]` if not None or `strLoc[strKey]` if not None.

Parameters

- **parent** (*wx.Panel*) – name of panel or frame that will be the parent to the widget. Can be None.
- **choiceList** (*list*) – a list or tuple of choices to offer the user.
- **indLoc** (*dict/list*) – a dict or list with the initial value to be placed in the Choice button. If this is None, this is ignored.
- **indKey** (*int/str*) – the dict key or the list index for the value to be edited by the Choice button. If indLoc is not None then this must be specified and the `indLoc[indKey]` will be set. If the value for `indLoc[indKey]` is not None, it should be an integer in range(len(choiceList)). The Choice button will be initialized to the choice corresponding to the value in this element if not None.
- **strLoc** (*dict/list*) – a dict or list with the string value corresponding to indLoc/indKey. Default (None) means that this is not used.
- **strKey** (*int/str*) – the dict key or the list index for the string value The `strLoc[strKey]` element must exist or strLoc must be None (default).
- **onChoice** (*function*) – name of a function to call when the choice is made.

class `GSASIIctrls.`**`G2ColumnIDDialog`**(*parent*, *title*, *header*, *Comments*, *ChoiceList*, *ColumnData*, *monoFont=False*, ***kw*)

A dialog for matching column data to desired items; some columns may be ignored.

Parameters

- **ParentFrame** (*wx.Frame*) – reference to parent frame
- **title** (*str*) – heading above list of choices
- **header** (*str*) – Title to place on window frame
- **ChoiceList** (*list*) – a list of possible choices for the columns
- **ColumnData** (*list*) – lists of column data to be matched with ChoiceList
- **monoFont** (*bool*) – If False (default), use a variable-spaced font; if True use a equally-spaced font.
- **kw** – optional keyword parameters for the wx.Dialog may be included such as size [which defaults to *(320,310)*] and style (which defaults to `wx.DEFAULT_DIALOG_STYLE | wx.RESIZE_BORDER | wx.CENTRE | wx.OK | wx.CANCEL`); note that `wx.OK` and `wx.CANCEL` controls the presence of the eponymous buttons in the dialog.

Returns the name of the created dialog

`GetSelection`()

Returns the selected sample parm for each column

class `GSASIIctrls.`**`G2HtmlWindow`**(*parent*, **args*, ***kwargs*)

Displays help information in a primitive HTML browser type window

class `GSASIIctrls.`**`G2LoggedButton`**(*parent*, *id=-1*, *label=''*, *locationcode=''*, *handler=None*, **args*, ***kwargs*)

A version of wx.Button that creates logging events. Bindings are saved in the object, and are looked up rather than directly set with a bind. An index to these buttons is saved as log.ButtonBindingLookup :param wx.Panel parent: parent widget :param int id: Id for button :param str label: label for button :param str locationcode: a label used internally to uniquely indentify the button :param function handler: a routine to call when the button is pressed

`onPress`(*event*)

create log event and call handler

`GSASIIctrls.`**`G2MessageBox`**(*parent*, *msg*, *title='Error'*)
Simple code to display a error or warning message

class `GSASIIctrls.`**`G2MultiChoiceDialog`**(*parent*, *title*, *header*, *ChoiceList*, *toggle=True*, *monoFont=False*, *filterBox=True*, ***kw*)
A dialog similar to MultiChoiceDialog except that buttons are added to set all choices and to toggle all choices.

Parameters

- **ParentFrame** (*wx.Frame*) – reference to parent frame
- **title** (*str*) – heading above list of choices
- **header** (*str*) – Title to place on window frame
- **ChoiceList** (*list*) – a list of choices where one will be selected
- **toggle** (*bool*) – If True (default) the toggle and select all buttons are displayed
- **monoFont** (*bool*) – If False (default), use a variable-spaced font; if True use a equally-spaced font.
- **filterBox** (*bool*) – If True (default) an input widget is placed on the window and only entries matching the entered text are shown.
- **kw** – optional keyword parameters for the wx.Dialog may be included such as size [which defaults to *(320,310)*] and style (which defaults to *wx.DEFAULT_DIALOG_STYLE|wx.RESIZE_BORDER|wx.CENTRE| wx.OK | wx.CANCEL*); note that *wx.OK* and *wx.CANCEL* controls the presence of the eponymous buttons in the dialog.

Returns the name of the created dialog

`Filter`(*event*)
Read text from filter control and select entries that match. Called by Timer after a delay with no input or if Enter is pressed.

`GetSelections`()
Returns a list of the indices for the selected choices

`OnCheck`(*event*)
for CheckListBox events; if Set Range is in use, this sets/clears all entries in range between start and end according to the value in start. Repeated clicks on the start change the checkbox state, but do not trigger the range copy. The caption next to the button is updated on the first button press.

`SetRange`(*event*)
Respond to a press of the Set Range button. Set the range flag and the caption next to the button

`SetSelections`(*selList*)
Sets the selection indices in selList as selected. Resets any previous selections for compatibility with wx.MultiChoiceDialog. Note that the state for only the filtered items is shown.

Parameters **selList** (*list*) – indices of items to be selected. These indices are referenced to the order in self.ChoiceList

`onChar`(*event*)
Respond to keyboard events in the Filter box

class `GSASIIctrls.`**`G2SingleChoiceDialog`**(*parent*, *title*, *header*, *ChoiceList*, *monoFont=False*, *filterBox=True*, ***kw*)
A dialog similar to wx.SingleChoiceDialog except that a filter can be added.

Parameters

- **ParentFrame** (*wx.Frame*) – reference to parent frame

- **title** (*str*) – heading above list of choices
- **header** (*str*) – Title to place on window frame
- **ChoiceList** (*list*) – a list of choices where one will be selected
- **monoFont** (*bool*) – If False (default), use a variable-spaced font; if True use a equally-spaced font.
- **filterBox** (*bool*) – If True (default) an input widget is placed on the window and only entries matching the entered text are shown.
- **kw** – optional keyword parameters for the wx.Dialog may be included such as size [which defaults to *(320,310)*] and style (which defaults to `wx.DEFAULT_DIALOG_STYLE | wx.RESIZE_BORDER | wx.CENTRE | wx.OK | wx.CANCEL`); note that `wx.OK` and `wx.CANCEL` controls the presence of the eponymous buttons in the dialog.

Returns the name of the created dialog

`GetSelection`()
Returns the index of the selected choice

class GSASIIctrls.**G2TreeCtrl**(*parent=None*, **args*, ***kwargs*)
Create a wrapper around the standard TreeCtrl so we can "wrap" various events.

This logs when a tree item is selected (in `onSelectionChanged()`)

This also wraps lists and dicts pulled out of the tree to track where they were retrieved from.

`Bind`(*eventtype*, *handler*, **args*, ***kwargs*)
Override the Bind() function so that page change events can be trapped

`ConvertRelativeHistNum`(*histtype*, *histnum*)
Converts a histogram type and relative histogram number to a histogram name in the current project

`ConvertRelativePhaseNum`(*phasenum*)
Converts relative phase number to a phase name in the current project

`GetRelativeHistNum`(*histname*)
Returns list with a histogram type and a relative number for that histogram, or the original string if not a histogram

`GetRelativePhaseNum`(*phasename*)
Returns a phase number if the string matches a phase name or else returns the original string

`onSelectionChanged`(*event*)
Log each press on a tree item here.

class GSASIIctrls.**GSGrid**(*parent*, *name=''*)
Basic wx.Grid implementation

`InstallGridToolTip`(*rowcolhintcallback*, *colLblCallback=None*, *rowLblCallback=None*)
code to display a tooltip for each item on a grid from http://wiki.wxpython.org/wxGrid%20ToolTips (buggy!), expanded to column and row labels using hints from https://groups.google.com/forum/#!topic/wxPython-users/bm8OARRVDCs

Parameters

- **rowcolhintcallback** (*function*) – a routine that returns a text string depending on the selected row and column, to be used in explaining grid entries.
- **colLblCallback** (*function*) – a routine that returns a text string depending on the selected column, to be used in explaining grid columns (if None, the default), column labels do not get a tooltip.

- **rowLblCallback** (*function*) – a routine that returns a text string depending on the selected row, to be used in explaining grid rows (if None, the default), row labels do not get a tooltip.

class `GSASIIctrls.`**`GSNoteBook`**(*parent*, *name=''*, *size=None*)
Notebook used in various locations; implemented with wx.aui extension

`Bind`(*eventtype*, *handler*, **args*, ***kwargs*)
Override the Bind() function so that page change events can be trapped

`GSASIIctrls.`**`GetItemOrder`**(*parent*, *keylist*, *vallookup*, *posdict*)
Creates a panel where items can be ordered into columns

Parameters

- **keylist** (*list*) – is a list of keys for column assignments
- **vallookup** (*dict*) – is a dict keyed by names in keylist where each item is a dict. Each inner dict contains variable names as keys and their associated values
- **posdict** (*dict*) – is a dict keyed by names in keylist where each item is a dict. Each inner dict contains column numbers as keys and their associated variable name as a value. This is used for both input and output.

class `GSASIIctrls.`**`GridFractionEditor`**(*grid*)
A grid cell editor class that allows entry of values as fractions as well as sine and cosine values [as s() and c()]

`ApplyEdit`(*row*, *col*, *grid*)
Called only in wx >= 2.9 Save the value of the control into the grid if EndEdit() returns as True

class `GSASIIctrls.`**`HelpButton`**(*parent*, *msg*)
Create a help button that displays help information. The text is displayed in a modal message window.

TODO: it might be nice if it were non-modal: e.g. it stays around until the parent is deleted or the user closes it, but this did not work for me.

Parameters

- **parent** – the panel which will be the parent of the button
- **msg** (*str*) – the help text to be displayed

`GSASIIctrls.`**`HorizontalLine`**(*sizer*, *parent*)
Draws a horizontal line as wide as the window. This shows up on the Mac as a very thin line, no matter what I do

`GSASIIctrls.`**`ItemSelector`**(*ChoiceList*, *ParentFrame=None*, *title='Select an item'*, *size=None*, *header='Item Selector'*, *useCancel=True*, *multiple=False*)
Provide a wx dialog to select a single item or multiple items from list of choices

Parameters

- **ChoiceList** (*list*) – a list of choices where one will be selected
- **ParentFrame** (*wx.Frame*) – Name of parent frame (default None)
- **title** (*str*) – heading above list of choices (default 'Select an item')
- **size** (*wx.Size*) – Size for dialog to be created (default None – size as needed)
- **header** (*str*) – Title to place on window frame (default 'Item Selector')
- **useCancel** (*bool*) – If True (default) both the OK and Cancel buttons are offered
- **multiple** (*bool*) – If True then multiple items can be selected (default False)

Returns the selection index or None or a selection list if multiple is true

class `GSASIIctrls.`**`MultiStringDialog`**(*parent*, *title*, *prompts*, *values=[ ]*)

Dialog to obtain a multi string values from user

Parameters

- **parent** (*wx.Frame*) – name of parent frame
- **title** (*str*) – title string for dialog
- **prompts** (*str*) – strings to tell use what they are inputting
- **values** (*str*) – default input values, if any

`GetValues`()

Use this method to get the value entered by the user :returns: string entered by user

`Show`()

Use this method after creating the dialog to post it :returns: True if the user pressed OK; False if the User pressed Cancel

class `GSASIIctrls.`**`MyHelp`**(*frame*, *helpType=None*, *helpLbl=None*, *morehelpitems=[ ]*, *title=''*)

A class that creates the contents of a help menu. The menu will start with two entries:

- 'Help on <helpType>': where helpType is a reference to an HTML page to be opened
- About: opens an About dialog using OnHelpAbout. N.B. on the Mac this gets moved to the App menu to be consistent with Apple style.

NOTE: for this to work properly with respect to system menus, the title for the menu must be &Help, or it will not be processed properly:

```
menu.Append(menu=MyHelp(self,...),title="&Help")
```

`OnCheckUpdates`(*event*)

Check if the GSAS-II repository has an update for the current source files and perform that update if requested.

`OnHelpAbout`(*event*)

Display an 'About GSAS-II' box

`OnHelpById`(*event*)

Called when Help on... is pressed in a menu. Brings up a web page for documentation.

`OnSelectVersion`(*event*)

Allow the user to select a specific version of GSAS-II

class `GSASIIctrls.`**`MyHtmlPanel`**(*frame*, *id*)

Defines a panel to display HTML help information, as an alternative to displaying help information in a web browser.

class `GSASIIctrls.`**`NumberValidator`**(*typ*, *positiveonly=False*, *min=None*, *max=None*, *result=None*, *key=None*, *OKcontrol=None*, *CIFinput=False*)

A validator to be used with a TextCtrl to prevent entering characters other than digits, signs, and for float input, a period and exponents.

The value is checked for validity after every keystroke If an invalid number is entered, the box is highlighted. If the number is valid, it is saved in result[key]

Parameters

- **typ** (*type*) – the base data type. Must be int or float.
- **positiveonly** (*bool*) – If True, negative integers are not allowed (default False). This prevents the + or - keys from being pressed. Used with typ=int; ignored for typ=float.

- **min** (*number*) – Minimum allowed value. If None (default) the lower limit is unbounded
- **max** (*number*) – Maximum allowed value. If None (default) the upper limit is unbounded
- **result** (*dict/list*) – List or dict where value should be placed when valid
- **key** (*any*) – key to use for result (int for list)
- **OKcontrol** (*function*) – function or class method to control an OK button for a window. Ignored if None (default)
- **CIFinput** (*bool*) – allows use of a single '?' or '.' character as valid input.

`CheckInput`(*previousInvalid*)
called to test every change to the TextCtrl for validity and to change the appearance of the TextCtrl

Anytime the input is invalid, call self.OKcontrol (if defined) because it is fast. If valid, check for any other invalid entries only when changing from invalid to valid, since that is slower.

Parameters **previousInvalid** (*bool*) – True if the TextCtrl contents were invalid prior to the current change.

`Clone`()
Create a copy of the validator, a strange, but required component

`OnChar`(*event*)
Called each type a key is pressed ignores keys that are not allowed for int and float types

`ShowValidity`(*tc*)
Set the control colors to show invalid input

Parameters **tc** (*wx.TextCtrl*) – A reference to the TextCtrl that the validator is associated with.

`TestValid`(*tc*)
Check if the value is valid by casting the input string into the current type.

Set the invalid variable in the TextCtrl object accordingly.

If the value is valid, save it in the dict/list where the initial value was stored, if appropriate.

Parameters **tc** (*wx.TextCtrl*) – A reference to the TextCtrl that the validator is associated with.

`TransferFromWindow`()
Needed by validator, strange, but required component

`TransferToWindow`()
Needed by validator, strange, but required component

class `GSASIIctrls.`**`OpenTutorial`**(*parent=None*)
Open a tutorial, optionally copying it to the local disk. Always copy the data files locally.

For now tutorials will always be copied into the source code tree, but it might be better to have an option to copy them somewhere else, for people who don't have write access to the GSAS-II source code location.

`LoadExercise`(*tutorialname, fullpath='/Users/toby/G2tutorials', baseURL='https://subversion.xray.aps.anl.gov/pyGSAS'*)
Load Exercise file(s) for a Tutorial to the selected location

`LoadTutorial`(*tutorialname, fullpath='/Users/toby/G2tutorials', baseURL='https://subversion.xray.aps.anl.gov/pyGSAS'*)
Load a Tutorial to the selected location

`OnModeSelect`(*event*)
Respond when the mode is changed

`OnTutorialSelected`(*event*)
Respond when a tutorial is selected. Load tutorials and data locally, as needed and then display the page

SelectDownloadLoc(*event*)
Select a download location, Cancel resets to the default

ShowTutorialPath()
Show the help and exercise directory names

ValidateTutorialDir(*fullpath='/Users/toby/G2tutorials'*, *baseURL='https://subversion.xray.aps.anl.gov/pyGSAS'*)
Load help to new directory or make sure existing directory looks correctly set up throws an exception if there is a problem.

class GSASIIctrls.**OrderBox**(*parent*, *keylist*, *vallookup*, *posdict*, **arg*, ***kw*)
Creates a panel with scrollbars where items can be ordered into columns

Parameters

- **keylist** (*list*) – is a list of keys for column assignments
- **vallookup** (*dict*) – is a dict keyed by names in keylist where each item is a dict. Each inner dict contains variable names as keys and their associated values
- **posdict** (*dict*) – is a dict keyed by names in keylist where each item is a dict. Each inner dict contains column numbers as keys and their associated variable name as a value. This is used for both input and output.

OnChoice(*event*)
Called when a column is assigned to a variable

class GSASIIctrls.**PickTwoDialog**(*parent*, *title*, *prompt*, *names*, *choices*)
This does not seem to be in use

class GSASIIctrls.**ScrolledMultiEditor**(*parent*, *dictlst*, *elemlst*, *prelbl=[ ]*, *postlbl=[ ]*, *title='Edit items'*, *header=''*, *size=(300, 250)*, *CopyButton=False*, *minvals=[ ]*, *maxvals=[ ]*, *sizevals=[ ]*, *checkdictlst=[ ]*, *checkelemlst=[ ]*, *checklabel=''*)
Define a window for editing a potentially large number of dict- or list-contained values with validation for each item. Edited values are automatically placed in their source location. If invalid entries are provided, the TextCtrl is turned yellow and the OK button is disabled.

The type for each TextCtrl validation is determined by the initial value of the entry (int, float or string). Float values can be entered in the TextCtrl as numbers or also as algebraic expressions using operators + - / * () and **, in addition pi, sind(), cosd(), tand(), and sqrt() can be used, as well as appreviations s(), sin(), c(), cos(), t(), tan() and sq().

Parameters

- **parent** (*wx.Frame*) – name of parent window, or may be None
- **dictlst** (*tuple*) – a list of dicts or lists containing values to edit
- **elemlst** (*tuple*) – a list of keys for each item in a dictlst. Must have the same length as dictlst.
- **parent** – name of parent window, or may be None
- **prelbl** (*tuple*) – a list of labels placed before the TextCtrl for each item (optional)
- **postlbl** (*tuple*) – a list of labels placed after the TextCtrl for each item (optional)
- **title** (*str*) – a title to place in the frame of the dialog
- **header** (*str*) – text to place at the top of the window. May contain new line characters.
- **size** (*wx.Size*) – a size parameter that dictates the size for the scrolled region of the dialog. The default is (300,250).

- **CopyButton** (*bool*) – if True adds a small button that copies the value for the current row to all fields below (default is False)
- **minvals** (*list*) – optional list of minimum values for validation of float or int values. Ignored if value is None.
- **maxvals** (*list*) – optional list of maximum values for validation of float or int values. Ignored if value is None.
- **sizevals** (*list*) – optional list of wx.Size values for each input widget. Ignored if value is None.
- **checkdictlst** (*tuple*) – an optional list of dicts or lists containing bool values (similar to dictlst).
- **checkelemlst** (*tuple*) – an optional list of dicts or lists containing bool key values (similar to elemlst). Must be used with checkdictlst.
- **checklabel** (*string*) – a string to use for each checkbutton

Returns the wx.Dialog created here. Use method .ShowModal() to display it.

Example for use of ScrolledMultiEditor:

```
dlg = <pkg>.ScrolledMultiEditor(frame,dictlst,elemlst,prelbl,postlbl,
                                header=header)
if dlg.ShowModal() == wx.ID_OK:
     for d,k in zip(dictlst,elemlst):
         print d[k]
```

Example definitions for dictlst and elemlst:

```
    dictlst = (dict1,list1,dict1,list1)
    elemlst = ('a', 1, 2, 3)

This causes items dict1['a'], list1[1], dict1[2] and list1[3] to be edited.
```

Note that these items must have int, float or str values assigned to them. The dialog will force these types to be retained. String values that are blank are marked as invalid.

`ControlOKButton`(*setvalue*)

Enable or Disable the OK button for the dialog. Note that this is passed into the ValidatedTxtCtrl for use by validators.

Parameters **setvalue** (*bool*) – if True, all entries in the dialog are checked for validity. if False then the OK button is disabled.

`GSASIIctrls.`**`SelectEdit1Var`**(*G2frame*, *array*, *labelLst*, *elemKeysLst*, *dspLst*, *refFlgElem*)

Select a variable from a list, then edit it and select histograms to copy it to.

Parameters

- **G2frame** (*wx.Frame*) – main GSAS-II frame
- **array** (*dict*) – the array (dict or list) where values to be edited are kept
- **labelLst** (*list*) – labels for each data item
- **elemKeysLst** (*list*) – a list of lists of keys needed to be applied (see below) to obtain the value of each parameter
- **dspLst** (*list*) – list list of digits to be displayed (10,4) is 10 digits with 4 decimal places. Can be None.

- **refFlgElem** (*list*) – a list of lists of keys needed to be applied (see below) to obtain the refine flag for each parameter or None if the parameter does not have refine flag.

Example::

array = data labelLst = ['v1','v2'] elemKeysLst = [['v1'], ['v2',0]] refFlgElem = [None, ['v2',1]]

- The value for v1 will be in data['v1'] and this cannot be refined while,
- The value for v2 will be in data['v2'][0] and its refinement flag is data['v2'][1]

`GSASIIctrls.`**`ShowHelp`**`(`*helpType*, *frame*`)`
Called to bring up a web page for documentation.

`GSASIIctrls.`**`ShowWebPage`**`(`*URL*, *frame*`)`
Called to show a tutorial web page.

class `GSASIIctrls.`**`SingleFloatDialog`**`(`*parent, title, prompt, value, limits=[0.0, 1.0], format='%.5g'*`)`
Dialog to obtain a single float value from user

class `GSASIIctrls.`**`SingleStringDialog`**`(`*parent*, *title*, *prompt*, *value=''*, *size=(200, -1)*`)`
Dialog to obtain a single string value from user

Parameters

- **parent** (*wx.Frame*) – name of parent frame
- **title** (*str*) – title string for dialog
- **prompt** (*str*) – string to tell use what they are inputting
- **value** (*str*) – default input value, if any

`GetValue``()`
Use this method to get the value entered by the user :returns: string entered by user

`Show``()`
Use this method after creating the dialog to post it :returns: True if the user pressed OK; False if the User pressed Cancel

`GSASIIctrls.`**`StripIndents`**`(`*msg*`)`
Strip indentation from multiline strings

class `GSASIIctrls.`**`Table`**`(`*data=*[ ], *rowLabels=None*, *colLabels=None*, *types=None*`)`
Basic data table for use with GSgrid

class `GSASIIctrls.`**`ValidatedTxtCtrl`**`(`*parent*, *loc*, *key*, *nDig=None*, *notBlank=True*, *min=None*, *max=None*, *OKcontrol=None*, *OnLeave=None*, *typeHint=None*, *CIFinput=False*, *OnLeaveArgs={}*, ***kw*`)`
Create a TextCtrl widget that uses a validator to prevent the entry of inappropriate characters and changes color to highlight when invalid input is supplied. As valid values are typed, they are placed into the dict or list where the initial value came from. The type of the initial value must be int, float or str or None (see `key` and `typeHint`); this type (or the one in `typeHint`) is preserved.

Float values can be entered in the TextCtrl as numbers or also as algebraic expressions using operators + - / * () and **, in addition pi, sind(), cosd(), tand(), and sqrt() can be used, as well as appreviations s, sin, c, cos, t, tan and sq.

Parameters

- **parent** (*wx.Panel*) – name of panel or frame that will be the parent to the TextCtrl. Can be None.

- **loc** (*dict/list*) – the dict or list with the initial value to be placed in the TextCtrl.
- **key** (*int/str*) – the dict key or the list index for the value to be edited by the TextCtrl. The `loc[key]` element must exist, but may have value None. If None, the type for the element is taken from `typeHint` and the value for the control is set initially blank (and thus invalid.) This is a way to specify a field without a default value: a user must set a valid value. If the value is not None, it must have a base type of int, float, str or unicode; the TextCrtl will be initialized from this value.
- **nDig** (*list*) – number of digits & places ([nDig,nPlc]) after decimal to use for display of float. Alternately, None can be specified which causes numbers to be displayed with approximately 5 significant figures (Default=None).
- **notBlank** (*bool*) – if True (default) blank values are invalid for str inputs.
- **min** (*number*) – minimum allowed valid value. If None (default) the lower limit is unbounded.
- **max** (*number*) – maximum allowed valid value. If None (default) the upper limit is unbounded
- **OKcontrol** (*function*) – specifies a function or method that will be called when the input is validated. The called function is supplied with one argument which is False if the TextCtrl contains an invalid value and True if the value is valid. Note that this function should check all values in the dialog when True, since other entries might be invalid. The default for this is None, which indicates no function should be called.
- **OnLeave** (*function*) – specifies a function or method that will be called when the focus for the control is lost. The called function is supplied with (at present) three keyword arguments:
  - invalid: (*bool*) True if the value for the TextCtrl is invalid
  - value: (*int/float/str*) the value contained in the TextCtrl
  - tc: (*wx.TextCtrl*) the TextCtrl name

  The number of keyword arguments may be increased in the future should needs arise, so it is best to code these functions with a **kwargs argument so they will continue to run without errors

  The default for OnLeave is None, which indicates no function should be called.
- **typeHint** (*type*) – the value of typeHint is overrides the initial value for the dict/list element `loc[key]`, if set to int or float, which specifies the type for input to the TextCtrl. Defaults as None, which is ignored.
- **CIFinput** (*bool*) – for str input, indicates that only printable ASCII characters may be entered into the TextCtrl. Forces output to be ASCII rather than Unicode. For float and int input, allows use of a single '?' or '.' character as valid input.
- **OnLeaveArgs** (*dict*) – a dict with keyword args that are passed to the `OnLeave` function. Defaults to `{}`
- **(other)** – other optional keyword parameters for the wx.TextCtrl widget such as size or style may be specified.

