High-resolution Spectral-imaging of SN 1987A at 20 Years:
A one-dimensional look at the recent HETG data


By way of Introduction ...

SN 1987A Anatomy

SN 1987A is a complex 3D system - even when shown as simple schematics, as in the images above. At left is a "side view" oriented with North up and Earth to the left. At right is a view looking face on at the equatorial plane. The densities, temperatures, and velocities of the components all vary over many orders of magnitude.

Multi-wavelength View

SN 1987A is seen, above, in combined optical (HST-red), X-ray (Chandra-green) and radio (ATCA-blue) wavelengths (from Gaensler et al. 2007.)

Ground-based optical and NIR spectroscopy is very valuable for studying '87A e.g.: Groningsson et al. 2007; Kjaer et al. 2007.)

HETG Observations, Spring 2007

SN 1987A X-ray events are seen spread into the four HETG diffraction orders (diagram from the isis-3d model).

The first-order spectra from the HETG are plotted in the three panels below. The MEG plus (red) & minus (blue) spectra are plotted above the "0" level. The HEG plus (red) & minus (blue) spectra are shown offset below "0".

Doppler signature of a ring on the move

Following on earlier LETG analysis results, we see and can measure clear Doppler effects of the radial motion of the shocked material of the ring and its protrusions.

As the diagram at upper left shows, a zeroth-order image that has a gradient of emission wavelength across it will appear stretched and narrowed in opposite diffraction orders (diagram from the Chandra POG.)

At lower left this effect is clearly see in the new HETG data (black) and is well modeled (red) by a simple expanding ring.

A tilted, expanding ring model, at left, was generated with 3D routines and interfaced for use in model fitting using the ISIS analysis system.

The plot and table at right gives the results of the model fitting for many of the bright lines.

Is what-we-see what-we-got?

The actual emission in a waveband at a given time can differ from the underlying density of matter.

As an example, the figure at right (Orlando et al. 2006) shows X-ray color-flux images from a shock-CSM interaction (e.g., shock-cloud or shock-protrusion) evolving with time from top to bottom. The white contours trace the in-plane mass density. The right-half simulation includes the effect of thermal conduction which results in a hot diffuse corona instead of a cooling-dominated (radiative) core.

A Few References


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