

gain: modify a response file gain

Modify a response file gain, in a particularly simple way. ***CAUTION*** This command is to be used with extreme care for investigation of the response properties. To properly fit data, the response matrix should be recalculated explicitly (outside of XSPEC) using any modified gain information derived.

The gain command has been slightly revised for XSPEC12. Previously when a user entered a gain command, it was generally interpreted to apply to an entire **model**. This new implementation clearly defines an applied gain as belonging to a particular **response**. It also offers less ambiguity for dealing with XSPEC12's multiple models scheme. So for example if 2 spectra are loaded, each in its own data group, and the user enters a **gain fit** command, under the old system they would be prompted for 2 sets of parameters since the model is applied to 2 data groups. With the new system, the user specifies which particular response (belonging to either spectrum 1 or 2) they wish to apply the gain fit to, and are then prompted for just the 1 set of gain parameters for that response. This is more clearly demonstrated with the examples below. The new command options "gain nofit all" and "gain off" are also described below.

*** NOTE: Backwards incompatible syntax change ***

Beginning with XSPEC 12.5.1, **gain** parameters must be specified as [`<sourceNum>:`]`<specNum>` and NOT `<specNum>[:<sourceNum>]`. This reversal was made so that the **gain** command conforms to the [`<sourceNum>:`]`<specNum>` usage in other XSPEC commands, such as **response** and **arf**.

Syntax: **gain** [`<sourceNum>:`]`<specNum>` `<slope>` `<intercept>`
 gain fit [[`<sourceNum>:`]`<specNum>`]
 gain nofit { [[`<sourceNum>:`]`<specNum>`] | all }
 gain off

The first variant of the gain command shown above will apply the gain shift specified by the `<slope>` and `<intercept>` parameters to the response belonging to spectrum `<specNum>`, and optionally specified `<sourceNum>` if the data is analyzed with multiple models. The initial default `<specNum>` is 1; later, the default is the number of the spectrum last modified. Initially, all responses are assumed to have nominal gains, determined implicitly by the data in the response files. This is equivalent to a `<slope>` of 1 and an `<intercept>` of zero. All responses can be reset back to this original state by entering **gain off**. Note that in this mode of usage, the slope and intercept values do NOT become variable fit parameters. They are simply fixed values used to modify the response.

The **gain fit** mode is used when the user wishes to have the slope and intercept parameters determined by the results of a fit. The `<specNum>` and optional `<sourceNum>` parameters specify to which response the fit gain values are to be applied. These may be omitted only if a single

spectrum is loaded, with a single model source. Otherwise at least a spectrum number is required. The user will then be prompted for slope and intercept parameter information in the same way as model parameters are normally entered. These values are then immediately applied to the response, and will be adjusted the next time a fit is run.

Gain fit parameters belong to the more general category of **response parameters** in XSPEC, and may be modified using an equivalent set of commands to those used for regular model parameters. The command names are the same except prefixed by the letter ‘**r**’:

XSPEC commands for editing/viewing model parameters	Equivalent commands for gain (or response) parameters
newpar	rnewpar
freeze	rfreeze
thaw	rthaw
untie	runtie
error	rerror
model	rmodel
show par	show par, show rpar

For example after assigning gain fit parameters to source 1 of spectrum 1 (with “gain fit 1”):

```
XSPEC12> rfreeze 1
XSPEC12> rnewpar 2 .05
XSPEC12> show rpar
```

Response parameters defined:

=====

Source No.: 1

Rpar	Spectrum	Rmodel	Rpar_name	Unit	Value
1	1	gain	slope		1.00000 frozen
2	1	gain	offset		5.00000E-02 +/- 0.0

Rnewpar can also link gain parameters to one another and can adjust the hard and soft parameter limits, as newpar does for model parameters. The default gain parameter hard limits are hardcoded in XSPEC, but these can be overridden by setting GSLOP_MIN, GSLOP_MAX, GOFFS_MIN, and GOFFS_MAX keywords in the matrix extension of your response file.

The gain operation itself belongs to the category of **response functions**, which in future versions of XSPEC may be defined with **rmodel** just as regular XSPEC model functions are

defined with **model**. Though gain is currently the only available response function, the following command will work:

```
// Apply gain to the response belonging to source 2 of spectrum 1
XSPEC12>rmodel 2:1 gain
```

which is equivalent to:

```
XSPEC12>gain fit 2:1
```

The **nofit** argument switches off the fitting and leaves the gain at the current values of the parameters. Unless the argument **all** is given, it is applied to a single response specified by <specNum> and optional <sourceNum>. As with gain fit, both arguments may be omitted if only a single spectrum with 1 source is loaded. When **all** is specified, fitting is switched off for the gain parameters of all responses. **gain off** will switch off fitting for all gain parameters, and will reset all of them to their nominal value.

Whenever a new response file is defined for a spectrum, the response will return to the nofit state with nominal value. The ignore and notice commands however will not affect the current gain of the response. THE GAIN COMMAND IS NOT CURRENTLY IMPLEMENTED FOR DUMMY RESPONSES.

Algorithm:

The gain command shifts the energies on which the response matrix is defined and shifts the effective area curve to match. The effective area curve stored by XSPEC is either the ARF, if one was in use, or is calculated from the RSP file as the total area in each energy range. This means that if there are sharp features in the response then these will only be handled correctly by the gain command if they are in the ARF or if no ARF is input. The new energy is calculated by $E/(\text{slope} - \text{intercept})$.

Examples:

```
XSPEC12>gain 1 0.98
```

```
// The response belonging to spectrum 1 is adjusted with a slope of 0.98.
```

```
// The 1 may be omitted if only 1 spectrum (with 1 source) is loaded.
```

```
XSPEC12>gain 1,,.03
```

```
// The offset also is moved now by 0.03
```

```
XSPEC12>gain 2:4 1.1 0.1
```

```
// The response belonging to source number 2, spectrum 4, is adjusted with slope 1.1
```

```
// and offset 0.1.
```

```
XSPEC12>gain off
```

```
// The above 2 responses, and any others that have been adjusted, are reset to slope
```

```
// 1.0, offset 0.0.
```

```
XSPEC12> gain fit 3
```

// Variable fit parameters are created for spectrum 3 response. User will be prompted
// for starting fit parameter values of slope and offset.

XSPEC12> fit

// Best fit gain values will now be determined for and applied to spectrum 3 response.

XSPEC12> gain nofit 3

// Spectrum 3 response will retain its current gain values, but values will not be

// adjusted during future fits.

NOTE: Current gain information may be easily viewed with the **show response** command. Gain
fit parameters may also be viewed with the **show par** or **show rpar** commands.