`EvaluateExpression``()`
Show the computed value when an expression is entered to the TextCtrl Make sure that the number fits by truncating decimal places and switching to scientific notation, as needed. Called on loss of focus, enter, etc..

`OnKeyDown``(`*event*`)`
Special callback for wx 2.9+ on Mac where backspace is not processed by validator

ShowStringValidity(*previousInvalid=True*)
Check if input is valid. Anytime the input is invalid, call self.OKcontrol (if defined) because it is fast. If valid, check for any other invalid entries only when changing from invalid to valid, since that is slower.

Parameters **previousInvalid** (*bool*) – True if the TextCtrl contents were invalid prior to the current change.

class `GSASIIctrls.`**downdate**(*parent=None*)
Dialog to allow a user to select a version of GSAS-II to install

getVersion()
Get the version number in the dialog

4.2 *GSASIIgrid: Basic GUI routines*

class `GSASIIgrid.`**DataFrame**(*parent*, *frame*, *data=None*, *name=None*, *size=None*, *pos=None*)
Create the data item window and all the entries in menus used in that window. For Linux and windows, the menu entries are created for the current data item window, but in the Mac the menu is accessed from all windows. This means that a different menu is posted depending on which data item is posted. On the Mac, all the menus contain the data tree menu items, but additional menus are added specific to the data item.

Note that while the menus are created here, the binding for the menus is done later in various GSASII*GUI modules, where the functions to be called are defined.

Bind(*eventtype*, *handler*, **args*, ***kwargs*)
Override the Bind() function: on the Mac the binding is to the main window, so that menus operate with any window on top. For other platforms, either wrap calls that will be logged or call the default wx.Frame Bind() to bind to the menu item directly.

Note that bindings can be made to objects by Id or by direct reference to the object. As a convention, when bindings are to objects, they are not logged but when bindings are by Id, they are logged.

PostfillDataMenu(*empty=False*)
Create the "standard" part of data frame menus. Note that on Linux and Windows, this is the standard help Menu. On Mac, this menu duplicates the tree menu, but adds an extra help command for the data item and a separator.

PrefillDataMenu(*menu*, *helpType*, *helpLbl=None*, *empty=False*)
Create the "standard" part of data frame menus. Note that on Linux and Windows nothing happens here. On Mac, this menu duplicates the tree menu, but adds an extra help command for the data item and a separator.

class `GSASIIgrid.`**DisAglDialog**(*parent*, *data*, *default*)
Distance/Angle Controls input dialog. After `ShowModal()` returns, the results are found in dict `self.data`, which is accessed using `GetData()`.

Parameters

- **parent** (*wx.Frame*) – reference to parent frame (or None)
- **data** (*dict*) – a dict containing the current search ranges or an empty dict, which causes default values to be used. Will be used to set element *DisAglCtls* in *Phase Tree Item*
- **default** (*dict*) – A dict containing the default search ranges for each element.

Draw(*data*)
Creates the contents of the dialog. Normally called by `__init__()`.

GetData()
Returns the values from the dialog

OnOk (*event*)
Called when the OK button is pressed

OnReset (*event*)
Called when the Reset button is pressed

GSASIIgrid.**GetPatternTreeDataNames** (*G2frame*, *dataTypes*)
Needs a doc string

GSASIIgrid.**GetPatternTreeItemId** (*G2frame*, *parentId*, *itemText*)
Needs a doc string

GSASIIgrid.**HowDidIgetHere** ()
Show a traceback with calls that brought us to the current location. Used for debugging.

GSASIIgrid.**MovePatternTreeToGrid** (*G2frame*, *item*)
Called from GSASII.OnPatternTreeSelChanged when a item is selected on the tree

class GSASIIgrid.**SGMessageBox** (*parent*, *title*, *text*, *table*)
Special version of MessageBox that displays space group & super space group text in two blocks

Show ()
Use this method after creating the dialog to post it

GSASIIgrid.**SetDataMenuBar** (*G2frame*, *menu=None*)
Set the menu for the data frame. On the Mac put this menu for the data tree window instead.

Note that data frame items do not have menus, for these (menu=None) display a blank menu or on the Mac display the standard menu for the data tree window.

class GSASIIgrid.**ShowLSParms** (*parent*, *title*, *parmDict*, *varyList*, *fullVaryList*, *size=(300, 430)*)
Create frame to show least-squares parameters

class GSASIIgrid.**SymOpDialog** (*parent*, *SGData*, *New=True*, *ForceUnit=False*)
Class to select a symmetry operator

GSASIIgrid.**UpdateControls** (*G2frame*, *data*)
Edit overall GSAS-II controls in main Controls data tree entry

GSASIIgrid.**UpdateNotebook** (*G2frame*, *data*)
Called when the data tree notebook entry is selected. Allows for editing of the text in that tree entry

GSASIIgrid.**UpdatePWHKPlot** (*G2frame*, *kind*, *item*)
Called when the histogram main tree entry is called. Displays the histogram weight factor, refinement statistics for the histogram and the range of data for a simulation.

Also invokes a plot of the histogram.

GSASIIgrid.**UpdateSeqResults** (*G2frame*, *data*, *prevSize=None*)
Called when the Sequential Results data tree entry is selected to show results from a sequential refinement.

Parameters

- **G2frame** (*wx.Frame*) – main GSAS-II data tree windows
- **data** (*dict*) – a dictionary containing the following items:
  - ‘histNames’ - list of histogram names in order as processed by Sequential Refinement
  - ‘varyList’ - list of variables - identical over all refinements in sequence note that this is the original list of variables, prior to processing constraints.
  - ‘variableLabels’ – a dict of labels to be applied to each parameter (this is created as an empty dict if not present in data).

- keyed by histName - dictionaries for all data sets processed, which contains:
  - ‘variables’- result[0] from leastsq call
  - ‘varyList’ - list of variables passed to leastsq call (not same as above)
  - ‘sig’ - esds for variables
  - ‘covMatrix’ - covariance matrix from individual refinement
  - ‘title’ - histogram name; same as dict item name
  - ‘newAtomDict’ - new atom parameters after shifts applied
  - ‘newCellDict’ - refined cell parameters after shifts to A0-A5 from Dij terms applied’

4.3 *GSASIIIO: Misc I/O routines*

Module with miscellaneous routines for input and output. Many are GUI routines to interact with user.

Includes support for image reading.

Also includes base classes for data import routines.

`GSASIIIO.`**`CheckImageFile`**(*G2frame*, *imagefile*)
Get an new image file name if the specified one does not exist

Parameters

- **G2frame** (*wx.Frame*) – main GSAS-II Frame and data object
- **imagefile** (*str*) – name of image file

Returns imagefile, if it exists, or the name of a file that does exist or False if the user presses Cancel

class `GSASIIIO.`**`ExportBaseclass`**(*G2frame*, *formatName*, *extension*, *longFormatName=None*)
Defines a base class for the exporting of GSAS-II results.

This class is subclassed in the various exports/G2export_*.py files. Those files are imported in `GSASII.GSASII._init_Exports()` which defines the appropriate menu items for each one and the .Exporter method is called directly from the menu item.

`CloseFile`(*fp=None*)
Close a file opened in OpenFile

Parameters **fp** (*file*) – the file object to be closed. If None (default) file object self.fp is closed.

`ExportSelect`(*AskFile=’ask’*)
Selects histograms or phases when needed. Sets a default file name when requested in self.filename; always sets a default directory in self.dirname.

Parameters **AskFile** (*bool*) – Determines how this routine processes getting a location to store the current export(s).

- if AskFile is ‘ask’ (default option), get the name of the file to be written; self.filename and self.dirname are always set. In the case where multiple files must be generated, the export routine should do this based on self.filename as a template.
- if AskFile is ‘dir’, get the name of the directory to be used; self.filename is not used, but self.dirname is always set. The export routine will always generate the file name.
- if AskFile is ‘single’, get only the name of the directory to be used when multiple items will be written (as multiple files) are used *or* a complete file name is requested when a

single file name is selected. self.dirname is always set and self.filename used only when a single file is selected.

- if AskFile is 'default', creates a name of the file to be used from the name of the project (.gpx) file. If the project has not been saved, then the name of file is requested. self.filename and self.dirname are always set. In the case where multiple file names must be generated, the export routine should do this based on self.filename.
- if AskFile is 'default-dir', sets self.dirname from the project (.gpx) file. If the project has not been saved, then a directory is requested. self.filename is not used.

Returns True in case of an error

`GetAtoms`(*phasenam*)
Gets the atoms associated with a phase. Can be used with standard or macromolecular phases

Parameters **phasenam** (*str*) – the name for the selected phase

Returns

a list of items for eac atom where each item is a list containing: label, typ, mult, xyz, and td, where

- label and typ are the atom label and the scattering factor type (str)
- mult is the site multiplicity (int)
- xyz is contains a list with four pairs of numbers: x, y, z and fractional occupancy and their standard uncertainty (or a negative value)
- td is contains a list with either one or six pairs of numbers: if one number it is U_{iso} and with six numbers it is U_{11}, U_{22}, U_{33}, U_{12}, U_{13} & U_{23} paired with their standard uncertainty (or a negative value)

`GetCell`(*phasenam*)
Gets the unit cell parameters and their s.u.'s for a selected phase

Parameters **phasenam** (*str*) – the name for the selected phase

Returns *cellList,cellSig* where each is a 7 element list corresponding to a, b, c, alpha, beta, gamma, volume where *cellList* has the cell values and *cellSig* has their uncertainties.

`InitExport`(*event*)
Determines the type of menu that called the Exporter and misc initialization.

`MakePWDRfilename`(*hist*)
Make a filename root (no extension) from a PWDR histogram name

Parameters **hist** (*str*) – the histogram name in data tree (starts with "PWDR ")

`OpenFile`(*fil=None*, *mode='w'*)
Open the output file

Parameters **fil** (*str*) – The name of the file to open. If None (default) the name defaults to self.dirname + self.filename. If an extension is supplied, it is not overridded, but if not, the default extension is used.

Returns the file object opened by the routine which is also saved as self.fp

`Write`(*line*)
write a line of output, attaching a line-end character

Parameters **line** (*str*) – the text to be written.

askSaveDirectory()

Ask the user to supply a directory name. Path name is used as the starting point for the next export path search.

Returns a directory name (str) or None if Cancel is pressed

askSaveFile()

Ask the user to supply a file name

Returns a file name (str) or None if Cancel is pressed

dumpTree(*mode='type'*)

Print out information on the data tree dicts loaded in loadTree

loadParmDict()

Load the GSAS-II refinable parameters from the tree into a dict (self.parmDict). Update refined values to those from the last cycle and set the uncertainties for the refined parameters in another dict (self.sigDict).

Expands the parm & sig dicts to include values derived from constraints.

loadTree()

Load the contents of the data tree into a set of dicts (self.OverallParms, self.Phases and self.Histogram as well as self.powderDict & self.xtalDict)

- The childrenless data tree items are overall parameters/controls for the entire project and are placed in self.OverallParms
- Phase items are placed in self.Phases
- Data items are placed in self.Histogram. The key for these data items begin with a keyword, such as PWDR, IMG, HKLF,... that identifies the data type.

GSASIIIO.**ExtractFileFromZip**(*filename*, *selection=None*, *confirmread=True*, *confirmoverwrite=True*, *parent=None*, *multipleselect=False*)

If the filename is a zip file, extract a file from that archive.

Parameters

- **Selection** (*list*) – used to predefine the name of the file to be extracted. Filename case and zip directory name are ignored in selection; the first matching file is used.
- **confirmread** (*bool*) – if True asks the user to confirm before expanding the only file in a zip
- **confirmoverwrite** (*bool*) – if True asks the user to confirm before overwriting if the extracted file already exists
- **multipleselect** (*bool*) – if True allows more than one zip file to be extracted, a list of file(s) is returned. If only one file is present, do not ask which one, otherwise offer a list of choices (unless selection is used).

Returns the name of the file that has been created or a list of files (see multipleselect)

If the file is not a zipfile, return the name of the input file. If the zipfile is empty or no file has been selected, return None

GSASIIIO.**FileDlgFixExt**(*dlg*, *file*)

this is needed to fix a problem in linux wx.FileDialog

GSASIIIO.**GetEdfData**(*filename*, *imageOnly=False*)

Read European detector data edf file

GSASIIIO.**GetG2Image**(*filename*)

Read an image as a python pickle

GSASIIIO.**GetGEsumData** (*filename*, *imageOnly=False*)
Read SUM file as produced at 1-ID from G.E. images

GSASIIIO.**GetImageData** (*G2frame*, *imagefile*, *imageOnly=False*)
Read an image with the file reader keyed by the file extension

Parameters

- **G2frame** (*wx.Frame*) – main GSAS-II Frame and data object.
- **imagefile** (*str*) – name of image file
- **imageOnly** (*bool*) – If True return only the image, otherwise (default) return more (see below)

Returns an image as a numpy array or a list of four items: Comments, Data, Npix and the Image, as selected by imageOnly

GSASIIIO.**GetImgData** (*filename*, *imageOnly=False*)
Read an ADSC image file

GSASIIIO.**GetMAR345Data** (*filename*, *imageOnly=False*)
Read a MAR-345 image plate image

GSASIIIO.**GetPNGData** (*filename*, *imageOnly=False*)
Read an image in a png format, assumes image is converted from CheMin tif file so default parameters are that machine.

GSASIIIO.**GetPowderPeaks** (*fileName*)
Read powder peaks from a file

GSASIIIO.**GetTifData** (*filename*, *imageOnly=False*)
Read an image in a pseudo-tif format, as produced by a wide variety of software, almost always incorrectly in some way.

class GSASIIIO.**ImportBaseclass** (*formatName*, *longFormatName=None*, *extensionlist=[ ]*, *strictExtension=False*)
Defines a base class for the reading of input files (diffraction data, coordinates,...). See *Writing a Import Routine* for an explanation on how to use a subclass of this class.

BlockSelector (*ChoiceList*, *ParentFrame=None*, *title='Select a block'*, *size=None*, *header='Block Selector'*, *useCancel=True*)
Provide a wx dialog to select a block if the file contains more than one set of data and one must be selected

CIFValidator (*filepointer*)
A `ContentsValidator()` for use to validate CIF files.

ContentsValidator (*filepointer*)
This routine will attempt to determine if the file can be read with the current format. This will typically be overridden with a method that takes a quick scan of [some of] the file contents to do a "sanity" check if the file appears to match the selected format. Expected to be called via self.Validator()

ExtensionValidator (*filename*)
This methods checks if the file has the correct extension Return False if this filename will not be supported by this reader Return True if the extension matches the list supplied by the reader Return None if the reader allows un-registered extensions

exception ImportException
Defines an Exception that is used when an import routine hits an expected error, usually in .Reader.

Good practice is that the Reader should define a value in self.errors that tells the user some information about what is wrong with their file.

`ImportBaseclass.`**`MultipleBlockSelector`**(*ChoiceList*, *ParentFrame=None*, *title='Select a block'*, *size=None*, *header='Block Selector'*)

Provide a wx dialog to select a block of data if the file contains more than one set of data and one must be selected.

Returns a list of the selected blocks

`ImportBaseclass.`**`MultipleChoicesDialog`**(*choicelist*, *headinglist*, *ParentFrame=None*, ***kwargs*)

A modal dialog that offers a series of choices, each with a title and a wx.Choice widget. Typical input:

- choicelist=[('a','b','c'), ('test1','test2'),('no choice',)]
- headinglist = ['select a, b or c', 'select 1 of 2', 'No option here']

optional keyword parameters are: head (window title) and title returns a list of selected indicies for each choice (or None)

`ImportBaseclass.`**`ReInitialize`**()

Reinitialize the Reader to initial settings

class `GSASIIIO.`**`ImportPhase`**(*formatName*, *longFormatName=None*, *extensionlist=[ ]*, *strictExtension=False*)

Defines a base class for the reading of files with coordinates

Objects constructed that subclass this (in import/G2phase_*.py etc.) will be used in `GSASII.GSASII.OnImportPhase()`. See *Writing a Import Routine* for an explanation on how to use this class.

`PhaseSelector`(*ChoiceList*, *ParentFrame=None*, *title='Select a phase'*, *size=None*, *header='Phase Selector'*)

Provide a wx dialog to select a phase if the file contains more than one phase

class `GSASIIIO.`**`ImportPowderData`**(*formatName*, *longFormatName=None*, *extensionlist=[ ]*, *strictExtension=False*)

Defines a base class for the reading of files with powder data.

Objects constructed that subclass this (in import/G2pwd_*.py etc.) will be used in `GSASII.GSASII.OnImportPowder()`. See *Writing a Import Routine* for an explanation on how to use this class.

`ReInitialize`()

Reinitialize the Reader to initial settings

class `GSASIIIO.`**`ImportSmallAngleData`**(*formatName*, *longFormatName=None*, *extensionlist=[ ]*, *strictExtension=False*)

Defines a base class for the reading of files with small angle data. See *Writing a Import Routine* for an explanation on how to use this class.

`ReInitialize`()

Reinitialize the Reader to initial settings

class `GSASIIIO.`**`ImportStructFactor`**(*formatName*, *longFormatName=None*, *extensionlist=[ ]*, *strictExtension=False*)

Defines a base class for the reading of files with tables of structure factors.

Structure factors are read with a call to `GSASII.GSASII.OnImportSfact()` which in turn calls `GSASII.GSASII.OnImportGeneric()`, which calls methods `ExtensionValidator()`, `ContentsValidator()` and `Reader()`.

See *Writing a Import Routine* for an explanation on how to use import classes in general. The specifics for reading a structure factor histogram require that the `Reader()` routine in the import class need to do only a few things: It should load `RefDict` item `'RefList'` with the reflection list, and set `Parameters` with the instrument parameters (initialized with `InitParameters()` and set with `UpdateParameters()`).

Banks = None
self.RefDict is a dict containing the reflection information, as read from the file. Item 'RefList' contains the reflection information. See the *Single Crystal Reflection Data Structure* for the contents of each row. Dict element 'FF' contains the form factor values for each element type; if this entry is left as initialized (an empty list) it will be initialized as needed later.

InitParameters()
initialize the instrument parameters structure

Parameters = None
self.Parameters is a list with two dicts for data parameter settings

ReInitialize()
Reinitialize the Reader to initial settings

UpdateParameters(*Type=None*, *Wave=None*)
Revise the instrument parameters

GSASIIIO.**IndexPeakListSave**(*G2frame*, *peaks*)
Save powder peaks from the indexing list

class GSASIIIO.**MultipleChoicesDialog**(*choicelist*, *headinglist*, *head='Select options'*, *title='Please select from options below'*, *parent=None*)
A dialog that offers a series of choices, each with a title and a wx.Choice widget. Intended to be used Modally. typical input:

- choicelist=[('a','b','c'), ('test1','test2'),('no choice',)]
- headinglist = ['select a, b or c', 'select 1 of 2', 'No option here']

selections are placed in self.chosen when OK is pressed

GSASIIIO.**PDFSave**(*G2frame*, *exports*)
Save a PDF G(r) and S(Q) in column formats

GSASIIIO.**PeakListSave**(*G2frame*, *file*, *peaks*)
Save powder peaks to a data file

GSASIIIO.**ProjFileOpen**(*G2frame*)
Read a GSAS-II project file and load into the G2 data tree

GSASIIIO.**ProjFileSave**(*G2frame*)
Save a GSAS-II project file

GSASIIIO.**PutG2Image**(*filename*, *Comments*, *Data*, *Npix*, *image*)
Write an image as a python pickle - might be better as an .edf file?

GSASIIIO.**ReadCIF**(*URLorFile*)
Open a CIF, which may be specified as a file name or as a URL using PyCifRW (from James Hester). The open routine gets confused with DOS names that begin with a letter and colon "C:dir" so this routine will try to open the passed name as a file and if that fails, try it as a URL

Parameters **URLorFile** (*str*) – string containing a URL or a file name. Code will try first to open it as a file and then as a URL.

Returns a PyCifRW CIF object.

GSASIIIO.**SaveIntegration**(*G2frame*, *PickId*, *data*)
Save image integration results as powder pattern(s)

GSASIIIO.**SetNewPhase**(*Name='New Phase'*, *SGData=None*, *cell=None*, *Super=None*)
Create a new phase dict with default values for various parameters

Parameters

- **Name** (*str*) – Name for new Phase
- **SGData** (*dict*) – space group data from `GSASIIspc:SpcGroup()`; defaults to data for P 1
- **cell** (*list*) – unit cell parameter list; defaults to [1.0,1.0,1.0,90.,90,90.,1.]

`GSASIIIO.`**`sfloat`**(*S*)
Convert a string to float. An empty field is treated as zero

`GSASIIIO.`**`sint`**(*S*)
Convert a string to int. An empty field is treated as zero

`GSASIIIO.`**`trim`**(*val*)
Simplify a string containing leading and trailing spaces as well as newlines, tabs, repeated spaces etc. into a shorter and more simple string, by replacing all ranges of whitespace characters with a single space.

Parameters **val** (*str*) – the string to be simplified

Returns the (usually) shortened version of the string

4.4 *ReadMarCCDFrame: Read Mar Files*

class `ReadMarCCDFrame.`**`marFrame`**(*File*, *byteOrd='<'*, *IFD={}*)
A class to extract correct mar header and image info from a MarCCD file

Parameters

- **File** (*str*) – file object [from open()]
- **byteOrd** – '<' (default) or '>'
- **IFD** (*dict*) – ?

4.5 *GSASIIpy3: Python 3.x Routines*

Module to hold python 3-compatible code, to keep it separate from code that will break with __future__ options.

`GSASIIpy3.`**`FormatPadValue`**(*val*, *maxdigits=None*)
Format a float to fit in `maxdigits[0]` spaces with maxdigits[1] after decimal.

Parameters

- **val** (*float*) – number to be formatted.
- **maxdigits** (*list*) – the number of digits & places after decimal to be used for display of the number (defaults to [10,2]).

Returns a string with exactly maxdigits[0] characters (except under error conditions), but last character will always be a space

`GSASIIpy3.`**`FormatSigFigs`**(*val*, *maxdigits=10*, *sigfigs=5*, *treatAsZero=1e-20*)
Format a float to use `maxdigits` or fewer digits with `sigfigs` significant digits showing (if room allows).

Parameters

- **val** (*float*) – number to be formatted.
- **maxdigits** (*int*) – the number of digits to be used for display of the number (defaults to 10).
- **sigfigs** (*int*) – the number of significant figures to use, if room allows

- **treatAsZero** (*float*) – numbers that are less than this in magnitude are treated as zero. Defaults to 1.0e-20, but this can be disabled if set to None.

Returns a string with <= maxdigits characters (I hope).

`GSASIIpy3.`**`FormatValue`**`(`*val*, *maxdigits=None*`)`

Format a float to fit in at most `maxdigits[0]` spaces with maxdigits[1] after decimal. Note that this code has been hacked from FormatSigFigs and may have unused sections.

Parameters

- **val** (*float*) – number to be formatted.
- **maxdigits** (*list*) – the number of digits & places after decimal to be used for display of the number (defaults to [10,2]).

Returns a string with <= maxdigits characters (usually).

`GSASIIpy3.`**`FormulaEval`**`(`*string*`)`

Evaluates a algebraic formula into a float, if possible. Works properly on fractions e.g. 2/3 only with python 3.0+ division.

Expressions such as 2/3, 3*pi, sin(45)/2, 2*sqrt(2), 2**10 can all be evaluated.

Parameters **string** (*str*) – Character string containing a Python expression to be evaluated.

Returns the value for the expression as a float or None if the expression does not evaluate to a valid number.

