

- **project: project 3-D ellipsoidal shells onto 2-D elliptical annuli**

This model performs a 3-D to 2-D projection of prolate ellipsoidal shells onto elliptical annuli. The annuli can have varying ellipticities and position angles but must have the same center. The user should extract spectra in a series of annuli. Each spectrum needs three additional keywords (XFLT0001, XFLT0002, XFLT0003) in the spectrum extension. These keywords contain the semi-major axis, semi-minor axis, and position angle (in degrees) for the outer boundary of the annulus. It is assumed that the inner boundary is specified by the outer boundary of the next annulus in. The lengths can be in any consistent units although for numerical accuracy they should have reasonable values. Optional pairs of extra keywords (eg XFLT0004/5, XFLT0006/7, etc.) can be used to specify start and end angles for a partial annulus. These angles should be given relative to the same zero as the position angle.

The user reads in the spectra as separate datagroups and sets model parameters for each datagroup. The model for datagroup J will be the model in the shell whose outer boundary is a prolate ellipsoid of semi-major and semi-minor axes given by the semi-major and semi-minor axes in the XFLT keywords for dataset J. The project model sums up the appropriate fractions of each ellipsoid model to make the projected spectrum.

For example, suppose we extract spectrum from three elliptical regions defined by (1,0.5,0), (2,1,0), (3,1.5,0). That is the first region is in an ellipse of semi-major axis 1 and semi-minor axis 0.5. The second region is an elliptical annulus whose inner boundary has semi-major axis 1 and semi-minor axes 0.5 and whose outer boundary has semi-major axis 2 and semi-minor axis 1. The third region is defined similarly. The model fit has a temperature of 2 keV for the first datagroup, 3 keV for the second, and 4 keV for the third. The actual model fit to the first dataset has contributions from all three temperatures, the second only from the 3 and 4 keV components, and the third only from the 4 keV component. The weighting is the fraction of the ellipsoidal volume intersected by the elliptical annular cross-section. Thus the normalizations correspond to the emission measure in each ellipsoidal shell.

If multiple observations are to be analyzed, data sets from different observations corresponding to the same annulus should be part of the same data group. For example, given the following 4 data files:

Data sets for obs 1: obs1_an1, obs1_an2

Data sets for obs 2: obs2_an1, obs2_an2

The proper data loading command is:

```
XSPEC12>data 1:1 obs1_an1 1:2 obs2_an1 2:3 obs1_an2 2:4 obs2_an2
```

The `project` model has 3 (fixed) parameters, which can be used to define the inner ellipse of the region being analyzed. For instance, in the example above we could have only read in spectra for the outer two regions but then set the `project` parameters to (1.0,0.5,0.0). This would have allowed us to determine the temperatures and emission

measures of the outer two annuli without having to worry about fitting a model to the central region.

par1	semi-major axis of inner boundary ellipse
par2	semi-minor axis of inner boundary ellipse
par3	position angle of inner boundary ellipse