Science Investigations with a CAT Grating Spectrometer on the International X-ray Observatory

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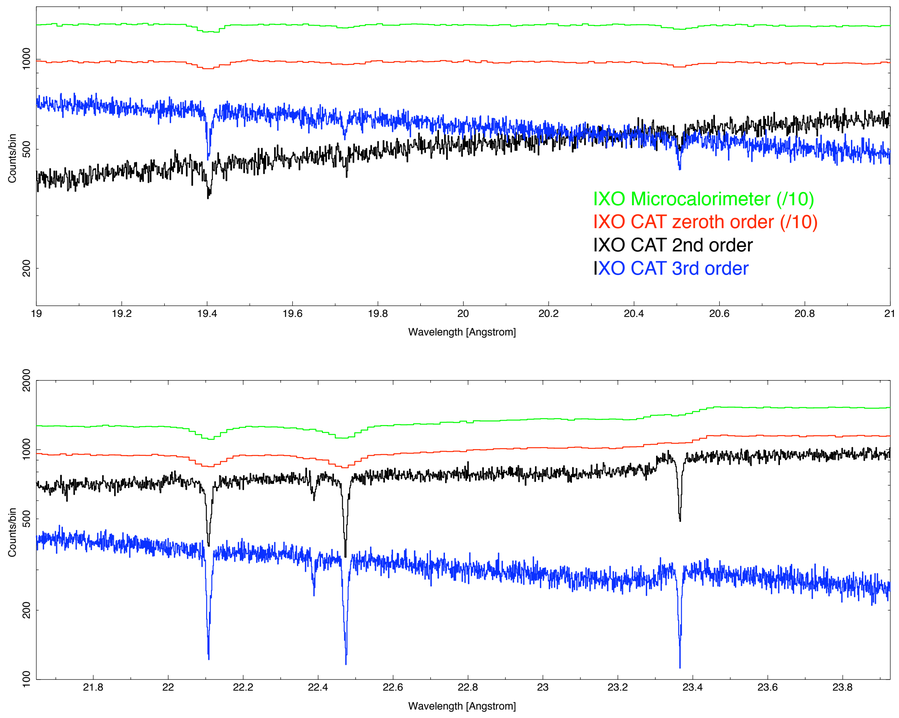
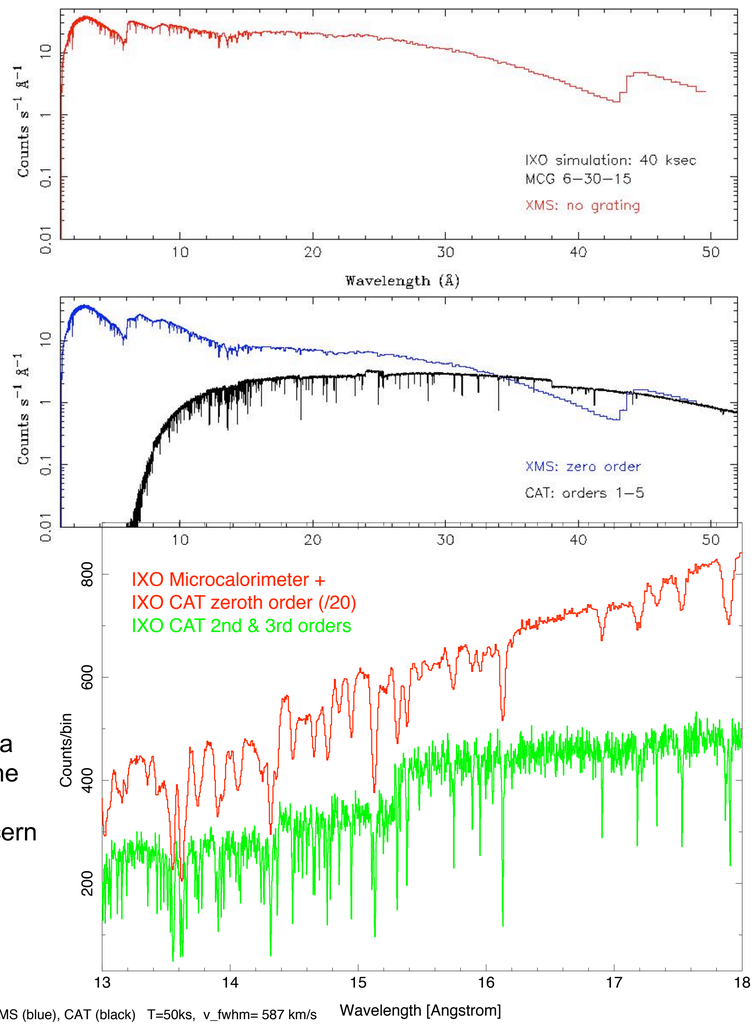
We present examples of scientific investigations that could be performed with a grating spectrometer on the International X-ray Observatory (IXO). The simulations are based on configurations using critical angle transmission (CAT) gratings, providing high spectral resolution and effective area. See also related posters by Heilmann et al. (457.10), Huenemoerder et al. (454.16), Drake et al. (454.15), Gagne et al. (454.14), and Nicastro et al. (454.08).