CHAPTER

FIVE

GSAS-II GUI SUBMODULES

5.1 *GSASIIphsGUI: Phase GUI*

Module to create the GUI for display of phase information in the data display window when a phase is selected. Phase information is stored in one or more *Phase Tree Item* objects. Note that there are functions that respond to some tabs in the phase GUI in other modules (such as GSASIIddata).

`GSASIIphsGUI.`**`UpdatePhaseData`**`(`*G2frame*, *Item*, *data*, *oldPage*`)`

Create the data display window contents when a phase is clicked on in the main (data tree) window. Called only from `GSASIIgrid.MovePatternTreeToGrid()`, which in turn is called from `GSASII.GSASII.OnPatternTreeSelChanged()` when a tree item is selected.

Parameters

- **G2frame** (*wx.frame*) – the main GSAS-II frame object
- **Item** (*wx.TreeItemId*) – the tree item that was selected
- **data** (*dict*) – all the information on the phase in a dictionary
- **oldPage** (*int*) – This sets a tab to select when moving from one phase to another, in which case the same tab is selected to display first. This is set only when the previous data tree selection is a phase, if not the value is None. The default action is to bring up the General tab.

5.2 *GSASIIddataGUI: Phase Diffraction Data GUI*

Module to create the GUI for display of diffraction data * phase information that is shown in the data display window (when a phase is selected.)

`GSASIIddataGUI.`**`UpdateDData`**`(`*G2frame*, *DData*, *data*, *hist='‘*`)`

Display the Diffraction Data associated with a phase (items where there is a value for each histogram and phase)

Parameters

- **G2frame** (*wx.frame*) – the main GSAS-II frame object
- **DData** (*wx.ScrolledWindow*) – notebook page to be used for the display
- **data** (*dict*) – all the information on the phase in a dictionary

5.3 *GSASIIElemGUI: GUI to select and delete element lists*

Module to select elements from a periodic table and to delete an element from a list of selected elements.

class `GSASIIElemGUI.`**`DeleteElement`**(*parent*, *choice*)
    Delete element from selected set widget

  `ElButton`(*id*, *name*, *pos*)
    Needs a doc string

class `GSASIIElemGUI.`**`PickElement`**(*parent*, *oneOnly=False*, *ifNone=False*)
    Makes periodic table widget for picking element - caller maintains element list

  `ElButton`(*name*, *pos*, *tip*, *color*)
    Needs a doc string

class `GSASIIElemGUI.`**`PickElements`**(*parent*, *list*)
    Makes periodic table widget for picking elements - caller maintains element list

5.4 *GSASIIconstrGUI: Constraint GUI routines*

Used to define constraints and rigid bodies.

class `GSASIIconstrGUI.`**`ConstraintDialog`**(*parent*, *title*, *text*, *data*, *separator='*'*, *varname=''*, *varyflag=False*)
    Window to edit Constraint values

class `GSASIIconstrGUI.`**`MultiIntegerDialog`**(*parent*, *title*, *prompts*, *values*)
    Input a series of integers based on prompts

`GSASIIconstrGUI.`**`UpdateConstraints`**(*G2frame*, *data*)
    Called when Constraints tree item is selected. Displays the constraints in the data window

`GSASIIconstrGUI.`**`UpdateRigidBodies`**(*G2frame*, *data*)
    Called when Rigid bodies tree item is selected. Displays the rigid bodies in the data window

5.5 *GSASIIimgGUI: Image GUI*

Control image display and processing

`GSASIIimgGUI.`**`CleanupMasks`**(*data*)
    If a mask creation is not completed, an empty mask entry is created in the masks array. This cleans them out. It is called when the masks page is first loaded and before saving them or after reading them in. This should also probably be done before they are used for integration.

`GSASIIimgGUI.`**`UpdateImageControls`**(*G2frame*, *data*, *masks*)
    Shows and handles the controls on the "Image Controls" data tree entry

`GSASIIimgGUI.`**`UpdateMasks`**(*G2frame*, *data*)
    Shows and handles the controls on the "Masks" data tree entry

`GSASIIimgGUI.`**`UpdateStressStrain`**(*G2frame*, *data*)
    Shows and handles the controls on the "Stress/Strain" data tree entry

5.6 *GSASIIpwdGUI: Powder Pattern GUI routines*

Used to define GUI controls for the routines that interact with the powder histogram (PWDR) data tree items.

`GSASIIpwdGUI.`**`CopyPlotCtrls`**`(`*G2frame*`)`
Global copy: Copy plot controls from current histogram to others.

`GSASIIpwdGUI.`**`CopySelectedHistItems`**`(`*G2frame*`)`
Global copy: Copy items from current histogram to others.

`GSASIIpwdGUI.`**`GetHistsLikeSelected`**`(`*G2frame*`)`
Get the histograms that match the current selected one: The histogram prefix and data type (PXC etc.), the number of wavelengths and the instrument geometry (Debye-Scherrer etc.) must all match. The current histogram is not included in the list.

Parameters G2frame (*wx.Frame*) – pointer to main GSAS-II data tree

`GSASIIpwdGUI.`**`IsHistogramInAnyPhase`**`(`*G2frame*, *histoName*`)`
Needs a doc string

`GSASIIpwdGUI.`**`SetCopyNames`**`(`*histName*, *dataType*, *addNames=[ ]*`)`
Determine the items in the sample parameters that should be copied, depending on the histogram type and the instrument type.

`GSASIIpwdGUI.`**`SetDefaultSASDModel`**`()`
Fills in default items for the SASD Models dictionary

`GSASIIpwdGUI.`**`SetDefaultSample`**`()`
Fills in default items for the Sample dictionary

`GSASIIpwdGUI.`**`SetDefaultSubstances`**`()`
Fills in default items for the SASD Substances dictionary

`GSASIIpwdGUI.`**`SetupSampleLabels`**`(`*histName*, *dataType*, *histType*`)`
Setup a list of labels and number formatting for use in labeling sample parameters. :param str histName: Name of histogram, ("PWDR ...") :param str dataType:

`GSASIIpwdGUI.`**`UpdateBackground`**`(`*G2frame*, *data*`)`
respond to selection of PWDR background data tree item.

`GSASIIpwdGUI.`**`UpdateIndexPeaksGrid`**`(`*G2frame*, *data*`)`
respond to selection of PWDR Index Peak List data tree item.

`GSASIIpwdGUI.`**`UpdateInstrumentGrid`**`(`*G2frame*, *data*`)`
respond to selection of PWDR/SASD Instrument Parameters data tree item.

`GSASIIpwdGUI.`**`UpdateLimitsGrid`**`(`*G2frame*, *data*, *plottype*`)`
respond to selection of PWDR Limits data tree item.

`GSASIIpwdGUI.`**`UpdateModelsGrid`**`(`*G2frame*, *data*`)`
respond to selection of SASD Models data tree item.

`GSASIIpwdGUI.`**`UpdatePDFGrid`**`(`*G2frame*, *data*`)`
respond to selection of PWDR PDF data tree item.

`GSASIIpwdGUI.`**`UpdatePeakGrid`**`(`*G2frame*, *data*`)`
respond to selection of PWDR powder peaks data tree item.

`GSASIIpwdGUI.`**`UpdateReflectionGrid`**`(`*G2frame*, *data*, *HKLF=False*, *Name=''*`)`
respond to selection of PWDR Reflections data tree item by displaying a table of reflections in the data window.

`GSASIIpwdGUI.`**`UpdateSampleGrid`**`(`*G2frame*, *data*`)`
respond to selection of PWDR/SASD Sample Parameters data tree item.

`GSASIIpwdGUI.`**`UpdateSubstanceGrid`**(*G2frame*, *data*)
respond to selection of SASD Substance data tree item.

`GSASIIpwdGUI.`**`UpdateUnitCellsGrid`**(*G2frame*, *data*)
respond to selection of PWDR Unit Cells data tree item.

5.7 *GSASIIrestrGUI: Restraint GUI routines*

Used to define restraints.

`GSASIIrestrGUI.`**`UpdateRestraints`**(*G2frame*, *data*, *Phases*, *phaseName*)
Respond to selection of the Restraints item on the data tree

5.8 *GSASIIexprGUI: Expression Handling*

This module defines a class for defining an expression in terms of values in a parameter dictionary via a wx.Dialog. The dialog creates a `GSASII.ExpressionObj` which is used to evaluate the expression against a supplied parameter dictionary.

The expression is parsed to find variables used in the expression and then the user is asked to assign parameters from the dictionary to each variable.

Default expressions are read from file DefaultExpressions.txt using `GSASIIpath.LoadConfigFile()`.

class `GSASIIexprGUI.`**`ExpressionDialog`**(*parent*, *parmDict*, *exprObj=None*, *header='Enter restraint expression here'*, *wintitle='Expression Editor'*, *fit=True*, *VarLabel=None*, *depVarDict=None*, *ExtraButton=None*, *usedVars=[ ]*)
A wx.Dialog that allows a user to input an arbitrary expression to be evaluated and possibly minimized.

To do this, the user assigns a new (free) or existing GSAS-II parameter to each parameter label used in the expression. The free parameters can optionally be designated to be refined. For example, is an expression is used such as:

```
'A*np.exp(-B/C)'
```

then A, B and C can each be assigned as Free parameter with a user-selected value or to any existing GSAS-II variable in the parameter dictionary. As the expression is entered it is checked for validity.

After the `ExpressionDialog` object is created, use `Show()` to run it and obtain a `GSASIIobj.ExpressionObj` object with the user input.

Parameters

- **parent** (*wx.Frame*) – The parent of the Dialog. Can be None, but better is to provide the name of the Frame where the dialog is called.
- **parmDict** (*dict*) – a dict with defined parameters and their values. Each value may be a list with parameter values and a refine flag or may just contain the parameter value (non-float/int values in dict are ignored)
- **exprObj** (*str*) – a `GSASIIobj.ExpressionObj` object with an expression and label assignments or None (default)
- **wintitle** (*str*) – String placed on title bar of dialog; defaults to “Expression Editor”
- **header** (*str*) – String placed at top of dialog to tell the user what they will do here; default is “Enter restraint expression here”

- **fit** (*bool*) – determines if the expression will be used in fitting (default=True). If set to False, and refinement flags are not shown and Free parameters are not offered as an assignment option.
- **VarLabel** (*str*) – an optional variable label to include before the expression input. Ignored if None (default)
- **depVarDict** (*list*) – a dict of choices for the dependent variable to be fitted to the expression and their values. Ignored if None (default).
- **ExtraButton** (*list*) – a list with two terms that define [0]: the label for an extra button and [1] the callback routine to be used when the button is pressed. The button will only be enabled when the OK button can be used (meaning the equation/expression is valid). The default is None, meaning this will not be used.
- **usedVars** (*list*) – defines a list of previously used variable names. These names will not be reused as defaults for new free variables. (The default is an empty list).

`CheckVars`()
Check that appropriate variables are defined for each symbol used in `self.expr`

Returns a text error message or None if all needed input is present

`GetDepVar`()
Returns the name of the dependent variable, when depVarDict is used.

`OnChar`(*event*)
Called as each character is entered. Cancels any running timer and starts a new one. The timer causes a check of syntax after 2 seconds without input. Disables the OK button until a validity check is complete.

`OnChoice`(*event*)
Respond to a selection of a variable type for a label in an expression

`OnDepChoice`(*event*)
Respond to a selection of a variable type for a label in an expression

`OnValidate`(*event*)
Respond to a press of the Validate button or when a variable is associated with a label (in `OnChoice()`)

`Repaint`(*exprObj*)
Redisplay the variables and continue the validation

`RestartTimer`()
Cancels any running timer and starts a new one. The timer causes a check of syntax after 2 seconds unless there is further input. Disables the OK button until a validity check is complete.

`SelectG2var`(*sel*, *var*, *parmList*)
Offer a selection of a GSAS-II variable.

Parameters **sel** (*int*) – Determines the type of variable to be selected. where 1 is used for Phase variables, and 2 for Histogram/Phase vars, 3 for Histogram vars and 4 for Global vars.

Returns a variable name or None (if Cancel is pressed)

`Show`(*mode=True*)
Call to use the dialog after it is created.

Returns None (On Cancel) or a new `ExpressionObj`

`defSize` = **None**
Starting size for dialog

`depVarDict` = **None**
dict for dependent variables

dependentVar = None
name for dependent variable selection, when depVarDict is specified

expr = None
Expression as a text string

exprVarLst = None
A list containing the variables utilized in the current expression. Placed into a `GSASIIobj.ExpressionObj` object when the dialog is closed with "OK", saving any changes.

parmDict = None
A copy of the G2 parameter dict (parmDict) except only numerical values are included and only the value (not the vary flag, if present) is included.

setEvalResult (*msg*)
Show a string in the expression result area

showError (*msg1*, *msg2=''*, *msg3=''*)
Show an error message of 1 to 3 sections. The second section is shown in an equally-spaced font.

Parameters

- **msg1** (*str*) – msg1 is shown in a the standard font
- **msg2** (*str*) – msg2 is shown in a equally-spaced (wx.MODERN) font
- **msg3** (*str*) – msg3 is shown in a the standard font

usedVars = None
variable names that have been used and should not be reused by default

varName = None
Name assigned to each variable

varRefflag = None
Refinement flag for a variable (Free parameters only)

varSelect = None
A dict that shows the variable type for each label found in the expression.

- If the value is None or is not defined, the value is not assigned.
- If the value is 0, then the varible is "free" – a new refineable parameter.
- Values above 1 determine what variables will be shown when the option is selected.

varValue = None
Value for a variable (Free parameters only)

GSASIIexprGUI.**IndexParmDict** (*parmDict*, *wildcard*)
Separate the parameters in parmDict into list of keys by parameter type.

Parameters

- **parmDict** (*dict*) – a dict with GSAS-II parameters
- **wildcard** (*bool*) – True if wildcard versions of parameters should be generated and added to the lists

Returns a dict of lists where key 1 is a list of phase parameters, 2 is histogram/phase parms, 3 is histogram parms and 4 are global parameters

GSASIIexprGUI.**LoadDefaultExpressions** ()
Read a configuration file with default expressions from all files named DefaultExpressions.txt found in the path. Duplicates are removed and expressions are sorted alphabetically

CHAPTER

SIX

GSAS-II STRUCTURE SUBMODULES

6.1 GSASIIstrMain: main structure routine

`GSASIIstrMain.`**`BestPlane`**(*PlaneData*)
Needs a doc string

`GSASIIstrMain.`**`DisAglTor`**(*DATData*)
Needs a doc string

`GSASIIstrMain.`**`PrintDistAngle`**(*DisAglCtls*, *DisAglData*, *out=<open file '<stdout>', mode 'w' at 0x10028e150>*)
Print distances and angles

Parameters

- **DisAglCtls** (*dict*) – contains distance/angle radii usually defined using `GSASIIgrid.DisAglDialog()`
- **DisAglData** (*dict*) – contains phase data: Items 'OrigAtoms' and 'TargAtoms' contain the atoms to be used for distance/angle origins and atoms to be used as targets. Item 'SGData' has the space group information (see *Space Group object*)
- **out** (*file*) – file object for output. Defaults to sys.stdout.

`GSASIIstrMain.`**`Refine`**(*GPXfile*, *dlg*)
Global refinement – refines to minimize against all histograms

`GSASIIstrMain.`**`RefineCore`**(*Controls*, *Histograms*, *Phases*, *restraintDict*, *rigidbodyDict*, *parmDict*, *varyList*, *calcControls*, *pawleyLookup*, *ifPrint*, *printFile*, *dlg*)
Core optimization routines, shared between SeqRefine and Refine

`GSASIIstrMain.`**`RetDistAngle`**(*DisAglCtls*, *DisAglData*)
Compute and return distances and angles

Parameters

- **DisAglCtls** (*dict*) – contains distance/angle radii usually defined using `GSASIIgrid.DisAglDialog()`
- **DisAglData** (*dict*) – contains phase data: Items 'OrigAtoms' and 'TargAtoms' contain the atoms to be used for distance/angle origins and atoms to be used as targets. Item 'SGData' has the space group information (see *Space Group object*)

Returns

AtomLabels,DistArray,AngArray where:

AtomLabels is a dict of atom labels, keys are the atom number

DistArray is a dict keyed by the origin atom number where the value is a list of distance entries. The value for each distance is a list containing:

0. the target atom number (int);
1. the unit cell offsets added to x,y & z (tuple of int values)
2. the symmetry operator number (which may be modified to indicate centering and center of symmetry)
3. an interatomic distance in A (float)
4. an uncertainty on the distance in A or 0.0 (float)

AngArray is a dict keyed by the origin (central) atom number where the value is a list of angle entries. The value for each angle entry consists of three values:

0. a distance item reference for one neighbor (int)
1. a distance item reference for a second neighbor (int)
2. a angle, uncertainty pair; the s.u. may be zero (tuple of two floats)

The AngArray distance reference items refer directly to the index of the items in the DistArray item for the list of distances for the central atom.

`GSASIIstrMain.`**`SeqRefine`**`(`*GPXfile*, *dlg*`)`
Perform a sequential refinement – cycles through all selected histgrams, one at a time

`GSASIIstrMain.`**`main`**`()`
Needs a doc string

6.2 *GSASIIstrMath - structure math routines*

`GSASIIstrMath.`**`ApplyRBModelDervs`**`(`*dFdvDict*, *parmDict*, *rigidbodyDict*, *Phase*`)`
Needs a doc string

`GSASIIstrMath.`**`ApplyRBModels`**`(`*parmDict*, *Phases*, *rigidbodyDict*, *Update=False*`)`
Takes RB info from RBModels in Phase and RB data in rigidbodyDict along with current RB values in parmDict & modifies atom contents (xyz & Uij) of parmDict

`GSASIIstrMath.`**`ApplyXYZshifts`**`(`*parmDict*, *varyList*`)`
takes atom x,y,z shift and applies it to corresponding atom x,y,z value

Parameters

- **parmDict** (*dict*) – parameter dictionary
- **varyList** (*list*) – list of variables (not used!)

Returns newAtomDict - dictionary of new atomic coordinate names & values; key is parameter shift name

`GSASIIstrMath.`**`Dict2Values`**`(`*parmdict*, *varylist*`)`
Use before call to leastsq to setup list of values for the parameters in parmdict, as selected by key in varylist

`GSASIIstrMath.`**`GetAbsorb`**`(`*refl*, *im*, *hfx*, *calcControls*, *parmDict*`)`
Needs a doc string

`GSASIIstrMath.`**`GetAbsorbDerv`**`(`*refl*, *im*, *hfx*, *calcControls*, *parmDict*`)`
Needs a doc string

`GSASIIstrMath.`**`GetAtomFXU`**(*pfx*, *calcControls*, *parmDict*)
Needs a doc string

`GSASIIstrMath.`**`GetAtomSSFXU`**(*pfx*, *calcControls*, *parmDict*)
Needs a doc string

`GSASIIstrMath.`**`GetFobsSq`**(*Histograms*, *Phases*, *parmDict*, *calcControls*)
Needs a doc string

`GSASIIstrMath.`**`GetHStrainShift`**(*refl*, *im*, *SGData*, *phfx*, *hfx*, *calcControls*, *parmDict*)
Needs a doc string

`GSASIIstrMath.`**`GetHStrainShiftDerv`**(*refl*, *im*, *SGData*, *phfx*, *hfx*, *calcControls*, *parmDict*)
Needs a doc string

`GSASIIstrMath.`**`GetIntensityCorr`**(*refl*, *im*, *uniq*, *G*, *g*, *pfx*, *phfx*, *hfx*, *SGData*, *calcControls*, *parmDict*)
Needs a doc string

`GSASIIstrMath.`**`GetIntensityDerv`**(*refl*, *im*, *wave*, *uniq*, *G*, *g*, *pfx*, *phfx*, *hfx*, *SGData*, *calcControls*, *parmDict*)
Needs a doc string

`GSASIIstrMath.`**`GetNewCellParms`**(*parmDict*, *varyList*)
Needs a doc string

`GSASIIstrMath.`**`GetPrefOri`**(*uniq*, *G*, *g*, *phfx*, *hfx*, *SGData*, *calcControls*, *parmDict*)
March-Dollase preferred orientation correction

`GSASIIstrMath.`**`GetPrefOriDerv`**(*refl*, *im*, *uniq*, *G*, *g*, *phfx*, *hfx*, *SGData*, *calcControls*, *parmDict*)
Needs a doc string

`GSASIIstrMath.`**`GetPwdrExt`**(*refl*, *im*, *pfx*, *phfx*, *hfx*, *calcControls*, *parmDict*)
Needs a doc string

`GSASIIstrMath.`**`GetPwdrExtDerv`**(*refl*, *im*, *pfx*, *phfx*, *hfx*, *calcControls*, *parmDict*)
Needs a doc string

`GSASIIstrMath.`**`GetReflPos`**(*refl*, *im*, *wave*, *A*, *pfx*, *hfx*, *calcControls*, *parmDict*)
Needs a doc string

`GSASIIstrMath.`**`GetReflPosDerv`**(*refl*, *im*, *wave*, *A*, *pfx*, *hfx*, *calcControls*, *parmDict*)
Needs a doc string

`GSASIIstrMath.`**`GetSampleSigGam`**(*refl*, *im*, *wave*, *G*, *GB*, *SGData*, *hfx*, *phfx*, *calcControls*, *parmDict*)
Needs a doc string

`GSASIIstrMath.`**`GetSampleSigGamDerv`**(*refl*, *im*, *wave*, *G*, *GB*, *SGData*, *hfx*, *phfx*, *calcControls*, *parmDict*)
Needs a doc string

`GSASIIstrMath.`**`HessRefine`**(*values*, *HistoPhases*, *parmDict*, *varylist*, *calcControls*, *pawleyLookup*, *dlg*)
Loop over histograms and compute derivatives of the fitting model (M) with respect to all parameters. For each histogram, the Jacobian matrix, dMdv, with dimensions (n by m) where n is the number of parameters and m is the number of data points *in the histogram*. The (n by n) Hessian is computed from each Jacobian and it is returned. This routine is used when refinement derivatives are selected as "analtytic Hessian" in Controls.

Returns Vec,Hess where Vec is the least-squares vector and Hess is the Hessian

`GSASIIstrMath.`**`SCExtinction`**(*ref*, *im*, *phfx*, *hfx*, *pfx*, *calcControls*, *parmDict*, *varyList*)
Single crystal extinction function; returns extinction & derivative

GSASIIstrMath.**SHPOcal**(*refl*, *im*, *g*, *phfx*, *hfx*, *SGData*, *calcControls*, *parmDict*)
spherical harmonics preferred orientation (cylindrical symmetry only)

GSASIIstrMath.**SHPOcalDerv**(*refl*, *im*, *g*, *phfx*, *hfx*, *SGData*, *calcControls*, *parmDict*)
spherical harmonics preferred orientation derivatives (cylindrical symmetry only)

GSASIIstrMath.**SHTXcal**(*refl*, *im*, *g*, *pfx*, *hfx*, *SGData*, *calcControls*, *parmDict*)
Spherical harmonics texture

GSASIIstrMath.**SHTXcalDerv**(*refl*, *im*, *g*, *pfx*, *hfx*, *SGData*, *calcControls*, *parmDict*)
Spherical harmonics texture derivatives

GSASIIstrMath.**SStructureFactor**(*refDict*, *im*, *G*, *hfx*, *pfx*, *SGData*, *SSGData*, *calcControls*, *parmDict*)
Compute super structure factors for all h,k,l,m for phase puts the result, F^2, in each ref[8+im] in refList input:

Parameters

- **refDict** (*dict*) – where 'RefList' list where each ref = h,k,l,m,d,... 'FF' dict of form factors - filed in below
- **G** (*np.array*) – reciprocal metric tensor
- **pfx** (*str*) – phase id string
- **SGData** (*dict*) – space group info. dictionary output from SpcGroup
- **calcControls** (*dict*) –
- **ParmDict** (*dict*) –

GSASIIstrMath.**SStructureFactorDerv**(*refDict*, *im*, *G*, *hfx*, *pfx*, *SGData*, *SSGData*, *calcControls*, *parmDict*)
Needs a doc string

GSASIIstrMath.**StructureFactor**(*refDict*, *G*, *hfx*, *pfx*, *SGData*, *calcControls*, *parmDict*)
Not Used: here only for comparison the StructureFactor2 - faster version Compute structure factors for all h,k,l for phase puts the result, F^2, in each ref[8] in refList input:

Parameters

- **refDict** (*dict*) – where 'RefList' list where each ref = h,k,l,m,d,... 'FF' dict of form factors - filed in below
- **G** (*np.array*) – reciprocal metric tensor
- **pfx** (*str*) – phase id string
- **SGData** (*dict*) – space group info. dictionary output from SpcGroup
- **calcControls** (*dict*) –
- **ParmDict** (*dict*) –

GSASIIstrMath.**StructureFactor2**(*refDict*, *G*, *hfx*, *pfx*, *SGData*, *calcControls*, *parmDict*)
Compute structure factors for all h,k,l for phase puts the result, F^2, in each ref[8] in refList input:

Parameters

- **refDict** (*dict*) – where 'RefList' list where each ref = h,k,l,m,d,... 'FF' dict of form factors - filed in below
- **G** (*np.array*) – reciprocal metric tensor
- **pfx** (*str*) – phase id string
- **SGData** (*dict*) – space group info. dictionary output from SpcGroup

- **calcControls** (*dict*) –
- **ParmDict** (*dict*) –

GSASIIstrMath.**StructureFactorDerv**(*refDict*, *G*, *hfx*, *pfx*, *SGData*, *calcControls*, *parmDict*)
Needs a doc string

GSASIIstrMath.**Values2Dict**(*parmdict*, *varylist*, *values*)
Use after call to leastsq to update the parameter dictionary with values corresponding to keys in varylist

GSASIIstrMath.**dervHKLF**(*Histogram*, *Phase*, *calcControls*, *varylist*, *parmDict*, *rigidbodyDict*)
Loop over reflections in a HKLF histogram and compute derivatives of the fitting model (M) with respect to all parameters. Independent and dependant dM/dp arrays are returned to either dervRefine or HessRefine.

