Hydra progress: fitting beginnings

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Motivation: 3D Sources
OK …, the real Motivation…

Fit_fun = "( wabs(1) * vnei(1) )";

VS.

My screen

My son’s screen
What are the Hydra Goals?

- Realistic multi-D source models
- Multiple missions, appropriate fidelity
- Advanced statistics [&fitting] on multi-D data
- Visualization: sources; analyses
- Flexible environment
- High-performance from dest-top
About a year ago...

Define a model
Define 3D components (3D norm array)
sphere, cylinder, torus
Assign spectra to them (MARX format)
Include LoS Doppler shift for radial v-field.

Use the model
Generate simulated events
Calculate model properties:
  n_e vs radius, ion masses

HEAD 2004
"A Coarse 3D Model of E0102 ..."
http://space.mit.edu/home/dd/Pubs/head04dd.pdf
Past year progress...

Simplified model definition
- text tables define components and spectra
- model the cluster A1068 too

Simulated event generation
- table defines observations
- simple approx to ACIS, MEG, RGS, (XRS)
- simulated events put in structure

Read in real data
- same obs. table defines real data
- real events put in structure

Compare real and simulated events
- scatter plots, PHA spectra, K-S test
Components and Spectra Tables

Optically thin components, norm arrays

Spatial string: v3d functions; radial lookup
Ancillary info:
   "type" (thermal), velocity info, spec id

Spectrum - energy, flux columns
Ancillary info:
   reference norm, ion("H" for solar), e's and m per ion
A1068 Model …

3 nested spherical shell components w/beta norm
Parameters include: ellipticity and position angle

3D rendering of model (sliced in half; boundaries of model cube visible)

2D projection on sky; color ~ count rate

Hmm… What's on Dad's screen?
A1068: $n_e$ in model
Observation Table

Table includes:
Inst, params, obsid, expos, roll, date, "product",
gotdata, datappro
calcmad, method, arf

Simulated Events:
simple approx. w/ARF, E blur, dp/p, etc.

Real Data:
Datapro a string that gets executed:
  ihy_data(iob) = [datapro string]
Generic FITS X,Y,E input
Custom routine, e.g., load grating data
Example: Data and Simulations

E0102: MEG K-S test --> needed to add Fe XVII, XVIII
Other Progress…

Rendering (Noble)
- volview, SLIRPed volpack

Model definition (Houck)
- 3D cube with emission and opacity

PVM (Noble, etc.)
- PVM getting used…

3D array of pointers, contains multiple components
Most recent progress: fitting

Define parameters
Define "knobs" array
Define FOM:
  Chi^2 between 2-D histograms
  sigma - Gehrels, includes sim'ed noise, lower-limit

General evaluation sequence ( knobs --> FOM ):
  knobs --> parameters
  update components
  generate simulated events
  select/filter/bin simulated events
  calculate FOM from binned real and sim events
pa=110, ellip=0.85, Chi^2 ~950 (~3.0 per bin)

Starting model

Data

Fitted model

pa=135, ellip=0.67, Chi^2 ~580 (~1.8 per bin)
Event comparison: "event_diff"

"common" events

A1068 Model–common (41339 evts)

A1068 Data–common (41339 evts)

"extra" model events

A1068 Model–only (1501 evts)

A1068 Data–only (6566 evts)

"extra" real events
Event comparison - cont. ...

The "extra" real events show a more pronounced low-energy "bump" than in the global/common spectrum. Due to Oxygen (or Fe) lines?

Oxygen VIII, z=0.1386

Oxygen VIII
A1068: Chi^2 vs pa and ellipticity

Can plot FOM vs knob values (fitting start/end indicated)
Simulation "noise" visible (n_sim = n_data here)
What next ...

Improvements:
Try 2D K-S test
Consider data-derived Voronoi-based measures
Other fitting engine(s), e.g., Levenberg-Marquardt

Apply to:
E0102 - still ... and forever!
SS 433 - additional test case
Binary star system - VW Cep, opaque objects