Returns

GSASIIstrMath.**dervRefine**(*values*, *HistoPhases*, *parmDict*, *varylist*, *calcControls*, *pawleyLookup*, *dlg*)
Loop over histograms and compute derivatives of the fitting model (M) with respect to all parameters. Results are returned in a Jacobian matrix (aka design matrix) of dimensions (n by m) where n is the number of parameters and m is the number of data points. This can exceed memory when m gets large. This routine is used when refinement derivatives are selected as "analtytic Jacobian" in Controls.

Returns Jacobian numpy.array dMdv for all histograms concatinated

GSASIIstrMath.**errRefine**(*values*, *HistoPhases*, *parmDict*, *varylist*, *calcControls*, *pawleyLookup*, *dlg=None*)
Computes the point-by-point discrepancies between every data point in every histogram and the observed value

Returns an np array of differences between observed and computed diffraction values.

GSASIIstrMath.**getPowderProfile**(*parmDict*, *x*, *varylist*, *Histogram*, *Phases*, *calcControls*, *pawleyLookup*)
Needs a doc string

GSASIIstrMath.**getPowderProfileDerv**(*parmDict*, *x*, *varylist*, *Histogram*, *Phases*, *rigidbodyDict*, *calcControls*, *pawleyLookup*)
Needs a doc string

GSASIIstrMath.**penaltyDeriv**(*pNames*, *pVal*, *HistoPhases*, *calcControls*, *parmDict*, *varyList*)
Needs a doc string

GSASIIstrMath.**penaltyFxn**(*HistoPhases*, *calcControls*, *parmDict*, *varyList*)
Needs a doc string

6.3 *GSASIIstrIO: structure I/O routines*

GSASIIstrIO.**GPXBackup**(*GPXfile*, *makeBack=True*)
makes a backup of the current .gpx file (?)

Parameters

- **GPXfile** (*str*) – full .gpx file name
- **makeBack** (*bool*) – if True (default), the backup is written to a new file; if False, the last backup is overwritten

Returns the name of the backup file that was written

GSASIIstrIO.**GetAllPhaseData**(*GPXfile*, *PhaseName*)
Returns the entire dictionary for PhaseName from GSASII gpx file

Parameters

- **GPXfile** (*str*) – full .gpx file name
- **PhaseName** (*str*) – phase name

Returns phase dictionary

`GSASIIstrIO.`**`GetConstraints`**(*GPXfile*)

Read the constraints from the GPX file and interpret them

called in `ReadCheckConstraints()`, `GSASIIstrMain.Refine()` and `GSASIIstrMain.SeqRefine()`.

`GSASIIstrIO.`**`GetControls`**(*GPXfile*)

Returns dictionary of control items found in GSASII gpx file

Parameters **GPXfile** (*str*) – full .gpx file name

Returns dictionary of control items

`GSASIIstrIO.`**`GetFprime`**(*controlDict*, *Histograms*)

Needs a doc string

`GSASIIstrIO.`**`GetHistogramData`**(*Histograms*, *Print=True*, *pFile=None*)

needs a doc string

`GSASIIstrIO.`**`GetHistogramNames`**(*GPXfile*, *hType*)

Returns a list of histogram names found in GSASII gpx file

Parameters

- **GPXfile** (*str*) – full .gpx file name
- **hType** (*str*) – list of histogram types

Returns list of histogram names (types = PWDR & HKLF)

`GSASIIstrIO.`**`GetHistogramPhaseData`**(*Phases*, *Histograms*, *Print=True*, *pFile=None*, *resetRefList=True*)

Loads the HAP histogram/phase information into dicts

Parameters

- **Phases** (*dict*) – phase information
- **Histograms** (*dict*) – Histogram information
- **Print** (*bool*) – prints information as it is read
- **pFile** (*file*) – file object to print to (the default, None causes printing to the console)
- **resetRefList** (*bool*) – Should the contents of the Reflection List be initialized on loading. The default, True, initializes the Reflection List as it is loaded.

Returns (hapVary,hapDict,controlDict) * hapVary: list of refined variables * hapDict: dict with refined variables and their values * controlDict: dict with computation controls (?)

`GSASIIstrIO.`**`GetHistograms`**(*GPXfile*, *hNames*)

Returns a dictionary of histograms found in GSASII gpx file

Parameters

- **GPXfile** (*str*) – full .gpx file name
- **hNames** (*str*) – list of histogram names

Returns dictionary of histograms (types = PWDR & HKLF)

`GSASIIstrIO.`**`GetPawleyConstr`**(*SGLaue*, *PawleyRef*, *im*, *pawleyVary*)
needs a doc string

`GSASIIstrIO.`**`GetPhaseData`**(*PhaseData*, *RestraintDict={}*, *rbIds={}*, *Print=True*, *pFile=None*)
needs a doc string

`GSASIIstrIO.`**`GetPhaseNames`**(*GPXfile*)
Returns a list of phase names found under 'Phases' in GSASII gpx file

Parameters **GPXfile** (*str*) – full .gpx file name

Returns list of phase names

`GSASIIstrIO.`**`GetRestraints`**(*GPXfile*)
Read the restraints from the GPX file. Throws an exception if not found in the .GPX file

`GSASIIstrIO.`**`GetRigidBodies`**(*GPXfile*)
Read the rigid body models from the GPX file

`GSASIIstrIO.`**`GetRigidBodyModels`**(*rigidbodyDict*, *Print=True*, *pFile=None*)
needs a doc string

`GSASIIstrIO.`**`GetUsedHistogramsAndPhases`**(*GPXfile*)
Returns all histograms that are found in any phase and any phase that uses a histogram. This also assigns numbers to used phases and histograms by the order they appear in the file.

Parameters **GPXfile** (*str*) – full .gpx file name

Returns

(Histograms,Phases)

- Histograms = dictionary of histograms as {name:data,...}
- Phases = dictionary of phases that use histograms

`GSASIIstrIO.`**`PrintRestraints`**(*cell*, *SGData*, *AtPtrs*, *Atoms*, *AtLookup*, *textureData*, *phaseRest*, *pFile*)
needs a doc string

`GSASIIstrIO.`**`ProcessConstraints`**(*constList*)
Interpret the constraints in the constList input into a dictionary, etc. All `GSASIIobj.G2VarObj` objects are mapped to the appropriate phase/hist/atoms based on the object internals (random Ids). If this can't be done (if a phase has been deleted, etc.), the variable is ignored. If the constraint cannot be used due to too many dropped variables, it is counted as ignored.

Parameters **constList** (*list*) – a list of lists where each item in the outer list specifies a constraint of some form, as described in the `GSASIIobj` *Constraint definition*.

Returns

a tuple of (constDict,fixedList,ignored) where:

- constDict (list of dicts) contains the constraint relationships
- fixedList (list) contains the fixed values for each type of constraint.
- ignored (int) counts the number of invalid constraint items (should always be zero!)

`GSASIIstrIO.`**`ReadCheckConstraints`**(*GPXfile*)
Load constraints and related info and return any error or warning messages

`GSASIIstrIO.`**`SetHistogramData`**(*parmDict*, *sigDict*, *Histograms*, *Print=True*, *pFile=None*)
needs a doc string

GSASIIstrIO.**SetHistogramPhaseData**(*parmDict*, *sigDict*, *Phases*, *Histograms*, *Print=True*, *pFile=None*)
needs a doc string

GSASIIstrIO.**SetPhaseData**(*parmDict*, *sigDict*, *Phases*, *RBIds*, *covData*, *RestraintDict=None*, *pFile=None*)
needs a doc string

GSASIIstrIO.**SetRigidBodyModels**(*parmDict*, *sigDict*, *rigidbodyDict*, *pFile=None*)
needs a doc string

GSASIIstrIO.**SetSeqResult**(*GPXfile*, *Histograms*, *SeqResult*)
Needs doc string

Parameters **GPXfile** (*str*) – full .gpx file name

GSASIIstrIO.**SetUsedHistogramsAndPhases**(*GPXfile*, *Histograms*, *Phases*, *RigidBodies*, *CovData*, *makeBack=True*)
Updates gpxfile from all histograms that are found in any phase and any phase that used a histogram. Also updates rigid body definitions.

Parameters

- **GPXfile** (*str*) – full .gpx file name
- **Histograms** (*dict*) – dictionary of histograms as {name:data,...}
- **Phases** (*dict*) – dictionary of phases that use histograms
- **RigidBodies** (*dict*) – dictionary of rigid bodies
- **CovData** (*dict*) – dictionary of refined variables, varyList, & covariance matrix
- **makeBack** (*bool*) – True if new backup of .gpx file is to be made; else use the last one made

GSASIIstrIO.**ShowBanner**(*pFile=None*)
Print authorship, copyright and citation notice

GSASIIstrIO.**ShowControls**(*Controls*, *pFile=None*, *SeqRef=False*)
Print controls information

GSASIIstrIO.**cellFill**(*pfx*, *SGData*, *parmDict*, *sigDict*)
Returns the filled-out reciprocal cell (A) terms and their uncertainties from the parameter and sig dictionaries.

Parameters

- **pfx** (*str*) – parameter prefix (“n::”, where n is a phase number)
- **SGdata** (*dict*) – a symmetry object
- **parmDict** (*dict*) – a dictionary of parameters
- **sigDict** (*dict*) – a dictionary of uncertainties on parameters

Returns A,sigA where each is a list of six terms with the A terms

GSASIIstrIO.**cellVary**(*pfx*, *SGData*)
needs a doc string

GSASIIstrIO.**getBackupName**(*GPXfile*, *makeBack*)
Get the name for the backup .gpx file name

Parameters

- **GPXfile** (*str*) – full .gpx file name

- **makeBack** (*bool*) – if True the name of a new file is returned, if False the name of the last file that exists is returned

Returns the name of a backup file

`GSASIIstrIO.`**`getCellEsd`**(*pfx*, *SGData*, *A*, *covData*)
needs a doc string

CHAPTER

SEVEN

GSASIIMAPVARS: PARAMETER CONSTRAINTS

Module to implements algebraic contraints, parameter redefinition and parameter simplification contraints.

Parameter redefinition (new vars) is done by creating one or more relationships between a set of parameters

```
Mx1 * Px + My1 * Py +...
Mx2 * Px + Mz2 * Pz + ...
```

where Pj is a parameter name and Mjk is a constant.

Constant constraint Relations can also be supplied in the form of an equation:

```
nx1 * Px + ny1 * Py +... = C1
```

where Cn is a constant. These equations define an algebraic constrant.

Parameters can also be "fixed" (held), which prevents them from being refined.

All of the above three cases are input using routines GroupConstraints and GenerateConstraints. The input consists of a list of relationship dictionaries:

```
constrDict = [
     {'0:12:Scale': 2.0, '0:14:Scale': 4.0, '0:13:Scale': 3.0, '0:0:Scale': 0.5},
     {'2::C(10,6,1)': 1.0, '1::C(10,6,1)': 1.0},
     {'0::A0': 0.0}]
fixedList = ['5.0', None, '0']
```

Where the dictionary defines the first part of an expression and the corresponding fixedList item is either None (for parameter redefinition) or the constant value, for a constant constraint equation. A dictionary that contains a single term defines a variable that will be fixed (held). The multiplier and the fixedList value in this case are ignored.

Parameters can also be equivalenced or "slaved" to another parameter, such that one (independent) parameter is equated to several (now dependent) parameters. In algebraic form this is:

```
P0 = M1 * P1 = M2 * P2 = ...
```

Thus parameters P0, P1 and P2,... are linearly equivalent. Routine StoreEquivalence is used to specify these equivalences.

Parameter redefinition (new vars) describes a new, independent, parameter, which is defined in terms of dependent parameters that are defined in the Model, while fixed constrained relations effectively reduce the complexity of the Model by removing a degree of freedom. It is possible for a parameter to appear in both a parameter redefinition expression and a fixed constraint equation, but a parameter cannot be used a parameter equivalance cannot be used elsewhere (not fixed, constrained or redefined). Likewise a fixed parameter cannot be used elsewhere (not equivalanced, constrained or redefined).

Relationships are grouped so that a set of dependent parameters appear in only one group (done in routine GroupConstraints.) Note that if a group contains relationships/equations that involve N dependent parameters, there must exist N-C new parameters, where C is the number of contraint equations in the group. Routine GenerateConstraints takes the output from GroupConstraints and generates the "missing" relationships and saves that information in the module's global variables. Each generated parameter is named sequentially using paramPrefix.

A list of parameters that will be varied is specified as input to GenerateConstraints (varyList). A fixed parameter will simply be removed from this list preventing that parameter from being varied. Note that all parameters in a constraint relationship must specified as varied (appear in varyList) or none can be varied. This is checked in GenerateConstraints. Likewise, if all parameters in a constraint are not referenced in a refinement, the constraint is ignored, but if some parameters in a constraint group are not referenced in a refinement, but others are this constitutes and error.

- When a new variable is created, the variable is assigned the name associated in the constraint definition or it is assigned a default name of form `::constr<n>` (see paramPrefix). The vary setting for variables used in the constraint are ignored. Note that any generated "missing" relations are not varied. Only the input relations can be are varied.
- If all parameters in a fixed constraint equation are varied, the generated "missing" relations in the group are all varied. This provides the N-C degrees of freedom.

7.1 *External Routines*

To define a set of constrained and unconstrained relations, one defines a list of dictionary defining constraint parameters and their values, a list of fixed values for each constraint and a list of parameters to be varied. In addition, one uses `StoreEquivalence()` to define parameters that are equivalent. One can then use `CheckConstraints()` to check that the input is internally consistent and finally `GroupConstraints()` and `GenerateConstraints()` to generate the internally used tables. Routines `Map2Dict()` is used to initialize the parameter dictionary and `Dict2Map()`, `Dict2Deriv()`, and `ComputeDepESD()` are used to apply constraints. Routine `VarRemapShow()` is used to print out the constraint information, as stored by `GenerateConstraints()`.

`InitVars()` This is optionally used to clear out all defined previously defined constraint information

`StoreEquivalence()` To implement parameter redefinition, one calls StoreEquivalence. This should be called for every set of equivalence relationships. There is no harm in using StoreEquivalence with the same independent variable:

```
StoreEquivalence('x',('y',))
StoreEquivalence('x',('z',))
```

or equivalently

```
StoreEquivalence('x',('y','z'))
```

The latter will run more efficiently. Note that mixing independent and dependent variables is problematic. This is not allowed:

```
StoreEquivalence('x',('y',))
StoreEquivalence('y',('z',))
```

Use StoreEquivalence before calling GenerateConstraints or CheckConstraints

`CheckConstraints()` To check that input in internally consistent, use CheckConstraints

`Map2Dict()` To determine values for the parameters created in this module, one calls Map2Dict. This will not apply contraints.

`Dict2Map()` To take values from the new independent parameters and constraints, one calls Dict2Map. This will apply contraints.

`Dict2Deriv()` Use Dict2Deriv to determine derivatives on independent parameters from those on dependent ones

`ComputeDepESD()` Use ComputeDepESD to compute uncertainties on dependent variables

`VarRemapShow()` To show a summary of the parameter remapping, one calls VarRemapShow

7.2 *Global Variables*

dependentParmList: contains a list by group of lists of parameters used in the group. Note that parameters listed in dependentParmList should not be refined as they will not affect the model

indParmList: a list of groups of Independent parameters defined in each group. This contains both parameters used in parameter redefinitions as well as names of generated new parameters.

fixedVarList: a list of variables that have been 'fixed' by defining them as equal to a constant (::var: = 0). Note that the constant value is ignored at present. These variables are later removed from varyList which prevents them from being refined. Unlikely to be used externally.

arrayList: a list by group of relationship matrices to relate parameters in dependentParmList to those in indParmList. Unlikely to be used externally.

invarrayList: a list by group of relationship matrices to relate parameters in indParmList to those in dependentParmList. Unlikely to be used externally.

fixedDict: a dictionary containing the fixed values corresponding to parameter equations. The dict key is an ascii string, but the dict value is a float. Unlikely to be used externally.

7.3 *Routines*

Note that parameter names in GSAS-II are strings of form `<ph>:<hst>:<nam>`

`GSASIImapvars.`**`CheckConstraints`**`(`*varyList*, *constrDict*, *fixedList*`)`

Takes a list of relationship entries comprising a group of constraints and checks for inconsistencies such as conflicts in parameter/variable definitions and or inconsistently varied parameters.

Parameters

- **varyList** (*list*) – a list of parameters names that will be varied
- **constrDict** (*dict*) – a list of dicts defining relationships/constraints (as created in `GSASIIstrIO.ProcessConstraints()` and documented in `GroupConstraints()`)
- **fixedList** (*list*) – a list of values specifying a fixed value for each dict in constrDict. Values are either strings that can be converted to floats or `None` if the constraint defines a new parameter rather than a constant.

Returns

two strings:

- the first lists conflicts internal to the specified constraints
- the second lists conflicts where the varyList specifies some parameters in a constraint, but not all

If there are no errors, both strings will be empty

`GSASIImapvars.`**`ComputeDepESD`**`(`*covMatrix*, *varyList*, *parmDict*`)`

Compute uncertainties for dependent parameters from independent ones returns a dictionary containing the esd values for dependent parameters

`GSASIImapvars.`**`Dict2Deriv`**(*varyList*, *derivDict*, *dMdv*)

Compute derivatives for Independent Parameters from the derivatives for the original parameters

Parameters

- **varyList** (*list*) – a list of parameters names that will be varied
- **derivDict** (*dict*) – a dict containing derivatives for parameter values keyed by the parameter names.
- **dMdv** (*list*) – a Jacobian, as a list of np.array containing derivatives for dependent parameter computed from derivDict

`GSASIImapvars.`**`Dict2Map`**(*parmDict*, *varyList*)

Applies the constraints defined using `StoreEquivalence()`, `GroupConstraints()` and `GenerateConstraints()` by changing values in a dict containing the parameters. This should be done before the parameters are used for any computations

Parameters

- **parmDict** (*dict*) – a dict containing parameter values keyed by the parameter names. This will contain updated values for both dependent and independent parameters after Dict2Map is called. It will also contain some unexpected entries of every constant value {'0':0.0} & {'1.0':1.0}, which do not cause any problems.
- **varyList** (*list*) – a list of parameters names that will be varied

`GSASIImapvars.`**`GenerateConstraints`**(*groups*, *parmlist*, *varyList*, *constrDict*, *fixedList*, *parmDict=None*, *SeqHist=None*)

Takes a list of relationship entries comprising a group of constraints and builds the relationship lists and their inverse and stores them in global variables Also checks for internal conflicts or inconsistencies in parameter/variable definitions.

Parameters

- **groups** (*list*) – a list of grouped contraints where each constraint grouped containts a list of indices for constraint constrDict entries, created in `GroupConstraints()` (returned as 1st value)
- **parmlist** (*list*) – a list containing lists of parameter names contained in each group, created in `GroupConstraints()` (returned as 2nd value)
- **varyList** (*list*) – a list of parameters names (strings of form `<ph>:<hst>:<nam>`) that will be varied. Note that this is changed here.
- **constrDict** (*dict*) – a list of dicts defining relationships/constraints (as defined in `GroupConstraints()`)
- **fixedList** (*list*) – a list of values specifying a fixed value for each dict in constrDict. Values are either strings that can be converted to floats, float values or None if the constraint defines a new parameter.
- **parmDict** (*dict*) – a dict containing all parameters defined in current refinement.
- **SeqHist** (*int*) – number of current histogram, when used in a sequential refinement. None (default) otherwise. Wildcard variable names are set to the current histogram, when found if not None.

`GSASIImapvars.`**`GetDependentVars`**()

Return a list of dependent variables: e.g. variables that are constrained in terms of other variables

Returns a list of variable names

GSASIImapvars.**GetIndependentVars**()

Return a list of independent variables: e.g. variables that are created by constraints of other variables

Returns a list of variable names

GSASIImapvars.**GramSchmidtOrtho**(*a*, *nkeep=0*)

Use the Gram-Schmidt process (http://en.wikipedia.org/wiki/Gram-Schmidt) to find orthonormal unit vectors relative to first row.

If nkeep is non-zero, the first nkeep rows in the array are not changed

input: arrayin: a 2-D non-singular square array

returns: a orthonormal set of unit vectors as a square array

GSASIImapvars.**GroupConstraints**(*constrDict*)

divide the constraints into groups that share no parameters.

Parameters **constrDict** (*dict*) – a list of dicts defining relationships/constraints

```
constrDict = [{<constr1>}, {<constr2>}, ...]
```

where {<constr1>} is {'var1': mult1, 'var2': mult2,... }

Returns

two lists of lists:

- a list of grouped contraints where each constraint grouped containts a list of indices for constraint constrDict entries
- a list containing lists of parameter names contained in each group

GSASIImapvars.**InitVars**()

Initializes all constraint information

GSASIImapvars.**Map2Dict**(*parmDict*, *varyList*)

Create (or update) the Independent Parameters from the original set of Parameters

Removes dependent variables from the varyList

This should be done once, after the constraints have been defined using `StoreEquivalence()`, `GroupConstraints()` and `GenerateConstraints()` and before any variable refinement is done. This completes the parameter dictionary by defining independent parameters and it satisfies the constraint equations in the initial parameters

Parameters

- **parmDict** (*dict*) – a dict containing parameter values keyed by the parameter names. This will contain updated values for both dependent and independent parameters after Dict2Map is called. It will also contain some unexpected entries of every constant value {'0':0.0} & {'1.0':1.0}, which do not cause any problems.
- **varyList** (*list*) – a list of parameters names that will be varied

GSASIImapvars.**PrintIndependentVars**(*parmDict*, *varyList*, *sigDict*, *PrintAll=False*, *pFile=None*)

Print the values and uncertainties on the independent variables

GSASIImapvars.**StoreEquivalence**(*independentVar*, *dependentList*)

Takes a list of dependent parameter(s) and stores their relationship to a single independent parameter (independentVar)

Parameters

- **independentVar** (*str*) – name of master parameter that will be used to determine the value to set the dependent variables

- **dependentList** (*list*) – a list of parameters that will set from independentVar. Each item in the list can be a string with the parameter name or a tuple containing a name and multiplier: `['parm1',('parm2',.5),]`

`GSASIImapvars.`**`VarKeys`**`(`*constr*`)`

Finds the keys in a constraint that represent variables e.g. eliminates any that start with '_'

Parameters constr (*dict*) – a single constraint entry of form:

```
{'var1': mult1, 'var2': mult2,... '_notVar': val,...}
```

(see `GroupConstraints()`)

Returns a list of keys where any keys beginning with '_' are removed.

`GSASIImapvars.`**`VarRemapShow`**`(`*varyList*, *inputOnly=False*`)`

List out the saved relationships. This should be done after the constraints have been defined using `StoreEquivalence()`, `GroupConstraints()` and `GenerateConstraints()`.

Returns a string containing the details of the contraint relationships

CHAPTER

EIGHT

GSASIIIMAGE: IMAGE CALC MODULE

Ellipse fitting & image integration

`GSASIIimage.`**`EdgeFinder`**(*image*, *data*)
: this makes list of all x,y where I>edgeMin suitable for an ellipse search? Not currently used but might be useful in future?

`GSASIIimage.`**`Fill2ThetaAzimuthMap`**(*masks*, *TA*, *tam*, *image*)
: Needs a doc string

`GSASIIimage.`**`FitDetector`**(*rings*, *varyList*, *parmDict*, *Print=True*)
: Needs a doc string

`GSASIIimage.`**`FitStrSta`**(*Image*, *StrSta*, *Controls*)
: Needs a doc string

`GSASIIimage.`**`FitStrain`**(*rings*, *p0*, *dset*, *wave*, *phi*, *StaType*)
: Needs a doc string

`GSASIIimage.`**`GetAzm`**(*x*, *y*, *data*)
: Give azimuth value for detector x,y position; calibration info in data

`GSASIIimage.`**`GetDetXYfromThAzm`**(*Th*, *Azm*, *data*)
: Needs a doc string

`GSASIIimage.`**`GetDetectorXY`**(*dsp*, *azm*, *data*)
: Needs a doc string

`GSASIIimage.`**`GetDsp`**(*x*, *y*, *data*)
: Give d-spacing value for detector x,y position; calibration info in data

`GSASIIimage.`**`GetEllipse`**(*dsp*, *data*)
: uses Dandelin spheres to find ellipse or hyperbola parameters from detector geometry as given in image controls dictionary (data) and a d-spacing (dsp)

`GSASIIimage.`**`GetEllipse2`**(*tth*, *dxy*, *dist*, *cent*, *tilt*, *phi*)
: uses Dandelin spheres to find ellipse or hyperbola parameters from detector geometry on output radii[0] (b-minor axis) set < 0. for hyperbola

`GSASIIimage.`**`GetTth`**(*x*, *y*, *data*)
: Give 2-theta value for detector x,y position; calibration info in data

`GSASIIimage.`**`GetTthAzm`**(*x*, *y*, *data*)
: Give 2-theta, azimuth values for detector x,y position; calibration info in data

`GSASIIimage.`**`GetTthAzmDsp`**(*x*, *y*, *data*)
: Needs a doc string - checked OK for ellipses & hyperbola

`GSASIIimage.`**`GetTthAzmG`**(*x*, *y*, *data*)
Give 2-theta, azimuth & geometric corr. values for detector x,y position; calibration info in data - only used in integration

`GSASIIimage.`**`ImageCalibrate`**(*self*, *data*)
Needs a doc string

`GSASIIimage.`**`ImageCompress`**(*image*, *scale*)
Needs a doc string

`GSASIIimage.`**`ImageIntegrate`**(*image*, *data*, *masks*, *blkSize=128*, *dlg=None*, *returnN=False*)
Needs a doc string

`GSASIIimage.`**`ImageLocalMax`**(*image*, *w*, *Xpix*, *Ypix*)
Needs a doc string

`GSASIIimage.`**`ImageRecalibrate`**(*self*, *data*, *masks*)
Needs a doc string

`GSASIIimage.`**`Make2ThetaAzimuthMap`**(*data*, *masks*, *iLim*, *jLim*, *times*)
Needs a doc string

`GSASIIimage.`**`calcFij`**(*omg*, *phi*, *azm*, *th*)
Does something...

Uses parameters as defined by Bob He & Kingsley Smith, Adv. in X-Ray Anal. 41, 501 (1997)

Parameters

- **omg** – his omega = sample omega rotation; 0 when incident beam || sample surface, 90 when perp. to sample surface
- **phi** – his phi = sample phi rotation; usually = 0, axis rotates with omg.
- **azm** – his chi = azimuth around incident beam
- **th** – his theta = theta

`GSASIIimage.`**`checkEllipse`**(*Zsum*, *distSum*, *xSum*, *ySum*, *dist*, *x*, *y*)
Needs a doc string

`GSASIIimage.`**`makeMat`**(*Angle*, *Axis*)
Make rotation matrix from Angle and Axis

Parameters

- **Angle** (*float*) – in degrees
- **Axis** (*int*) – 0 for rotation about x, 1 for about y, etc.

`GSASIIimage.`**`makeRing`**(*dsp*, *ellipse*, *pix*, *reject*, *scalex*, *scaley*, *image*)
Needs a doc string

`GSASIIimage.`**`peneCorr`**(*tth*, *dep*, *tilt=0.0*, *azm=0.0*)
Needs a doc string

`GSASIIimage.`**`pointInPolygon`**(*pXY*, *xy*)
Needs a doc string

CHAPTER

NINE

GSASIIMATH: COMPUTATION MODULE

Routines for least-squares minimization and other stuff

GSASIImath.**AV2Q**(*A*, *V*)
convert angle (radians) & vector to quaternion q=r+ai+bj+ck

GSASIImath.**AVdeg2Q**(*A*, *V*)
convert angle (degrees) & vector to quaternion q=r+ai+bj+ck

GSASIImath.**AtomTLS2UIJ**(*atomData*, *atPtrs*, *Amat*, *rbObj*)
default doc string

Parameters **name** (*type*) – description

Returns type name: description

GSASIImath.**AtomUij2TLS**(*atomData*, *atPtrs*, *Amat*, *Bmat*, *rbObj*)
default doc string

Parameters **name** (*type*) – description

Returns type name: description

GSASIImath.**ChargeFlip**(*data*, *reflDict*, *pgbar*)
default doc string

Parameters **name** (*type*) – description

Returns type name: description

GSASIImath.**Den2Vol**(*Elements*, *density*)
converts density to molecular volume

Parameters

- **Elements** (*dict*) – elements in molecular formula; each must contain Num: number of atoms in formula Mass: at. wt.
- **density** (*float*) – material density in gm/cm^3

Returns float volume: molecular volume in A^3

GSASIImath.**El2EstVol**(*Elements*)
Estimate volume from molecular formula; assumes atom volume = 10A^3

Parameters **Elements** (*dict*) – elements in molecular formula; each must contain Num: number of atoms in formula

Returns float volume: estimate of molecular volume in A^3

GSASIImath.**El2Mass**(*Elements*)
compute molecular weight from Elements

Parameters **Elements** (*dict*) – elements in molecular formula; each must contain Num: number of atoms in formula Mass: at. wt.

Returns float mass: molecular weight.

`GSASIImath.`**`FillAtomLookUp`**(*atomData*, *indx*)
create a dictionary of atom indexes with atom IDs as keys

Parameters **atomData** (*list*) – Atom table to be used

Returns dict atomLookUp: dictionary of atom indexes with atom IDs as keys

`GSASIImath.`**`FindAtomIndexByIDs`**(*atomData*, *IDs*, *Draw=True*)
finds the set of atom array indices for a list of atom IDs. Will search either the Atom table or the drawAtom table.

Parameters

- **atomData** (*list*) – Atom or drawAtom table containting coordinates, etc.
- **IDs** (*list*) – atom IDs to be found
- **Draw** (*bool*) – True if drawAtom table to be searched; False if Atom table is searched

Returns list indx: atom (or drawAtom) indices

`GSASIImath.`**`Fourier4DMap`**(*data*, *reflDict*)
default doc string

Parameters **name** (*type*) – description

Returns type name: description

`GSASIImath.`**`FourierMap`**(*data*, *reflDict*)
default doc string

Parameters **name** (*type*) – description

Returns type name: description

`GSASIImath.`**`GetAngleSig`**(*Oatoms*, *Atoms*, *Amat*, *SGData*, *covData={}*)
default doc string

Parameters **name** (*type*) – description

Returns type name: description

`GSASIImath.`**`GetAtomCoordsByID`**(*pId*, *parmDict*, *AtLookup*, *indx*)
default doc string

Parameters **name** (*type*) – description

Returns type name: description

`GSASIImath.`**`GetAtomItemsById`**(*atomData*, *atomLookUp*, *IdList*, *itemLoc*, *numItems=1*)
gets atom parameters for atoms using atom IDs

Parameters

- **atomData** (*list*) – Atom table to be used
- **atomLookUp** (*dict*) – dictionary of atom indexes with atom IDs as keys
- **IdList** (*list*) – atom IDs to be found
- **itemLoc** (*int*) – pointer to desired 1st item in an atom table entry
- **numItems** (*int*) – number of items to be retrieved

Returns type name: description

`GSASIImath.`**`GetAtomsById`**(*atomData*, *atomLookUp*, *IdList*)
gets a list of atoms from Atom table that match a set of atom IDs

Parameters

- **atomData** (*list*) – Atom table to be used
- **atomLookUp** (*dict*) – dictionary of atom indexes with atom IDs as keys
- **IdList** (*list*) – atom IDs to be found

Returns list atoms: list of atoms found

`GSASIImath.`**`GetDATSig`**(*Oatoms*, *Atoms*, *Amat*, *SGData*, *covData={}*)
default doc string

Parameters **name** (*type*) – description

Returns type name: description

`GSASIImath.`**`GetDistSig`**(*Oatoms*, *Atoms*, *Amat*, *SGData*, *covData={}*)
default doc string

Parameters **name** (*type*) – description

Returns type name: description

`GSASIImath.`**`GetSHCoeff`**(*pId*, *parmDict*, *SHkeys*)
default doc string

Parameters **name** (*type*) – description

Returns type name: description

`GSASIImath.`**`GetTorsionSig`**(*Oatoms*, *Atoms*, *Amat*, *SGData*, *covData={}*)
default doc string

Parameters **name** (*type*) – description

Returns type name: description

`GSASIImath.`**`GetXYZDist`**(*xyz*, *XYZ*, *Amat*)

gets distance from position xyz to all XYZ, xyz & XYZ are np.array and are in crystal coordinates; Amat is crystal to Cart matrix

Parameters **name** (*type*) – description

Returns type name: description

`GSASIImath.`**`HessianLSQ`**(*func*, *x0*, *Hess*, *args=()*, *ftol=1.49012e-08*, *xtol=1.49012e-08*, *maxcyc=0*, *Print=False*)
Minimize the sum of squares of a function (f) evaluated on a series of values (y): $\sum_{y=0}^{N_{obs}} f(y, args)$

```
            Nobs
x = arg min(sum(func(y)**2,axis=0))
            y=0
```

Parameters

- **func** (*function*) – callable method or function should take at least one (possibly length N vector) argument and returns M floating point numbers.
- **x0** (*np.ndarray*) – The starting estimate for the minimization of length N

- **Hess** (*function*) – callable method or function A required function or method to compute the weighted vector and Hessian for func. It must be a symmetric NxN array
- **args** (*tuple*) – Any extra arguments to func are placed in this tuple.
- **ftol** (*float*) – Relative error desired in the sum of squares.
- **xtol** (*float*) – Relative error desired in the approximate solution.
- **maxcyc** (*int*) – The maximum number of cycles of refinement to execute, if -1 refine until other limits are met (ftol, xtol)
- **Print** (*bool*) – True for printing results (residuals & times) by cycle

Returns

(x,cov_x,infodict) where

- x : ndarray The solution (or the result of the last iteration for an unsuccessful call).
- cov_x : ndarray Uses the fjac and ipvt optional outputs to construct an estimate of the jacobian around the solution. `None` if a singular matrix encountered (indicates very flat curvature in some direction). This matrix must be multiplied by the residual standard deviation to get the covariance of the parameter estimates – see curve_fit.
- infodict : dict a dictionary of optional outputs with the keys:
  - 'fvec' : the function evaluated at the output
  - 'num cyc':
  - 'nfev':
  - 'lamMax':
  - 'psing':

`GSASIImath.`**`OmitMap`**(*data*, *reflDict*, *pgbar=None*)
default doc string

Parameters **name** (*type*) – description

Returns type name: description

`GSASIImath.`**`PeaksEquiv`**(*data*, *Ind*)
Find the equivalent map peaks for those selected. Works on the contents of data['Map Peaks'].

Parameters

- **data** – the phase data structure
- **Ind** (*list*) – list of selected peak indices

Returns augmented list of peaks including those related by symmetry to the ones in Ind

`GSASIImath.`**`PeaksUnique`**(*data*, *Ind*)
Finds the symmetry unique set of peaks from those selected. Works on the contents of data['Map Peaks'].

Parameters

- **data** – the phase data structure
- **Ind** (*list*) – list of selected peak indices

Returns the list of symmetry unique peaks from among those given in Ind

`GSASIImath.`**`Q2AV`**(*Q*)
convert quaternion to angle (radians 0-2pi) & normalized vector q=r+ai+bj+ck

GSASIImath.**Q2AVdeg**(*Q*)
convert quaternion to angle (degrees 0-360) & normalized vector q=r+ai+bj+ck

GSASIImath.**Q2Mat**(*Q*)
make rotation matrix from quaternion q=r+ai+bj+ck

GSASIImath.**RotateRBXYZ**(*Bmat*, *Cart*, *oriQ*)
rotate & transform cartesian coordinates to crystallographic ones no translation applied. To be used for numerical derivatives

Parameters **name** (*type*) – description

Returns type name: description

GSASIImath.**SSChargeFlip**(*data*, *reflDict*, *pgbar*)
default doc string

Parameters **name** (*type*) – description

Returns type name: description

GSASIImath.**SearchMap**(*generalData*, *drawingData*, *Neg=False*)
Does a search of a density map for peaks meeting the criterion of peak height is greater than mapData['cutOff']/100 of mapData['rhoMax'] where mapData is data['General']['mapData']; the map is also in mapData.

Parameters

- **generalData** – the phase data structure; includes the map
- **drawingData** – the drawing data structure
- **Neg** – if True then search for negative peaks (i.e. H-atoms & neutron data)

Returns

(peaks,mags,dzeros) where

- peaks : ndarray x,y,z positions of the peaks found in the map
- mags : ndarray the magnitudes of the peaks
- dzeros : ndarray the distance of the peaks from the unit cell origin
- dcent : ndarray the distance of the peaks from the unit cell center

GSASIImath.**SetMolCent**(*model*, *RBData*)
default doc string

Parameters **name** (*type*) – description

Returns type name: description

GSASIImath.**TLS2Uij**(*xyz*, *g*, *Amat*, *rbObj*)
default doc string

Parameters **name** (*type*) – description

Returns type name: description

GSASIImath.**UpdateMCSAxyz**(*Bmat*, *MCSA*)
default doc string

Parameters **name** (*type*) – description

Returns type name: description

GSASIImath.**UpdateRBUIJ**(*Bmat*, *Cart*, *RBObj*)
default doc string

Parameters **name** (*type*) – description

Returns type name: description

GSASIImath.**UpdateRBXYZ**(*Bmat*, *RBObj*, *RBData*, *RBType*)
default doc string

Parameters **name** (*type*) – description

Returns type name: description

GSASIImath.**ValEsd**(*value*, *esd=0*, *nTZ=False*)
Format a floating point number with a given level of precision or with in crystallographic format with a "esd", as value(esd). If esd is negative the number is formatted with the level of significant figures appropriate if abs(esd) were the esd, but the esd is not included. if the esd is zero, approximately 6 significant figures are printed. nTZ=True causes "extra" zeros to be removed after the decimal place. for example:

- "1.235(3)" for value=1.2346 & esd=0.003
- "1.235(3)e4" for value=12346. & esd=30
- "1.235(3)e6" for value=0.12346e7 & esd=3000
- "1.235" for value=1.2346 & esd=-0.003
- "1.240" for value=1.2395 & esd=-0.003
- "1.24" for value=1.2395 & esd=-0.003 with nTZ=True
- "1.23460" for value=1.2346 & esd=0.0

Parameters

- **value** (*float*) – number to be formatted
- **esd** (*float*) – uncertainty or if esd < 0, specifies level of precision to be shown e.g. esd=-0.01 gives 2 places beyond decimal
- **nTZ** (*bool*) – True to remove trailing zeros (default is False)

Returns value(esd) or value as a string

GSASIImath.**Vol2Den**(*Elements*, *volume*)
converts volume to density

Parameters

- **Elements** (*dict*) – elements in molecular formula; each must contain Num: number of atoms in formula Mass: at. wt.
- **volume** (*float*) – molecular volume in A^3

Returns float density: material density in gm/cm^3

GSASIImath.**XScattDen**(*Elements*, *vol*, *wave=0.0*)
Estimate X-ray scattering density from molecular formula & volume; ignores valence, but includes anomalous effects

Parameters

- **Elements** (*dict*) – elements in molecular formula; each element must contain Num: number of atoms in formula Z: atomic number

- **vol** (*float*) – molecular volume in A^3
- **wave** (*float*) – optional wavelength in A

Returns float rho: scattering density in 10^10cm^-2; if wave > 0 the includes f' contribution

Returns float mu: if wave>0 absorption coeff in cm^-1 ; otherwise 0

`GSASIImath.`**`adjHKLmax`**(*SGData*, *Hmax*)

default doc string

Parameters **name** (*type*) – description

Returns type name: description

`GSASIImath.`**`anneal`**(*func*, *x0*, *args=()*, *schedule='fast'*, *full_output=0*, *T0=None*, *Tf=1e-12*, *maxeval=None*, *maxaccept=None*, *maxiter=400*, *boltzmann=1.0*, *learn_rate=0.5*, *feps=1e-06*, *quench=1.0*, *m=1.0*, *n=1.0*, *lower=-100*, *upper=100*, *dwell=50*, *slope=0.9*, *ranStart=False*, *ranRange=0.1*, *autoRan=False*, *dlg=None*)

Minimize a function using simulated annealing.

Schedule is a schedule class implementing the annealing schedule. Available ones are 'fast', 'cauchy', 'boltzmann'

Parameters

- **func** (*callable*) – f(x, *args) Function to be optimized.
- **x0** (*ndarray*) – Initial guess.
- **args** (*tuple*) – Extra parameters to *func*.
- **schedule** (*base_schedule*) – Annealing schedule to use (a class).
- **full_output** (*bool*) – Whether to return optional outputs.
- **T0** (*float*) – Initial Temperature (estimated as 1.2 times the largest cost-function deviation over random points in the range).
- **Tf** (*float*) – Final goal temperature.
- **maxeval** (*int*) – Maximum function evaluations.
- **maxaccept** (*int*) – Maximum changes to accept.
- **maxiter** (*int*) – Maximum cooling iterations.
- **learn_rate** (*float*) – Scale constant for adjusting guesses.
- **boltzmann** (*float*) – Boltzmann constant in acceptance test (increase for less stringent test at each temperature).
- **feps** (*float*) – Stopping relative error tolerance for the function value in last four coolings.
- **quench,m,n** (*float*) – Parameters to alter fast_sa schedule.
- **lower,upper** (*float/ndarray*) – Lower and upper bounds on *x*.
- **dwell** (*int*) – The number of times to search the space at each temperature.
- **slope** (*float*) – Parameter for log schedule
- **ranStart=False** (*bool*) – True for set 10% of ranges about x

Returns

(xmin, Jmin, T, feval, iters, accept, retval) where

- xmin (ndarray): Point giving smallest value found.

- Jmin (float): Minimum value of function found.
- T (float): Final temperature.
- feval (int): Number of function evaluations.
- iters (int): Number of cooling iterations.
- accept (int): Number of tests accepted.
- retval (int): Flag indicating stopping condition:
  - 0: Points no longer changing
  - 1: Cooled to final temperature
  - 2: Maximum function evaluations
  - 3: Maximum cooling iterations reached
  - 4: Maximum accepted query locations reached
  - 5: Final point not the minimum amongst encountered points

Notes: Simulated annealing is a random algorithm which uses no derivative information from the function being optimized. In practice it has been more useful in discrete optimization than continuous optimization, as there are usually better algorithms for continuous optimization problems.

Some experimentation by trying the difference temperature schedules and altering their parameters is likely required to obtain good performance.

The randomness in the algorithm comes from random sampling in numpy. To obtain the same results you can call numpy.random.seed with the same seed immediately before calling scipy.optimize.anneal.

We give a brief description of how the three temperature schedules generate new points and vary their temperature. Temperatures are only updated with iterations in the outer loop. The inner loop is over xrange(dwell), and new points are generated for every iteration in the inner loop. (Though whether the proposed new points are accepted is probabilistic.)

For readability, let d denote the dimension of the inputs to func. Also, let x_old denote the previous state, and k denote the iteration number of the outer loop. All other variables not defined below are input variables to scipy.optimize.anneal itself.

In the 'fast' schedule the updates are

```
u ~ Uniform(0, 1, size=d)
y = sgn(u - 0.5) * T * ((1+ 1/T)**abs(2u-1) -1.0)
xc = y * (upper - lower)
x_new = x_old + xc

c = n * exp(-n * quench)
T_new = T0 * exp(-c * k**quench)
```

In the 'cauchy' schedule the updates are

```
u ~ Uniform(-pi/2, pi/2, size=d)
xc = learn_rate * T * tan(u)
x_new = x_old + xc

T_new = T0 / (1+k)
```

In the 'boltzmann' schedule the updates are

```
std = minimum( sqrt(T) * ones(d), (upper-lower) / (3*learn_rate) )
y ~ Normal(0, std, size=d)
x_new = x_old + learn_rate * y

T_new = T0 / log(1+k)
```

`GSASIImath.`**`calcRamaEnergy`**(*phi*, *psi*, *Coeff=[ ]*)

Computes pseudo potential energy from a pair of torsion angles and a numerical description of the potential energy surface. Used to create penalty function in LS refinement: $Eval(\phi, \psi) = C[0] * exp(-V/1000)$

where $V = -C[3] * (\phi - C[1])^2 - C[4] * (\psi - C[2])^2 - 2 * (\phi - C[1]) * (\psi - C[2])$

Parameters

- **phi** (*float*) – first torsion angle (ϕ)
- **psi** (*float*) – second torsion angle (ψ)
- **Coeff** (*list*) – pseudo potential coefficients

Returns list (sum,Eval): pseudo-potential difference from minimum & value; sum is used for penalty function.

`GSASIImath.`**`calcTorsionEnergy`**(*TOR*, *Coeff=[ ]*)

default doc string

Parameters **name** (*type*) – description

Returns type name: description

`GSASIImath.`**`findOffset`**(*SGData*, *A*, *Fhkl*)

default doc string

Parameters **name** (*type*) – description

Returns type name: description

`GSASIImath.`**`findSSOffset`**(*SGData*, *SSGData*, *A*, *Fhklm*)

default doc string

Parameters **name** (*type*) – description

Returns type name: description

`GSASIImath.`**`getAngSig`**(*VA*, *VB*, *Amat*, *SGData*, *covData={}*)

default doc string

Parameters **name** (*type*) – description

Returns type name: description

`GSASIImath.`**`getAtomXYZ`**(*atoms*, *cx*)

default doc string

Parameters **name** (*type*) – description

Returns type name: description

`GSASIImath.`**`getCWgam`**(*ins*, *pos*)

get CW peak profile gamma

Parameters

- **ins** (*dict*) – instrument parameters with at least ‘X’ & ‘Y’ as values only
- **pos** (*float*) – 2-theta of peak

Returns float getCWgam: peak gamma

`GSASIImath.`**`getCWgamDeriv`**(*pos*)
get derivatives of CW peak profile gamma wrt X & Y

Parameters **pos** (*float*) – 2-theta of peak

Returns list getCWgamDeriv: d(gam)/dX & d(gam)/dY

`GSASIImath.`**`getCWsig`**(*ins*, *pos*)
get CW peak profile sigma

Parameters

- **ins** (*dict*) – instrument parameters with at least 'U', 'V', & 'W' as values only
- **pos** (*float*) – 2-theta of peak

Returns float getCWsig: peak sigma

`GSASIImath.`**`getCWsigDeriv`**(*pos*)
get derivatives of CW peak profile sigma wrt U,V, & W

Parameters **pos** (*float*) – 2-theta of peak

Returns list getCWsigDeriv: d(sig)/dU, d(sig)/dV & d(sig)/dW

`GSASIImath.`**`getDensity`**(*generalData*)
calculate crystal structure density

Parameters **generalData** (*dict*) – The General dictionary in Phase

Returns float density: crystal density in gm/cm^3

`GSASIImath.`**`getDistDerv`**(*Oxyz*, *Txyz*, *Amat*, *Tunit*, *Top*, *SGData*)
default doc string

Parameters **name** (*type*) – description

Returns type name: description

`GSASIImath.`**`getMass`**(*generalData*)
Computes mass of unit cell contents

Parameters **generalData** (*dict*) – The General dictionary in Phase

Returns float mass: Crystal unit cell mass in AMU.

`GSASIImath.`**`getRamaDeriv`**(*XYZ*, *Amat*, *Coeff*)
Computes numerical derivatives of torsion angle pair pseudo potential with respect of crystallographic atom coordinates of the 5 atom sequence

Parameters

- **XYZ** (*nparray*) – crystallographic coordinates of 5 atoms
- **Amat** (*nparray*) – crystal to cartesian transformation matrix
- **Coeff** (*list*) – pseudo potential coefficients

Returns list (deriv) derivatives of pseudopotential with respect to 5 atom crystallographic xyz coordinates.

`GSASIImath.`**`getRestAngle`**(*XYZ*, *Amat*)
default doc string

Parameters **name** (*type*) – description

Returns type name: description

GSASIImath.**getRestChiral**(*XYZ*, *Amat*)
default doc string

Parameters **name** (*type*) – description

Returns type name: description

GSASIImath.**getRestDeriv**(*Func*, *XYZ*, *Amat*, *ops*, *SGData*)
default doc string

Parameters **name** (*type*) – description

Returns type name: description

GSASIImath.**getRestDist**(*XYZ*, *Amat*)
default doc string

Parameters **name** (*type*) – description

Returns type name: description

GSASIImath.**getRestPlane**(*XYZ*, *Amat*)
default doc string

Parameters **name** (*type*) – description

Returns type name: description

GSASIImath.**getRestPolefig**(*ODFln*, *SamSym*, *Grid*)
default doc string

Parameters **name** (*type*) – description

Returns type name: description

GSASIImath.**getRestPolefigDerv**(*HKL*, *Grid*, *SHCoeff*)
default doc string

Parameters **name** (*type*) – description

Returns type name: description

GSASIImath.**getRestRama**(*XYZ*, *Amat*)
Computes a pair of torsion angles in a 5 atom string

Parameters

- **XYZ** (*nparray*) – crystallographic coordinates of 5 atoms
- **Amat** (*nparray*) – crystal to cartesian transformation matrix

Returns list (phi,psi) two torsion angles in degrees

GSASIImath.**getRestTorsion**(*XYZ*, *Amat*)
default doc string

Parameters **name** (*type*) – description

Returns type name: description

GSASIImath.**getSyXYZ**(*XYZ*, *ops*, *SGData*)
default doc string

Parameters **name** (*type*) – description

Returns type name: description

GSASIImath.**getTOFalpha**(*ins*, *dsp*)
get TOF peak profile alpha

Parameters

- **ins** (*dict*) – instrument parameters with at least 'alpha' as values only
- **dsp** (*float*) – d-spacing of peak

Returns flaot getTOFalpha: peak alpha

GSASIImath.**getTOFalphaDeriv**(*dsp*)
get derivatives of TOF peak profile beta wrt alpha

Parameters dsp (*float*) – d-spacing of peak

Returns float getTOFalphaDeriv: d(alp)/d(alpha)

GSASIImath.**getTOFbeta**(*ins*, *dsp*)
get TOF peak profile beta

Parameters

- **ins** (*dict*) – instrument parameters with at least 'beat-0', 'beta-1' & 'beta-q' as values only
- **dsp** (*float*) – d-spacing of peak

Returns float getTOFbeta: peak beat

GSASIImath.**getTOFbetaDeriv**(*dsp*)
get derivatives of TOF peak profile beta wrt beta-0, beta-1, & beat-q

Parameters dsp (*float*) – d-spacing of peak

Returns list getTOFbetaDeriv: d(beta)/d(beat-0), d(beta)/d(beta-1) & d(beta)/d(beta-q)

GSASIImath.**getTOFgamma**(*ins*, *dsp*)
get TOF peak profile gamma

Parameters

- **ins** (*dict*) – instrument parameters with at least 'X' & 'Y' as values only
- **dsp** (*float*) – d-spacing of peak

Returns float getTOFgamma: peak gamma

GSASIImath.**getTOFgammaDeriv**(*dsp*)
get derivatives of TOF peak profile gamma wrt X & Y

Parameters dsp (*float*) – d-spacing of peak

Returns list getTOFgammaDeriv: d(gam)/dX & d(gam)/dY

GSASIImath.**getTOFsig**(*ins*, *dsp*)
get TOF peak profile sigma

Parameters

- **ins** (*dict*) – instrument parameters with at least 'sig-0', 'sig-1' & 'sig-q' as values only
- **dsp** (*float*) – d-spacing of peak

Returns float getTOFsig: peak sigma

GSASIImath.**getTOFsigDeriv**(*dsp*)
get derivatives of TOF peak profile gamma wrt sig-0, sig-1, & sig-q

Parameters dsp (*float*) – d-spacing of peak

Returns list getTOFsigDeriv: d(sig0/d(sig-0), d(sig)/d(sig-1) & d(sig)/d(sig-q)

GSASIImath.**getTorsionDeriv**(*XYZ*, *Amat*, *Coeff*)
default doc string

Parameters **name** (*type*) – description

Returns type name: description

GSASIImath.**getVCov**(*varyNames*, *varyList*, *covMatrix*)
obtain variance-covariance terms for a set of variables. NB: the varyList and covMatrix were saved by the last least squares refinement so they must match.

Parameters

- **varyNames** (*list*) – variable names to find v-cov matric for
- **varyList** (*list*) – full list of all variables in v-cov matrix
- **covMatrix** (*nparray*) – full variance-covariance matrix from the last least squares refinement

Returns nparray vcov: variance-covariance matrix for the variables given in varyNames

GSASIImath.**getWave**(*Parms*)
returns wavelength from Instrument parameters dictionary

Parameters **Parms** (*dict*) – Instrument parameters; must contain: Lam: single wavelength or Lam1: Ka1 radiation wavelength

Returns float wave: wavelength

GSASIImath.**invQ**(*Q*)
get inverse of quaternion q=r+ai+bj+ck; q* = r-ai-bj-ck

GSASIImath.**makeQuat**(*A*, *B*, *C*)
Make quaternion from rotation of A vector to B vector about C axis

Parameters **A,B,C** (*np.array*) – Cartesian 3-vectors

Returns quaternion & rotation angle in radians q=r+ai+bj+ck

GSASIImath.**mcsaSearch**(*data*, *RBdata*, *reflType*, *reflData*, *covData*, *pgbar*)
default doc string

Parameters **name** (*type*) – description

Returns type name: description

GSASIImath.**normQ**(*QA*)
get length of quaternion & normalize it q=r+ai+bj+ck

GSASIImath.**printRho**(*SGLaue*, *rho*, *rhoMax*)
default doc string

Parameters **name** (*type*) – description

Returns type name: description

GSASIImath.**prodQQ**(*QA*, *QB*)
Grassman quaternion product QA,QB quaternions; q=r+ai+bj+ck

GSASIImath.**prodQVQ**(*Q*, *V*)
compute the quaternion vector rotation qvq-1 = v' q=r+ai+bj+ck

GSASIImath.**randomAVdeg**(*r0*, *r1*, *r2*, *r3*)
create random angle (deg),vector from 4 random number in range (-1,1)

GSASIImath.**randomQ**(*r0*, *r1*, *r2*, *r3*)
create random quaternion from 4 random numbers in range (-1,1)

GSASIImath.**setPeakparms**(*Parms*, *Parms2*, *pos*, *mag*, *ifQ=False*, *useFit=False*)
set starting peak parameters for single peak fits from plot selection or auto selection

Parameters

- **Parms** (*dict*) – instrument parameters dictionary
- **Parms2** (*dict*) – table lookup for TOF profile coefficients
- **pos** (*float*) – peak position in 2-theta, TOF or Q (ifQ=True)
- **mag** (*float*) – peak top magnitude from pick
- **ifQ** (*bool*) – True if pos in Q
- **useFit** (*bool*) – True if use fitted CW Parms values (not defaults)

Returns list XY: peak list entry: for CW: [pos,0,mag,1,sig,0,gam,0] for TOF: [pos,0,mag,1,alp,0,bet,0,sig,0,gam,0] NB: mag refinement set by default, all others off

GSASIImath.**sortArray**(*data*, *pos*, *reverse=False*)
data is a list of items sort by pos in list; reverse if True

GSASIImath.**wavekE**(*wavekE*)
Convert wavelength to energy & vise versa

:param float waveKe:wavelength in A or energy in kE

:returns float waveKe:the other one

CHAPTER

TEN

GSASIIINDEX: CELL INDEXING MODULE

Cell indexing program: variation on that of A. Coehlo includes cell refinement from peak positions (not zero as yet)

This needs a bit of refactoring to remove the little bit of GUI code referencing wx

`GSASIIindex.`**`A2values`**`(`*ibrav*, *A*`)`
    needs a doc string

`GSASIIindex.`**`DoIndexPeaks`**`(`*peaks*, *controls*, *bravais*, *ifX20=True*`)`
    needs a doc string

`GSASIIindex.`**`FitHKL`**`(`*ibrav*, *peaks*, *A*, *Pwr*`)`
    needs a doc string

`GSASIIindex.`**`FitHKLT`**`(`*difC*, *ibrav*, *peaks*, *A*, *Z*, *Zref*`)`
    needs a doc string

`GSASIIindex.`**`FitHKLZ`**`(`*wave*, *ibrav*, *peaks*, *A*, *Z*, *Zref*`)`
    needs a doc string

`GSASIIindex.`**`FitHKLZSS`**`(`*wave*, *ibrav*, *peaks*, *A*, *V*, *Vref*, *Z*, *Zref*`)`
    needs a doc string

`GSASIIindex.`**`IndexPeaks`**`(`*peaks*, *HKL*`)`
    needs a doc string

`GSASIIindex.`**`IndexSSPeaks`**`(`*peaks*, *HKL*`)`
    needs a doc string

`GSASIIindex.`**`TestData`**`()`
    needs a doc string

`GSASIIindex.`**`Values2A`**`(`*ibrav*, *values*`)`
    needs a doc string

`GSASIIindex.`**`calc_M20`**`(`*peaks*, *HKL*, *ifX20=True*`)`
    needs a doc string

`GSASIIindex.`**`calc_M20SS`**`(`*peaks*, *HKL*`)`
    needs a doc string

`GSASIIindex.`**`findBestCell`**`(`*dlg*, *ncMax*, *A*, *Ntries*, *ibrav*, *peaks*, *V1*, *ifX20=True*`)`
    needs a doc string

`GSASIIindex.`**`getDmax`**`(`*peaks*`)`
    needs a doc string

`GSASIIindex.`**`getDmin`**`(`*peaks*`)`
    needs a doc string

GSASIIindex.**halfCell**(*ibrav*, *A*, *peaks*)
needs a doc string

GSASIIindex.**monoCellReduce**(*ibrav*, *A*)
needs a doc string

GSASIIindex.**oddPeak**(*indx*, *peaks*)
needs a doc string

GSASIIindex.**ran2axis**(*k*, *N*)
needs a doc string

GSASIIindex.**ranAbyR**(*Bravais*, *A*, *k*, *N*, *ranFunc*)
needs a doc string

GSASIIindex.**ranAbyV**(*Bravais*, *dmin*, *dmax*, *V*)
needs a doc string

GSASIIindex.**ranaxis**(*dmin*, *dmax*)
needs a doc string

GSASIIindex.**rancell**(*Bravais*, *dmin*, *dmax*)
needs a doc string

GSASIIindex.**refinePeaks**(*peaks*, *ibrav*, *A*, *ifX20=True*)
needs a doc string

GSASIIindex.**refinePeaksT**(*peaks*, *difC*, *ibrav*, *A*, *Zero*, *ZeroRef*)
needs a doc string

GSASIIindex.**refinePeaksZ**(*peaks*, *wave*, *ibrav*, *A*, *Zero*, *ZeroRef*)
needs a doc string

GSASIIindex.**refinePeaksZSS**(*peaks*, *wave*, *Inst*, *SGData*, *SSGData*, *maxH*, *ibrav*, *A*, *vec*, *vecRef*, *Zero*, *ZeroRef*)
needs a doc string

GSASIIindex.**rotOrthoA**(*A*)
needs a doc string

GSASIIindex.**scaleAbyV**(*A*, *V*)
needs a doc string

GSASIIindex.**sortM20**(*cells*)
needs a doc string

GSASIIindex.**swapMonoA**(*A*)
needs a doc string

CHAPTER

ELEVEN

GSASIIPLOT: PLOTTING ROUTINES

class `GSASIIplot.`**`G2Plot3D`**(*parent*, *id=-1*, *dpi=None*, ***kwargs*)
needs a doc string

class `GSASIIplot.`**`G2PlotMpl`**(*parent*, *id=-1*, *dpi=None*, ***kwargs*)
needs a doc string

class `GSASIIplot.`**`G2PlotNoteBook`**(*parent*, *id=-1*)
create a tabbed window for plotting

`Delete`(*name*)
delete a tabbed page

`OnNotebookKey`(*event*)
Called when a keystroke event gets picked up by the notebook window rather the child. This is not expected, but somehow it does sometimes on the Mac and perhaps Linux.

Assume that the page associated with the currently displayed tab has a child, .canvas; give that child the focus and pass it the event.

`OnPageChanged`(*event*)
respond to someone pressing a tab on the plot window

`Rename`(*oldName*, *newName*)
rename a tab

`add3D`(*name=''*)
Add a tabbed page with a 3D plot

`addMpl`(*name=''*)
Add a tabbed page with a matplotlib plot

`addOgl`(*name=''*)
Add a tabbed page with an openGL plot

`clear`()
clear all pages from plot window

class `GSASIIplot.`**`G2PlotOgl`**(*parent*, *id=-1*, *dpi=None*, ***kwargs*)
needs a doc string

class `GSASIIplot.`**`GSASIItoolbar`**(*plotCanvas*)
Override the matplotlib toolbar so we can add more icons

`OnArrow`(*event*)
reposition limits to scan or zoom by button press

`OnHelp`(*event*)
Respond to press of help button on plot toolbar

OnKey (*event*)
Provide user with list of keystrokes defined for plot as well as an alternate way to access the same functionality

GSASIIplot.**OnStartMask** (*G2frame*)
Initiate the start of a Frame or Polygon map

Parameters

- **G2frame** (*wx.Frame*) – The main GSAS-II tree "window"
- **eventkey** (*str*) – a single letter ('f' or 'p') that determines what type of mask is created.

GSASIIplot.**OnStartNewDzero** (*G2frame*)
Initiate the start of adding a new d-zero to a strain data set

Parameters

- **G2frame** (*wx.Frame*) – The main GSAS-II tree "window"
- **eventkey** (*str*) – a single letter ('a') that triggers the addition of a d-zero.

GSASIIplot.**Plot3DSngl** (*G2frame*, *newPlot=False*, *Data=None*, *hklRef=None*, *Title=False*)
3D Structure factor plotting package - displays reflections as rings proportional to F, F**2, etc. as requested as 3D array

GSASIIplot.**PlotCalib** (*G2frame*, *Inst*, *XY*, *Sigs*, *newPlot=False*)
plot of CW or TOF peak calibration

GSASIIplot.**PlotCovariance** (*G2frame*, *Data*)
needs a doc string

GSASIIplot.**PlotDeltSig** (*G2frame*, *kind*)
needs a doc string

GSASIIplot.**PlotExposedImage** (*G2frame*, *newPlot=False*, *event=None*)
General access module for 2D image plotting

GSASIIplot.**PlotISFG** (*G2frame*, *newPlot=False*, *type=''*)
Plotting package for PDF analysis; displays I(q), S(q), F(q) and G(r) as single or multiple plots with waterfall and contour plots as options

GSASIIplot.**PlotImage** (*G2frame*, *newPlot=False*, *event=None*, *newImage=True*)
Plot of 2D detector images as contoured plot. Also plot calibration ellipses, masks, etc.

GSASIIplot.**PlotIntegration** (*G2frame*, *newPlot=False*, *event=None*)
Plot of 2D image after image integration with 2-theta and azimuth as coordinates

GSASIIplot.**PlotPatterns** (*G2frame*, *newPlot=False*, *plotType='PWDR'*)
Powder pattern plotting package - displays single or multiple powder patterns as intensity vs 2-theta, q or TOF. Can display multiple patterns as "waterfall plots" or contour plots. Log I plotting available.

GSASIIplot.**PlotPeakWidths** (*G2frame*)
Plotting of instrument broadening terms as function of 2-theta Seen when "Instrument Parameters" chosen from powder pattern data tree

GSASIIplot.**PlotPowderLines** (*G2frame*)
plotting of powder lines (i.e. no powder pattern) as sticks

GSASIIplot.**PlotRama** (*G2frame*, *phaseName*, *Rama*, *RamaName*, *Names=[ ]*, *PhiPsi=[ ]*, *Coeff=[ ]*)
needs a doc string

GSASIIplot.**PlotRigidBody** (*G2frame*, *rbType*, *AtInfo*, *rbData*, *defaults*)
RB plotting package. Can show rigid body structures as balls & sticks

`GSASIIplot.`**`PlotSelectedSequence`**(*G2frame*, *ColumnList*, *TableGet*, *SelectX*, *fitnum=None*, *fitvals=None*)

Plot a result from a sequential refinement

Parameters

- **G2frame** (*wx.Frame*) – The main GSAS-II tree "window"
- **ColumnList** (*list*) – list of int values corresponding to columns selected as y values
- **TableGet** (*function*) – a function that takes a column number as argument and returns the column label, the values and there ESDs (or None)
- **SelectX** (*function*) – a function that returns a selected column number (or None) as the X-axis selection

`GSASIIplot.`**`PlotSizeStrainPO`**(*G2frame*, *data*, *hist='‘*, *Start=False*)

Plot 3D mustrain/size/preferred orientation figure. In this instance data is for a phase

`GSASIIplot.`**`PlotSngl`**(*G2frame*, *newPlot=False*, *Data=None*, *hklRef=None*, *Title='‘*)

Structure factor plotting package - displays zone of reflections as rings proportional to F, F**2, etc. as requested

`GSASIIplot.`**`PlotStrain`**(*G2frame*, *data*, *newPlot=False*)

plot of strain data, used for diagnostic purposes

`GSASIIplot.`**`PlotStructure`**(*G2frame*, *data*, *firstCall=False*)

Crystal structure plotting package. Can show structures as balls, sticks, lines, thermal motion ellipsoids and polyhedra

`GSASIIplot.`**`PlotTRImage`**(*G2frame*, *tax*, *tay*, *taz*, *newPlot=False*)

a test plot routine - not normally used

`GSASIIplot.`**`PlotTexture`**(*G2frame*, *data*, *Start=False*)

Pole figure, inverse pole figure plotting. dict generalData contains all phase info needed which is in data

`GSASIIplot.`**`PlotTorsion`**(*G2frame*, *phaseName*, *Torsion*, *TorName*, *Names=*[ ], *Angles=*[ ], *Coeff=*[ ])

needs a doc string

`GSASIIplot.`**`PlotXY`**(*G2frame*, *XY*, *XY2=None*, *labelX=None*, *labelY=None*, *newPlot=False*, *Title='‘*)

simple plot of xy data, used for diagnostic purposes

CHAPTER

TWELVE

GSASII POWDER CALCULATION MODULE

GSASIIpwd.**Absorb**(*Geometry*, *MuR*, *Tth*, *Phi=0*, *Psi=0*)
Calculate sample absorption :param str Geometry: one of 'Cylinder','Bragg-Brentano','Tilting Flat Plate in transmission','Fixed flat plate' :param float MuR: absorption coeff * sample thickness/2 or radius :param Tth: 2-theta scattering angle - can be numpy array :param float Phi: flat plate tilt angle - future :param float Psi: flat plate tilt axis - future

GSASIIpwd.**AbsorbDerv**(*Geometry*, *MuR*, *Tth*, *Phi=0*, *Psi=0*)
needs a doc string

GSASIIpwd.**CalcPDF**(*data*, *inst*, *xydata*)
needs a doc string

GSASIIpwd.**Dict2Values**(*parmdict*, *varylist*)
Use before call to leastsq to setup list of values for the parameters in parmdict, as selected by key in varylist

GSASIIpwd.**DoPeakFit**(*FitPgm*, *Peaks*, *Background*, *Limits*, *Inst*, *Inst2*, *data*, *prevVaryList=*[ ], *oneCycle=False*, *controls=None*, *dlg=None*)
needs a doc string

GSASIIpwd.**GetAsfMean**(*ElList*, *Sthl2*)
Calculate various scattering factor terms for PDF calcs

Parameters

- **ElList** (*dict*) – element dictionary contains scattering factor coefficients, etc.
- **Sthl2** (*np.array*) – numpy array of sin theta/lambda squared values

Returns mean(f^2), mean(f)^2, mean(compton)

GSASIIpwd.**GetNumDensity**(*ElList*, *Vol*)
needs a doc string

GSASIIpwd.**LorchWeight**(*Q*)
needs a doc string

GSASIIpwd.**Oblique**(*ObCoeff*, *Tth*)
currently assumes detector is normal to beam

GSASIIpwd.**Polarization**(*Pola*, *Tth*, *Azm=0.0*)
Calculate angle dependent x-ray polarization correction (not scaled correctly!)

Parameters

- **Pola** – polarization coefficient e.g 1.0 fully polarized, 0.5 unpolarized
- **Azm** – azimuthal angle e.g. 0.0 in plane of polarization
- **Tth** – 2-theta scattering angle - can be numpy array which (if either) of these is "right"?

Returns (pola, dpdPola) * pola = ((1-Pola)*npcosd(Azm)**2+Pola*npsind(Azm)**2)*npcosd(Tth)**2+ (1-Pola)*npsind(Azm)**2+Pola*npcosd(Azm)**2 * dpdPola: derivative needed for least squares

`GSASIIpwd.`**`Ruland`**(*RulCoff*, *wave*, *Q*, *Compton*)
needs a doc string

`GSASIIpwd.`**`SetBackgroundParms`**(*Background*)
needs a doc string

`GSASIIpwd.`**`SurfaceRough`**(*SRA*, *SRB*, *Tth*)
Suortti (J. Appl. Cryst, 5,325-331, 1972) surface roughness correction :param float SRA: Suortti surface roughness parameter :param float SRB: Suortti surface roughness parameter :param float Tth: 2-theta(deg) - can be numpy array

`GSASIIpwd.`**`SurfaceRoughDerv`**(*SRA*, *SRB*, *Tth*)
Suortti surface roughness correction derivatives :param float SRA: Suortti surface roughness parameter (dimensionless) :param float SRB: Suortti surface roughness parameter (dimensionless) :param float Tth: 2-theta(deg) - can be numpy array :return list: [dydSRA,dydSRB] derivatives to be used for intensity derivative

`GSASIIpwd.`**`TestData`**()
needs a doc string

`GSASIIpwd.`**`Transmission`**(*Geometry*, *Abs*, *Diam*)
Calculate sample transmission

Parameters

- **Geometry** (*str*) – one of 'Cylinder','Bragg-Brentano','Tilting flat plate in transmission','Fixed flat plate'
- **Abs** (*float*) – absorption coeff in cm-1
- **Diam** (*float*) – sample thickness/diameter in mm

`GSASIIpwd.`**`Values2Dict`**(*parmdict*, *varylist*, *values*)
Use after call to leastsq to update the parameter dictionary with values corresponding to keys in varylist

`GSASIIpwd.`**`calcIncident`**(*Iparm*, *xdata*)
needs a doc string

class `GSASIIpwd.`**`cauchy_gen`**(*momtype=1*, *a=None*, *b=None*, *xtol=1e-14*, *badvalue=None*, *name=None*, *longname=None*, *shapes=None*, *extradoc=None*)
needs a doc string

`GSASIIpwd.`**`ellipseSize`**(*H*, *Sij*, *GB*)
needs a doc string

`GSASIIpwd.`**`ellipseSizeDerv`**(*H*, *Sij*, *GB*)
needs a doc string

`GSASIIpwd.`**`factorize`**(*num*)
Provide prime number factors for integer num :returns: dictionary of prime factors (keys) & power for each (data)

class `GSASIIpwd.`**`fcjde_gen`**(*momtype=1*, *a=None*, *b=None*, *xtol=1e-14*, *badvalue=None*, *name=None*, *longname=None*, *shapes=None*, *extradoc=None*)
Finger-Cox-Jephcoat D(2phi,2th) function for S/L = H/L Ref: J. Appl. Cryst. (1994) 27, 892-900.

Parameters

- **x** – array -1 to 1
- **t** – 2-theta position of peak

- **s** – sum(S/L,H/L); S: sample height, H: detector opening, L: sample to detector opening distance
- **dx** – 2-theta step size in deg

Returns

for fcj.pdf

- T = x*dx+t
- s = S/L+H/L
- if x < 0:

```
fcj.pdf = [1/sqrt({cos(T)**2/cos(t)**2}-1) - 1/s]/|cos(T)|
```

- if x >= 0: fcj.pdf = 0

GSASIIpwd.**getBackground**(*pfx*, *parmDict*, *bakType*, *dataType*, *xdata*)
needs a doc string

GSASIIpwd.**getBackgroundDerv**(*hfx*, *parmDict*, *bakType*, *dataType*, *xdata*)
needs a doc string

GSASIIpwd.**getEpsVoigt**(*pos*, *alp*, *bet*, *sig*, *gam*, *xdata*)
needs a doc string

GSASIIpwd.**getFCJVoigt**(*pos*, *intens*, *sig*, *gam*, *shl*, *xdata*)
needs a doc string

GSASIIpwd.**getFCJVoigt3**(*pos*, *sig*, *gam*, *shl*, *xdata*)
needs a doc string

GSASIIpwd.**getFWHM**(*pos*, *Inst*)
needs a doc string

GSASIIpwd.**getHKLMpeak**(*dmin*, *Inst*, *SGData*, *SSGData*, *Vec*, *maxH*, *A*)
needs a doc string

GSASIIpwd.**getHKLpeak**(*dmin*, *SGData*, *A*, *Inst=None*)
needs a doc string

GSASIIpwd.**getPeakProfile**(*dataType*, *parmDict*, *xdata*, *varyList*, *bakType*)
needs a doc string

GSASIIpwd.**getPeakProfileDerv**(*dataType*, *parmDict*, *xdata*, *varyList*, *bakType*)
needs a doc string

GSASIIpwd.**getPsVoigt**(*pos*, *sig*, *gam*, *xdata*)
needs a doc string

GSASIIpwd.**getWidthsCW**(*pos*, *sig*, *gam*, *shl*)
Compute the peak widths used for computing the range of a peak for constant wavelength data. On low-angle side, 10 FWHM are used, on high-angle side 15 are used (for peaks above 90 deg, these are reversed.)

GSASIIpwd.**getWidthsTOF**(*pos*, *alp*, *bet*, *sig*, *gam*)
needs a doc string

GSASIIpwd.**getdEpsVoigt**(*pos*, *alp*, *bet*, *sig*, *gam*, *xdata*)
needs a doc string

GSASIIpwd.**getdFCJVoigt3**(*pos*, *sig*, *gam*, *shl*, *xdata*)
needs a doc string

`GSASIIpwd.`**`getdPsVoigt`**`(`*pos*, *sig*, *gam*, *xdata*`)`

needs a doc string

`GSASIIpwd.`**`getgamFW`**`(`*g*, *s*`)`

needs a doc string

`GSASIIpwd.`**`makeFFTsizeList`**`(`*nmin=1*, *nmax=1023*, *thresh=15*`)`

Provide list of optimal data sizes for FFT calculations

Parameters

- **nmin** (*int*) – minimum data size >= 1
- **nmax** (*int*) – maximum data size > nmin
- **thresh** (*int*) – maximum prime factor allowed

Returns list of data sizes where the maximum prime factor is < thresh

class `GSASIIpwd.`**`norm_gen`**`(`*momtype=1*, *a=None*, *b=None*, *xtol=1e-14*, *badvalue=None*, *name=None*, *longname=None*, *shapes=None*, *extradoc=None*`)`

needs a doc string

CHAPTER

THIRTEEN

GSAS-II SMALL ANGLE SCATTERING SUBMODULES

13.1 *GSASII small angle calculation module*

`GSASIIsasd.`**`CylinderARFF`**(*Q*, *R*, *args*)
Compute form factor for cylinders - can use numpy arrays param float Q: Q value array (A-1) param float R: cylinder radius (A) param array args: [float AR]: cylinder aspect ratio = L/D = L/2R returns float: form factor

`GSASIIsasd.`**`CylinderARVol`**(*R*, *args*)
Compute cylinder volume for radius & aspect ratio = L/D - numpy array friendly param float: R radius (A) param array args: [float AR]: =L/D=L/2R aspect ratio returns float:volume

`GSASIIsasd.`**`CylinderDFF`**(*Q*, *L*, *args*)
Compute form factor for cylinders - can use numpy arrays param float Q: Q value array (A-1) param float L: cylinder half length (A) param array args: [float R]: cylinder radius (A) returns float: form factor

`GSASIIsasd.`**`CylinderDVol`**(*L*, *args*)
Compute cylinder volume for length & diameter - numpy array friendly param float: L half length (A) param array args: [float D]: diameter (A) returns float:volume (A^3)

`GSASIIsasd.`**`CylinderFF`**(*Q*, *R*, *args*)
Compute form factor for cylinders - can use numpy arrays param float Q: Q value array (A-1) param float R: cylinder radius (A) param array args: [float L]: cylinder length (A) returns float: form factor

`GSASIIsasd.`**`CylinderVol`**(*R*, *args*)
Compute cylinder volume for radius & length - numpy array friendly param float R: diameter (A) param array args: [float L]: length (A) returns float:volume (A^3)

`GSASIIsasd.`**`DiluteSF`**(*Q*, *args=*[ ])
Default: no structure factor correction for dilute system

`GSASIIsasd.`**`G_matrix`**(*q*, *r*, *contrast*, *FFfxn*, *Volfxn*, *args=()*)
Calculates the response matrix $G(Q,r)$

Parameters

- **q** (*float*) – Q
- **r** (*float*) – r
- **contrast** (*float*) – $|\Delta\rho|^2$, the scattering contrast
- **FFfxn** (*function*) – form factor function FF(q,r,args)
- **Volfxn** (*function*) – volume function Vol(r,args)

Returns float G(Q,r)

GSASIIsasd.**GaussCume**(*x*, *pos*, *args*)
Standard Normal cumulative distribution - numpy friendly on x axis param float x: independent axis (can be numpy array) param float pos: location of distribution param float scale: width of distribution (sigma) param float shape: not used returns float: Normal cumulative distribution

GSASIIsasd.**GaussDist**(*x*, *pos*, *args*)
Standard Normal distribution - numpy friendly on x axis param float x: independent axis (can be numpy array) param float pos: location of distribution param float scale: width of distribution (sigma) param float shape: not used returns float: Normal distribution

GSASIIsasd.**HardSpheresSF**(*Q*, *args*)
Computes structure factor for not dilute monodisperse hard spheres Refs.: PERCUS,YEVICK PHYS. REV. 110 1 (1958),THIELE J. CHEM PHYS. 39 474 (1968), WERTHEIM PHYS. REV. LETT. 47 1462 (1981)

param float Q: Q value array (A-1) param array args: [float R, float VolFrac]: interparticle distance & volume fraction returns numpy array S(Q)

GSASIIsasd.**IPG**(*datum*, *sigma*, *G*, *Bins*, *Dbins*, *IterMax*, *Qvec=[]*, *approach=0.8*, *Power=-1*, *report=False*)
An implementation of the Interior-Point Gradient method of Michael Merritt & Yin Zhang, Technical Report TR04-08, Dept. of Comp. and Appl. Math., Rice Univ., Houston, Texas 77005, U.S.A. found on the web at http://www.caam.rice.edu/caam/trs/2004/TR04-08.pdf Problem addressed: Total Non-Negative Least Squares (TNNLS) :param float datum[]: :param float sigma[]: :param float[][] G: transformation matrix :param int IterMax: :param float Qvec: data positions for Power = 0-4 :param float approach: 0.8 default fitting parameter :param int Power: 0-4 for Q^Power weighting, -1 to use input sigma

GSASIIsasd.**InterPrecipitateSF**(*Q*, *args*)
Computes structure factor for precipitates in a matrix Refs.: E-Wen Huang, Peter K. Liaw, Lionel Porcar, Yun Liu, Yee-Lang Liu, Ji-Jung Kai, and Wei-Ren Chen,APPLIED PHYSICS LETTERS 93, 161904 (2008) R. Giordano, A. Grasso, and J. Teixeira, Phys. Rev. A 43, 6894 1991 param float Q: Q value array (A-1) param array args: [float R, float VolFr]: “radius” & volume fraction returns numpy array S(Q)

GSASIIsasd.**LSWCume**(*x*, *pos*, *args=[]*)
Lifshitz-Slyozov-Wagner Ostwald ripening cumulative distribution - numpy friendly on x axis param float x: independent axis (can be numpy array) param float pos: location of distribution param float scale: not used param float shape: not used returns float: LSW cumulative distribution

GSASIIsasd.**LSWDist**(*x*, *pos*, *args=[]*)
Lifshitz-Slyozov-Wagner Ostwald ripening distribution - numpy friendly on x axis ref: param float x: independent axis (can be numpy array) param float pos: location of distribution param float scale: not used param float shape: not used returns float: LSW distribution

GSASIIsasd.**LogNormalCume**(*x*, *pos*, *args*)
Standard LogNormal cumulative distribution - numpy friendly on x axis ref: http://www.itl.nist.gov/div898/handbook/index.htm 1.3.6.6.9 param float x: independent axis (can be numpy array) param float pos: location of distribution param float scale: width of distribution (sigma) param float shape: shape parameter returns float: LogNormal cumulative distribution

GSASIIsasd.**LogNormalDist**(*x*, *pos*, *args*)
Standard LogNormal distribution - numpy friendly on x axis ref: http://www.itl.nist.gov/div898/handbook/index.htm 1.3.6.6.9 param float x: independent axis (can be numpy array) param float pos: location of distribution param float scale: width of distribution (m) param float shape: shape - (sigma of log(LogNormal)) returns float: LogNormal distribution

exception GSASIIsasd.**MaxEntException**
Any exception from this module

GSASIIsasd.**MaxEnt_SB**(*datum*, *sigma*, *G*, *base*, *IterMax*, *image_to_data=None*, *data_to_image=None*, *report=False*)
do the complete Maximum Entropy algorithm of Skilling and Bryan

Parameters

- **datum[]** (*float*) –
- **sigma[]** (*float*) –
- **G** (*float[][]*) – transformation matrix
- **base[]** (*float*) –
- **IterMax** (*int*) –
- **image_to_data** (*obj*) – opus function (defaults to opus)
- **data_to_image** (*obj*) – tropus function (defaults to tropus)

Returns float[] $f(r)dr$

GSASIIsasd.**SchulzZimmCume**(*x*, *pos*, *args*)
Schulz-Zimm cumulative distribution - numpy friendly on x axis param float x: independent axis (can be numpy array) param float pos: location of distribution param float scale: width of distribution (sigma) param float shape: not used returns float: Normal distribution

GSASIIsasd.**SchulzZimmDist**(*x*, *pos*, *args*)
Schulz-Zimm macromolecule distribution - numpy friendly on x axis ref: http://goldbook.iupac.org/S05502.html param float x: independent axis (can be numpy array) param float pos: location of distribution param float scale: width of distribution (sigma) param float shape: not used returns float: Schulz-Zimm distribution

GSASIIsasd.**SphereFF**(*Q*, *R*, *args=()*)
Compute hard sphere form factor - can use numpy arrays param float Q: Q value array (usually in A-1) param float R: sphere radius (Usually in A - must match Q-1 units) param array args: ignored returns float: form factors as array as needed

GSASIIsasd.**SphereVol**(*R*, *args=()*)
Compute volume of sphere - numpy array friendly param float R: sphere radius param array args: ignored returns float: volume

GSASIIsasd.**SpheroidFF**(*Q*, *R*, *args*)
Compute form factor of cylindrically symmetric ellipsoid (spheroid) - can use numpy arrays for R & AR; will return corresponding numpy array param float Q : Q value array (usually in A-1) param float R: radius along 2 axes of spheroid param array args: [float AR]: aspect ratio so 3rd axis = R*AR returns float: form factors as array as needed

GSASIIsasd.**SpheroidVol**(*R*, *args*)
Compute volume of cylindrically symmetric ellipsoid (spheroid) - numpy array friendly param float R: radius along 2 axes of spheroid param array args: [float AR]: aspect ratio so radius of 3rd axis = R*AR returns float: volume

GSASIIsasd.**SquareWellSF**(*Q*, *args*)
Computes structure factor for not dilute monodisperse hard sphere with a square well potential interaction. Refs.: SHARMA,SHARMA, PHYSICA 89A,(1977),213-

Parameters

- **Q** (*float*) – Q value array (A-1)
- **args** (*array*) – [float R, float VolFrac, float depth, float width]: interparticle distance, volume fraction (<0.08), well depth (e/kT<1.5kT), well width

Returns numpy array S(Q) well depth > 0 attractive & values outside above limits nonphysical cf. Monte Carlo simulations

`GSASIIsasd.`**`StickyHardSpheresSF`**(*Q*, *args*)
Computes structure factor for not dilute monodisperse hard spheres Refs.: PERCUS,YEVICK PHYS. REV. 110 1 (1958),THIELE J. CHEM PHYS. 39 474 (1968), WERTHEIM PHYS. REV. LETT. 47 1462 (1981)

param float Q: Q value array (A-1) param array args: [float R, float VolFrac]: sphere radius & volume fraction returns numpy array S(Q)

`GSASIIsasd.`**`UniDiskFF`**(*Q*, *R*, *args*)
Compute form factor for unified disk - can use numpy arrays param float Q: Q value array (A-1) param float R: cylinder radius (A) param array args: [float T]: disk thickness (A) returns float: form factor

`GSASIIsasd.`**`UniDiskVol`**(*R*, *args*)
Compute disk volume for radius & thickness - numpy array friendly param float R: diameter (A) param array args: [float T]: thickness returns float:volume (A^3)

`GSASIIsasd.`**`UniRodARFF`**(*Q*, *R*, *args*)
Compute form factor for unified rod of fixed aspect ratio - can use numpy arrays param float Q: Q value array (A-1) param float R: cylinder radius (A) param array args: [float AR]: cylinder aspect ratio = L/D = L/2R returns float: form factor

`GSASIIsasd.`**`UniRodARVol`**(*R*, *args*)
Compute rod volume for radius & aspect ratio - numpy array friendly param float R: diameter (A) param array args: [float AR]: =L/D=L/2R aspect ratio returns float:volume (A^3)

`GSASIIsasd.`**`UniRodFF`**(*Q*, *R*, *args*)
Compute form factor for unified rod - can use numpy arrays param float Q: Q value array (A-1) param float R: cylinder radius (A) param array args: [float R]: cylinder radius (A) returns float: form factor

`GSASIIsasd.`**`UniRodVol`**(*R*, *args*)
Compute cylinder volume for radius & length - numpy array friendly param float R: diameter (A) param array args: [float L]: length (A) returns float:volume (A^3)

`GSASIIsasd.`**`UniSphereFF`**(*Q*, *R*, *args=0*)
Compute form factor for unified sphere - can use numpy arrays param float Q: Q value array (A-1) param float R: cylinder radius (A) param array args: ignored returns float: form factor

`GSASIIsasd.`**`UniSphereVol`**(*R*, *args=()*)
Compute volume of sphere - numpy array friendly param float R: sphere radius param array args: ignored returns float: volume

`GSASIIsasd.`**`UniTubeFF`**(*Q*, *R*, *args*)
Compute form factor for unified tube - can use numpy arrays assumes that core of tube is same as the matrix/solvent so contrast is from tube wall vs matrix param float Q: Q value array (A-1) param float R: cylinder radius (A) param array args: [float L,T]: tube length & wall thickness(A) returns float: form factor

`GSASIIsasd.`**`UniTubeVol`**(*R*, *args*)
Compute tube volume for radius, length & wall thickness - numpy array friendly param float R: diameter (A) param array args: [float L,T]: tube length & wall thickness(A) returns float: volume (A^3) of tube wall

`GSASIIsasd.`**`print_arr`**(*text*, *a*)
print the contents of an array to the console

`GSASIIsasd.`**`print_vec`**(*text*, *a*)
print the contents of a vector to the console

13.2 *Substances: Define Materials*

Defines materials commonly found in small angle & reflectometry experiments. GSASII substances as a dictionary ‘’Substances.Substances” with these materials.

Each entry in ''Substances" consists of:

```
'key':{'Elements':{element:{'Num':number in formula},...},'Density':value, 'Volume':,value}
```

Density & Volume are optional, if one missing it is calculated from the other; if both are missing then Volume is estimated from composition & assuming 10A^3 for each atom, Density is calculated from that Volume. See examples below for what is needed.

CHAPTER

FOURTEEN

GSAS-II SCRIPTS

14.1 *testDeriv: Check derivative computation*

Use this to check derivatives used in structure least squares refinement against numerical values computed in this script.

To use set `DEBUG=True` in GSASIIstrMain.py (line 22, as of version 1110); run the least squares - one cycle is sufficient. Do the "Save Results"; this will write the file testDeriv.dat in the local directory.

Then run this program to see plots of derivatives for all parameters refined in the last least squares. Shown will be numerical derivatives generated over all observations (including penalty terms) and the corresponding analytical ones produced in the least squares. They should match.

`testDeriv.`**`main`**`()`
  Starts main application to compute and plot derivatives

14.2 *GSASIItestplot: Plotting for testDeriv*

Plotting module used for script testDeriv.

class `GSASIItestplot.`**`Plot`**`(`*parent*, *id=-1*, *dpi=None*, ***kwargs*`)`
  Creates a plotting window

class `GSASIItestplot.`**`PlotNotebook`**`(`*id=-1*`)`
  creates a Wx application and a plotting notebook

14.3 *scanCCD: reduce data from scanning CCD*

Quickly prototyped routine for reduction of data from detector described in B.H. Toby, T.J. Madden, M.R. Suchomel, J.D. Baldwin, and R.B. Von Dreele, "A Scanning CCD Detector for Powder Diffraction Measurements". Journal of Applied Crystallography. 46(4): p. 1058-63 (2013).

`scanCCD.`**`main`**`()`
  starts main application to merge data from scanning CCD

14.4 *makeMacApp: Create Mac Applet*

This script creates an AppleScript app to launch GSAS-II. The app is created in the directory where the GSAS-II script is located. A softlink to Python is created, but is named GSAS-II, so that GSAS-II shows up as the name of the app rather than Python in the menu bar, etc. Note that this requires finding an app version of Python (expected name .../Resources/Python.app/Contents/MacOS/Python in directory tree of the calling python interpreter).

Run this script with one optional argument, the path to the GSASII.py The script path may be specified relative to the current path or given an absolute path, but will be accessed via an absolute path. If no arguments are supplied, the GSASII.py script is assumed to be in the same directory as this file.

`makeMacApp.`**`AppleScript`** **= '(* GSAS-II AppleScript by B. Toby (brian.toby@anl.gov)\n It can launch GSAS-II by double**

Contains an AppleScript to start GSAS-II launching python and the GSAS-II python script

`makeMacApp.`**`RunPython`**`(`*image*, *cmd*`)`

Run a command in a python image

14.5 *unit_tests: Self-test Module*

A script that can be run to test a series of self-tests in GSAS-II. At present, only modules `GSASIIspc` and `GSASIIlattice` have self-tests.

`unit_tests.`**`test_GSASIIlattice`**`()`

Test registered self-tests in `GSASIIlattice`. Takes no input and returns nothing. Throws an Exception if a test fails.

`unit_tests.`**`test_GSASIIspc`**`()`

Test registered self-tests in `GSASIIspc`. Takes no input and returns nothing. Throws an Exception if a test fails.

CHAPTER

FIFTEEN

GSAS-II EXPORT MODULES

Exports are implemented by deriving a class from `GSASIIIO.ExportBaseClass`. Initialization of `self.exporttype` determines the type of export that will be performed ('project', 'phase', 'single', 'powder', 'image', 'map' or (someday) 'pdf') and of `self.multiple` determines if only a single phase, data set, etc. can be exported at a time (when False) or more than one can be selected.

15.1 *Module G2export_examples: Examples*

Code to demonstrate how GSAS-II data export routines are created. The classes defined here, `ExportPhaseText`, `ExportSingleText`, `ExportPowderReflText`, and `ExportPowderText` each demonstrate a different type of export. Also see `G2export_map.ExportMapASCII` for an example of a map export.

class `G2export_examples.`**`ExportPhaseText`**(*G2frame*)

Used to create a text file for a phase

Parameters **G2frame** (*wx.Frame*) – reference to main GSAS-II frame

`Exporter`(*event=None*)

Export a phase as a text file

class `G2export_examples.`**`ExportPowderReflText`**(*G2frame*)

Used to create a text file of reflections from a powder data set

Parameters **G2frame** (*wx.Frame*) – reference to main GSAS-II frame

`Exporter`(*event=None*)

Export a set of powder reflections as a text file

class `G2export_examples.`**`ExportPowderText`**(*G2frame*)

Used to create a text file for a powder data set

Parameters **G2frame** (*wx.Frame*) – reference to main GSAS-II frame

`Exporter`(*event=None*)

Export a set of powder data as a text file

class `G2export_examples.`**`ExportSingleText`**(*G2frame*)

Used to create a text file with single crystal reflection data

Parameters **G2frame** (*wx.Frame*) – reference to main GSAS-II frame

`Exporter`(*event=None*)

Export a set of single crystal data as a text file

15.2 *Module G2export_csv: Spreadsheet export*

Code to create .csv (comma-separated variable) files for GSAS-II data export to a spreadsheet program, etc.

class `G2export_csv.`**`ExportMultiPowderCSV`**(*G2frame*)

Used to create a csv file for a stack of powder data sets suitable for display purposes only; no y-calc or weights are exported only x & y-obs :param wx.Frame G2frame: reference to main GSAS-II frame

`Exporter`(*event=None*)

Export a set of powder data as a csv file

class `G2export_csv.`**`ExportPhaseCSV`**(*G2frame*)

Used to create a csv file for a phase

Parameters **G2frame** (*wx.Frame*) – reference to main GSAS-II frame

`Exporter`(*event=None*)

Export a phase as a csv file

class `G2export_csv.`**`ExportPowderCSV`**(*G2frame*)

Used to create a csv file for a powder data set

Parameters **G2frame** (*wx.Frame*) – reference to main GSAS-II frame

`Exporter`(*event=None*)

Export a set of powder data as a csv file

class `G2export_csv.`**`ExportPowderReflCSV`**(*G2frame*)

Used to create a csv file of reflections from a powder data set

Parameters **G2frame** (*wx.Frame*) – reference to main GSAS-II frame

`Exporter`(*event=None*)

Export a set of powder reflections as a csv file

class `G2export_csv.`**`ExportSingleCSV`**(*G2frame*)

Used to create a csv file with single crystal reflection data

Parameters **G2frame** (*wx.Frame*) – reference to main GSAS-II frame

`Exporter`(*event=None*)

Export a set of single crystal data as a csv file

class `G2export_csv.`**`ExportStrainCSV`**(*G2frame*)

Used to create a csv file with single crystal reflection data

Parameters **G2frame** (*wx.Frame*) – reference to main GSAS-II frame

`Exporter`(*event=None*)

Export a set of single crystal data as a csv file

`G2export_csv.`**`WriteList`**(*obj*, *headerItems*)

Write a CSV header

Parameters

- **obj** (*object*) – Exporter object
- **headerItems** (*list*) – items to write as a header

15.3 *Module G2export_PDB: Macromolecular export*

Code to export a phase into the venerated/obsolete (pick one) ASCII PDB format. Also defines exporter `ExportPhaseCartXYZ` which writes atom positions in orthogonal coordinates for a phase.

class `G2export_PDB.`**`ExportPhaseCartXYZ`**(*G2frame*)
Used to create a Cartesian XYZ file for a phase

Parameters **G2frame** (*wx.Frame*) – reference to main GSAS-II frame

`Exporter`(*event=None*)
Export as a XYZ file

class `G2export_PDB.`**`ExportPhasePDB`**(*G2frame*)
Used to create a PDB file for a phase

Parameters **G2frame** (*wx.Frame*) – reference to main GSAS-II frame

`Exporter`(*event=None*)
Export as a PDB file

15.4 *Module G2export_image: 2D Image data export*

Demonstrates how an image is retrieved and written. Uses a SciPy routine to write a PNG format file.

class `G2export_image.`**`ExportImagePNG`**(*G2frame*)
Used to create a PNG file for a GSAS-II image

Parameters **G2frame** (*wx.Frame*) – reference to main GSAS-II frame

`Exporter`(*event=None*)
Export an image

15.5 *Module G2export_map: Map export*

Code to write Fourier/Charge-Flip atomic density maps out in formats that can be read by external programs. At present a GSAS format that is supported by FOX and DrawXTL (`ExportMapASCII`) and the CCP4 format that is used by COOT (`ExportMapCCP4`) are implemented.

class `G2export_map.`**`ExportMapASCII`**(*G2frame*)
Used to create a text file for a phase

Parameters **G2frame** (*wx.Frame*) – reference to main GSAS-II frame

`Exporter`(*event=None*)
Export a map as a text file

class `G2export_map.`**`ExportMapCCP4`**(*G2frame*)
Used to create a text file for a phase

Parameters **G2frame** (*wx.Frame*) – reference to main GSAS-II frame

`Exporter`(*event=None*)
Export a map as a text file

15.6 *Module G2export_shelx: Examples*

Code to export coordinates in the SHELX .ins format (as best as I can makes sense of it).

class `G2export_shelx.`**`ExportPhaseShelx`**(*G2frame*)

Used to create a SHELX .ins file for a phase

Parameters **G2frame** (*wx.Frame*) – reference to main GSAS-II frame

`Exporter`(*event=None*)

Export as a SHELX .ins file

15.7 *Module G2export_CIF: CIF Exports*

This implements a complex exporter `ExportCIF` that can implement an entire project in a complete CIF intended for submission as a publication. In addition, there are two subclasses of `ExportCIF`: `ExportPhaseCIF` and `ExportDataCIF` that export a single phase or data set. Note that `self.mode` determines what is written:

- *self.mode="simple"* creates a simple CIF with only coordinates or data, while
- *self.mode="full"* creates a complete CIF of project.

`G2export_CIF.`**`CIF2dict`**(*cf*)

copy the contents of a CIF out from a PyCifRW block object into a dict

Returns cifblk, loopstructure where cifblk is a dict with CIF items and loopstructure is a list of lists that defines which items are in which loops.

class `G2export_CIF.`**`CIFdefHelp`**(*parent*, *msg*, *helpwin*, *helptxt*)

Create a help button that displays help information on the current data item

Parameters

- **parent** – the panel which will be the parent of the button
- **msg** (*str*) – the help text to be displayed
- **helpwin** (*wx.Dialog*) – Frame for CIF editing dialog
- **helptxt** (*wx.TextCtrl*) – TextCtrl where help text is placed

class `G2export_CIF.`**`CIFtemplateSelect`**(*frame*, *panel*, *tmplate*, *G2dict*, *repaint*, *title*, *defaultname=''*)

Create a set of buttons to show, select and edit a CIF template

Parameters

- **frame** – wx.Frame object of parent
- **panel** – wx.Panel object where widgets should be placed
- **tmplate** (*str*) – one of 'publ', 'phase', or 'instrument' to determine the type of template
- **G2dict** (*dict*) – GSAS-II dict where CIF should be placed. The key "CIF_template" will be used to store either a list or a string. If a list, it will contain a dict and a list defining loops. If an str, it will contain a file name.
- **repaint** (*function*) – reference to a routine to be called to repaint the frame after a change has been made
- **title** (*str*) – A line of text to show at the top of the window
- **defaultname** (*str*) – specifies the default file name to be used for saving the CIF.

class `G2export_CIF.`**`EditCIFpanel`**(*parent*, *cifblk*, *loopstructure*, *cifdic={}*, *OKbuttons=[ ]*, ***kw*)

Creates a scrolled panel for editing CIF template items

Parameters

- **parent** (*wx.Frame*) – parent frame where panel will be placed
- **cifblk** – dict or PyCifRW block containing values for each CIF item
- **loopstructure** (*list*) – a list of lists containing the contents of each loop, as an example:

  ```
  [ ["_a","_b"], ["_c"], ["_d_1","_d_2","_d_3"]]
  ```

  this describes a CIF with this type of structure:

  ```
  loop_ _a _b <a1> <b1> <a2> ...
  loop_ _c <c1> <c2>...
  loop _d_1 _d_2 _d_3 ...
  ```

  Note that the values for each looped CIF item, such as _a, are contained in a list, for example as cifblk["_a"]
- **cifdic** (*dict*) – optional CIF dictionary definitions
- **OKbuttons** (*list*) – A list of wx.Button objects that should be disabled when information in the CIF is invalid
- **(other)** – optional keyword parameters for wx.ScrolledPanel

`CIFEntryWidget`(*dct*, *item*, *dataname*)

Create an entry widget for a CIF item. Use a validated entry for numb values where int is required when limits are integers and floats otherwise. At present this does not allow entry of the special CIF values of "." and "?" for numerical values and highlights them as invalid. Use a selection widget when there are specific enumerated values for a string.

`ControlOKButton`(*setvalue*)

Enable or Disable the OK button(s) for the dialog. Note that this is passed into the ValidatedTxtCtrl for use by validators.

Parameters **setvalue** (*bool*) – if True, all entries in the dialog are checked for validity. The first invalid control triggers disabling of buttons. If False then the OK button(s) are disabled with no checking of the invalid flag for each control.

`DoLayout`()

Update the Layout and scroll bars for the Panel. Clears self.LayoutCalled so that next change to panel can request a new update

`OnAddRow`(*event*)

add a row to a loop

`OnLayoutNeeded`(*event*)

Called when an update of the panel layout is needed. Calls self.DoLayout after the current operations are complete using CallAfter. This is called only once, according to flag self.LayoutCalled, which is cleared in self.DoLayout.

class `G2export_CIF.`**`EditCIFtemplate`**(*parent*, *cifblk*, *loopstructure*, *defaultname*)

Create a dialog for editing a CIF template. The edited information is placed in cifblk. If the CIF is saved as a file, the name of that file is saved as `self.newfile`.

Parameters

- **parent** (*wx.Frame*) – parent frame or None

- **cifblk** – dict or PyCifRW block containing values for each CIF item
- **loopstructure** (*list*) – a list of lists containing the contents of each loop, as an example:

  ```
  [ ["_a","_b"], ["_c"], ["_d_1","_d_2","_d_3"]]
  ```

  this describes a CIF with this type of structure:

  ```
  loop_ _a _b <a1> <b1> <a2> ...
  loop_ _c <c1> <c2>...
  loop _d_1 _d_2 _d_3 ...
  ```

  Note that the values for each looped CIF item, such as _a, are contained in a list, for example as cifblk["_a"]
- **defaultname** (*str*) – specifies the default file name to be used for saving the CIF.

Post()
Display the dialog

Returns True unless Cancel has been pressed.

class G2export_CIF.**ExportCIF**(*G2frame*)
Used to create a CIF of an entire project

Parameters **G2frame** (*wx.Frame*) – reference to main GSAS-II frame

Exporter(*event=None*)
Export a CIF. Export can be full or simple (as set by self.mode). "simple" skips data, distances & angles, etc. and can only include a single phase while "full" is intended for for publication submission.

class G2export_CIF.**ExportDataCIF**(*G2frame*)
Used to create a simple CIF containing diffraction data only. Uses exact same code as ExportCIF except that *self.mode* is set to "simple" and *self.currentExportType* is set to "single" or "powder" in *self.InitExport*. Shows up in menus as Data-only CIF.

Parameters **G2frame** (*wx.Frame*) – reference to main GSAS-II frame

class G2export_CIF.**ExportPhaseCIF**(*G2frame*)
Used to create a simple CIF of at most one phase. Uses exact same code as ExportCIF except that *self.mode* is set to "simple" in *self.InitExport*. Shows up in menu as Quick CIF.

Parameters **G2frame** (*wx.Frame*) – reference to main GSAS-II frame

G2export_CIF.**LoadCIFdic**()
Create a composite core+powder CIF lookup dict containing information about all items in the CIF dictionaries, loading pickled files if possible. The routine looks for files named cif_core.cpickle and cif_pd.cpickle in every directory in the path and if they are not found, files cif_core.dic and/or cif_pd.dic are read.

Returns the dict with the definitions

G2export_CIF.**PickleCIFdict**(*fil*)
Loads a CIF dictionary, cherry picks out the items needed by local code and sticks them into a python dict and writes that dict out as a cPickle file for later reuse. If the write fails a warning message is printed, but no exception occurs.

Parameters **fil** (*str*) – file name of CIF dictionary, will usually end in .dic

Returns the dict with the definitions

G2export_CIF.**dict2CIF**(*dblk*, *loopstructure*, *blockname='Template'*)
Create a PyCifRW CIF object containing a single CIF block object from a dict and loop structure list.

Parameters

- **dblk** – a dict containing values for each CIF item
- **loopstructure** (*list*) – a list of lists containing the contents of each loop, as an example:

  ```
  [ ["_a","_b"], ["_c"], ["_d_1","_d_2","_d_3"]]
  ```

  this describes a CIF with this type of structure:

  ```
  loop_ _a _b <a1> <b1> <a2> ...
  loop_ _c <c1> <c2>...
  loop _d_1 _d_2 _d_3 ...
  ```

  Note that the values for each looped CIF item, such as _a, are contained in a list, for example as cifblk["_a"]
- **blockname** (*str*) – an optional name for the CIF block. Defaults to 'Template'

Returns the newly created PyCifRW CIF object

15.8 *Module G2export_pwdr: Export powder input files*

Creates files used by GSAS (FXYE) & TOPAS (XYE) as input

class `G2export_pwdr.`**`ExportPowderFXYE`**(*G2frame*)
Used to create a FXYE file for a powder data set

Parameters **G2frame** (*wx.Frame*) – reference to main GSAS-II frame

`Exporter`(*event=None*)
Export one or more sets of powder data as FXYE file(s)

`WriteInstFile`(*hist*, *Inst*)
Write an instrument parameter file

class `G2export_pwdr.`**`ExportPowderXYE`**(*G2frame*)
Used to create a Topas XYE file for a powder data set

Parameters **G2frame** (*wx.Frame*) – reference to main GSAS-II frame

`Exporter`(*event=None*)
Export one or more sets of powder data as XYE file(s)

CHAPTER

SIXTEEN

GSAS-II IMPORT MODULES

Imports are implemented by deriving a class from `GSASIIIO.ImportPhase`, `GSASIIIO.ImportStructFactor` or `GSASIIIO.ImportPowderData` (which are in turn derived from `GSASIIIO.ImportBaseclass`) to implement import of a phase, a single crystal or a powder dataset, respectively. Module file names (*G2phase_*, *G2pwd_* and *G2sfact_*, etc.) are used to determine which menu an import routine should be placed into. (N.B. this was an unnecessary choice; this could be done from the class used.)

This list may not include all currently defined formats, since modules may be loaded from anywhere in the path.

16.1 Writing an Import Routine

When writing a import routine, one should create a new class derived from `GSASIIIO.ImportPhase`, `GSASIIIO.ImportStructFactor` or `GSASIIIO.ImportPowderData`. As described below, all these classes will implement an `__init__()` and a `Reader()` method, and most will supply a `ContentsValidator()` method, too. See the `ImportPhase`, `ImportStructFactor` or `ImportPowderData` class documentation for details on what values each type of `Reader()` should set.

16.1.1 __init__()

The class should supply a `__init__` method which calls the parent `__init__` method and specifies the following parameters:

- *extensionlist*: a list of extensions that may be used for this type of file.
- *strictExtension*: Should be True if only files with extensions in *extensionlist* are allows; False if all file types should be offered in the file browser. Also if False, the import class will be used on all files when "guess from format" is tried, though readers with matching extensions will be tried first.
- *formatName*: a string to be used in the menu. Should be short.
- *longFormatName*: a longer string to be used to describe the format in help.

16.1.2 Reader()

The class must supply a `Reader` method that actually performs the reading. All readers must have at a minimum these arguments:

```
def Reader(self, filename, filepointer, ParentFrame, **unused):
```

where the arguments have the following uses:

- *filename*: a string with the name of the file being read

- *filepointer*: a file object (created by `open()`) that accesses the file and is points to the beginning of the file when Reader is called.
- *ParentFrame*: a reference to the main GSAS-II (tree) windows, for the unusual `Reader` routines that will create GUI windows to ask questions.

In addition, the following keyword parameters are defined that `Reader` routines may optionally use:

- *buffer*: a dict that can be used to retain information between repeated calls of the routine
- *blocknum*: counts the number of times that a reader is called
- *usedRanIdList*: a list of previously used random Id values that can be checked to determine that a value is unique.

As an example, the *buffer* dict is used for CIF reading to hold the parsed CIF file so that it can be reused without having to reread the file from scratch.

Reader return values

The `Reader` routine should return the value of True if the file has been read successfully. Optionally, use *self.warnings* to indicate any problems.

If the file cannot be read, the `Reader` routine should return False or raise an `GSASIIIO.ImportBaseclass.ImportException` exception. (Why either? Sometimes an exception is the easiest way to bail out of a called routine.) Place text in *self.errors* and/or use:

```
ImportException('Error message')
```

to give the user information on what went wrong during the reading.

self.warnings

Use *self.warnings* to indicate any information that should be displayed to the user if the file is read successfully, but perhaps not completely or additional settings will need to be made.

self.errors

Use *self.errors* to give the user information on where and why a read error occurs in the file. Note that text supplied with the `raise` statement will be appended to `self.errors`.

self.repeat

Set *self.repeat* to True (the default is False) if a Reader should be called again to read a second block from a file. Most commonly (only?) used for reading multiple powder histograms from a single file. Variable *self.repeatcount* is used to keep track of the block numbers.

support routines

Note that the base class (`GSASIIIO.ImportBaseclass`) supplies two routines, `BlockSelector()` and `MultipleBlockSelector()` that are useful for selecting amongst one or more datasets (and perhaps phases) for `Reader()` routines that may encounter more than one set of information in a file. Likewise, when an operation will take some time to complete, use `ShowBusy()` and `DoneBusy()` to show the user that something is happening.

16.1.3 ContentsValidator()

Defining a `ContentsValidator` method is optional, but is usually a good idea, particularly if the file extension is not a reliable identifier for the file type. The intent of this routine is to take a superficial look at the file to see if it has the expected characteristics of the expected file type. For example, are there numbers in the expected places?

This routine is passed a single argument:

- *filepointer*: a file object (created by `open()`) that accesses the file and is points to the beginning of the file when ContentsValidator is called.

Note that `GSASIIIO.ImportBaseclass.CIFValidator()` is a ContentsValidator for validating CIF files.

16.1.4 ReInitialize()

Import classes are substantiated only once and are used as needed. This means that if something needs to be initialized before the `Reader()` will be called to read a new file, it must be coded. The `ReInitialize()` method is provided for this and it is always called before the `ContentsValidator` method is called. Use care to call the parent class `ReInitialize()` method, if this is overridden.

ContentsValidator return values

The `ContentsValidator` routine should return the value of True if the file appears to match the type expected for the class.

If the file cannot be read by this class, the routine should return False. Preferably one will also place text in *self.errors* to give the user information on what went wrong during the reading.

16.2 Phase Import Routines

Phase import routines are classes derived from `GSASIIIO.ImportPhase`. They must be found in files named *G2phase*.py* that are in the Python path and the class must override the `__init__` method and add a `Reader` method. The distributed routines are:

16.2.1 *Module G2phase: PDB, .EXP & JANA m40,m50*

A set of short routines to read in phases using routines that were previously implemented in GSAS-II: PDB, GSAS .EXP and JANA m40-m50 file formats

class `G2phase.`**`EXP_ReaderClass`**
Routine to import Phase information from GSAS .EXP files

`ContentsValidator` (*filepointer*)
Look for a VERSION tag in 1st line

`ReadEXPPhase` (*G2frame*, *filepointer*)
Read a phase from a GSAS .EXP file.

`Reader` (*filename*, *filepointer*, *ParentFrame=None*, ***unused*)
Read a phase from a GSAS .EXP file using `ReadEXPPhase()`

class `G2phase.`**`JANA_ReaderClass`**
Routine to import Phase information from a JANA2006 file

ContentsValidator (*filepointer*)
Taking a stab a validating a .m50 file (look for cell & at least one atom)

ReadJANAPhase (*filename*, *parent=None*)
Read a phase from a JANA2006 m50 & m40 files.

Reader (*filename*, *filepointer*, *ParentFrame=None*, ***unused*)
Read a m50 file using `ReadJANAPhase()`

class `G2phase.`**PDB_ReaderClass**
Routine to import Phase information from a PDB file

ContentsValidator (*filepointer*)
Taking a stab a validating a PDB file (look for cell & at least one atom)

ReadPDBPhase (*filename*, *parent=None*)
Read a phase from a PDB file.

Reader (*filename*, *filepointer*, *ParentFrame=None*, ***unused*)
Read a PDF file using `ReadPDBPhase()`

16.2.2 *Module G2phase_GPX: Import phase from GSAS-II project*

Copies a phase from another GSAS-II project file into the current project.

class `G2phase_GPX.`**PhaseReaderClass**
Opens a .GPX file and pulls out a selected phase

ContentsValidator (*filepointer*)
Test if the 1st section can be read as a cPickle block, if not it can't be .GPX!

Reader (*filename*, *filepointer*, *ParentFrame=None*, ***unused*)
Read a phase from a .GPX file. Does not (yet?) support selecting and reading more than one phase at a time.

16.2.3 *Module G2phase_CIF: Coordinates from CIF*

Parses a CIF using PyCifRW from James Hester and pulls out the structural information.

If a CIF generated by ISODISTORT is encountered, extra information is added to the phase entry and constraints are generated.

class `G2phase_CIF.`**CIFPhaseReader**
Implements a phase importer from a possibly multi-block CIF file

ISODISTORT_proc (*blk*, *atomlbllist*, *ranIdlookup*)
Process ISODISTORT items to create constraints etc.

16.3 Powder Data Import Routines

Powder data import routines are classes derived from `GSASIIIO.ImportPowderData`. They must be found in files named *G2pwd*.py* that are in the Python path and the class must override the `__init__` method and add a `Reader` method. The distributed routines are:

16.3.1 *Module G2pwd_GPX: GSAS-II projects*

Routine to import powder data from GSAS-II .gpx files

class `G2pwd_GPX.`**`GSAS2_ReaderClass`**

Routines to import powder data from a GSAS-II file This should work to pull data out from a out of date .GPX file as long as the details of the histogram data itself don't change

`ContentsValidator` (*filepointer*)

Test if the 1st section can be read as a cPickle block, if not it can't be .GPX!

`Reader` (*filename*, *filepointer*, *ParentFrame=None*, ***kwarg*)

Read a dataset from a .GPX file. If multiple datasets are requested, use self.repeat and buffer caching.

16.3.2 *Module G2pwd_fxye: GSAS data files*

Routine to read in powder data in a variety of formats that are defined for GSAS.

class `G2pwd_fxye.`**`GSAS_ReaderClass`**

Routines to import powder data from a GSAS files

`ContentsValidator` (*filepointer*)

Validate by checking to see if the file has BANK lines

`Reader` (*filename*, *filepointer*, *ParentFrame=None*, ***kwarg*)

Read a GSAS (old formats) file of type FXY, FXYE, ESD or STD types. If multiple datasets are requested, use self.repeat and buffer caching.

`G2pwd_fxye.`**`sfloat`** (*S*)

convert a string to a float, treating an all-blank string as zero

`G2pwd_fxye.`**`sint`** (*S*)

convert a string to an integer, treating an all-blank string as zero

16.3.3 *Module G2pwd_xye: Topas .xye data*

Routine to read in powder data from a Topas-compatible .xye file

class `G2pwd_xye.`**`xye_ReaderClass`**

Routines to import powder data from a .xye file

`ContentsValidator` (*filepointer*)

Look through the file for expected types of lines in a valid Topas file

`Reader` (*filename*, *filepointer*, *ParentFrame=None*, ***unused*)

Read a Topas file

16.3.4 *Module G2pwd_CIF: CIF powder data*

Routine to read in powder data from a CIF.

class `G2pwd_CIF.`**`CIFpwdReader`**

Routines to import powder data from a CIF file

`ContentsValidator` (*filepointer*)

Use standard CIF validator

Reader (*filename*, *filepointer*, *ParentFrame=None*, ***kwarg*)
Read powder data from a CIF. If multiple datasets are requested, use self.repeat and buffer caching.

16.4 Single Crystal Data Import Routines

Single crystal data import routines are classes derived from , `GSASIIIO.ImportStructFactor`. They must be found in files named *G2sfact*.py* that are in the Python path and the class must override the `__init__` method and add a `Reader` method. The distributed routines are:

16.4.1 *Module G2sfact: simple HKL import*

Read structure factors from a simple hkl file. Two routines are provided to read from files containing F or F^2 values.

`G2sfact.`**ColumnValidator** (*parent*, *filepointer*, *nCol=5*)
Validate a file to check that it contains columns of numbers

class `G2sfact.`**HKLF2_ReaderClass**
Routines to import F**2, sig(F**2) reflections from a HKLF file

ContentsValidator (*filepointer*)
Make sure file contains the expected columns on numbers

Reader (*filename*, *filepointer*, *ParentFrame=None*, ***unused*)
Read the file

class `G2sfact.`**HKLF_ReaderClass**
Routines to import F, sig(F) reflections from a HKLF file

ContentsValidator (*filepointer*)
Make sure file contains the expected columns on numbers

Reader (*filename*, *filepointer*, *ParentFrame=None*, ***unused*)
Read the file

class `G2sfact.`**ISIS_SXD_INT_ReaderClass**
Routines to import neutron TOF F**2, sig(F**2) reflections from a ISIS int file

ContentsValidator (*filepointer*)
Make sure file contains the expected columns on numbers & count number of data blocks - “Banks”

Reader (*filename*, *filepointer*, *ParentFrame=None*, ***unused*)
Read the file

class `G2sfact.`**M90_ReaderClass**
Routines to import F**2, sig(F**2) reflections from a JANA M90 file

ContentsValidator (*filepointer*)
Discover how many columns are in the m90 file - could be 9-12 depending on satellites

Reader (*filename*, *filepointer*, *ParentFrame=None*, ***unused*)
Read the file

class `G2sfact.`**NT_HKLF2_ReaderClass**
Routines to import neutron TOF F**2, sig(F**2) reflections from a HKLF file

ContentsValidator (*filepointer*)
Make sure file contains the expected columns on numbers & count number of data blocks - “Banks”

Reader (*filename*, *filepointer*, *ParentFrame=None*, ***unused*)
Read the file

class G2sfact.**NT_JANA2K_ReaderClass**
Routines to import neutron TOF F**2, sig(F**2) reflections from a JANA2000 file

ContentsValidator (*filepointer*)
Make sure file contains the expected columns on numbers & count number of data blocks - "Banks"

Reader (*filename*, *filepointer*, *ParentFrame=None*, ***unused*)
Read the file

class G2sfact.**SHELX5_ReaderClass**
Routines to import F**2, sig(F**2) reflections from a fixed format SHELX HKLF5 file

ContentsValidator (*filepointer*)
Discover how many characters are in the SHELX file - could be 32-44 depending on satellites

Reader (*filename*, *filepointer*, *ParentFrame=None*, ***unused*)
Read the file

16.4.2 *Module G2sfact_CIF: CIF import*

Read structure factors from a CIF reflection table.

class G2sfact_CIF.**CIFhklReader**
Routines to import Phase information from a CIF file

ContentsValidator (*filepointer*)
Use standard CIF validator

Reader (*filename*, *filepointer*, *ParentFrame=None*, ***kwarg*)
Read single crystal data from a CIF. If multiple datasets are requested, use self.repeat and buffer caching.

16.5 Small Angle Scattering Data Import Routines

Small angle scattering data import routines are classes derived from , `GSASIIIO.ImportSmallAngle`. They must be found in files named *G2sad*.py* that are in the Python path and the class must override the `__init__` method and add a `Reader` method. The distributed routines are:

16.5.1 *Module G2sad_xye: read small angle data*

Routines to read in small angle data from an .xye type file, with two-theta or Q steps.

class G2sad_xye.**txt_CWNeutronReaderClass**
Routines to import neutron CW q SAXD data from a .nsad or .ndat file

ContentsValidator (*filepointer*)
Look through the file for expected types of lines in a valid q-step file

class G2sad_xye.**txt_XRayReaderClass**
Routines to import X-ray q SAXD data from a .xsad or .xdat file

ContentsValidator (*filepointer*)
Look through the file for expected types of lines in a valid q-step file

class G2sad_xye.**txt_nmCWNeutronReaderClass**
Routines to import neutron CW q in nm-1 SAXD data from a .nsad or .ndat file

ContentsValidator(*filepointer*)
Look through the file for expected types of lines in a valid q-step file

class G2sad_xye.**txt_nmXRayReaderClass**
Routines to import X-ray q SAXD data from a .xsad or .xdat file, q in nm-1

ContentsValidator(*filepointer*)
Look through the file for expected types of lines in a valid q-step file

CHAPTER SEVENTEEN

REQUIRED PACKAGES

Note that GSAS-II requires the Python extension packages

- wxPython (http://wxpython.org/docs/api/),
- NumPy (http://docs.scipy.org/doc/numpy/reference/),
- SciPy (http://docs.scipy.org/doc/scipy/reference/),
- matplotlib (http://matplotlib.org/contents.html)
- PIL or Pillow (https://pillow.readthedocs.org) and
- PyOpenGL (http://pyopengl.sourceforge.net/documentation)

These packages are not distributed as part of the Python standard library and must be obtained separately (or in a bundled Python package such as the Enthought Python Distribution/Canopy or Continuum.io's anaconda). The PyOpenGL package will be installed into Python by GSAS-II if not found, so it does not need to be included in the Python bundle, but the setuptools package (https://pythonhosted.org/setuptools/) is needed by GSAS-II to install PyOpenGL.