Warm-Hot Intergalactic Medium



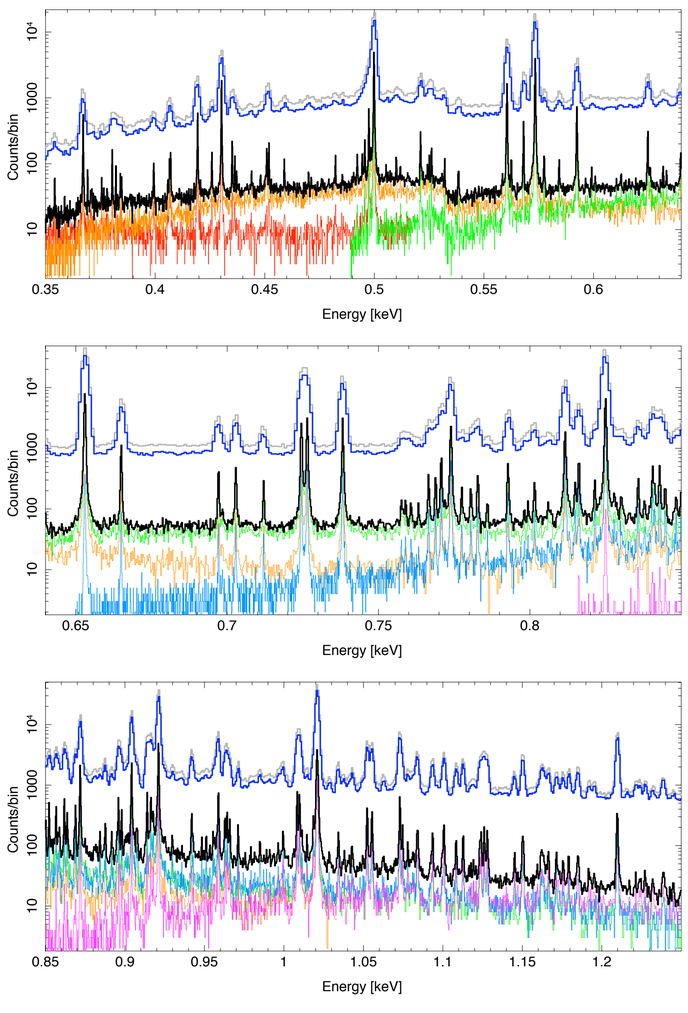
Left, *Top:* Simulation of a quasar spectrum at z=0.12 with intervening O VIII absorption due to the WHIM. The redshift of the quasar is 0.12 and the absorbing systems result from IGM enrichment model simulations (Cen & Fang 2006). The quasar flux is 2 x 10^{-12} erg/cm^2/s in the 0.5-2.0 keV band. ***Bottom:*** Same quasar simulation but plotted is the wavelength region where one finds the O VII lines corresponding to the O VIII lines in the top panel. Note that the O VIII to O VII ratios for the absorbers ranges over a factor of x. Note that the line pair near 22.4 Å is nearly unresolved in the calorimeter spectrum but readily resolved by the CAT spectrometer. *With the substantial effective area of a CAT grating spectrometer on IXO, many of lines of sight toward quasars can be examined for evidence of ionized, intergalactic gas, probing the structure of the baryonic material in the Universe.*

Warm Absorbing Gas in AGN



Right: Simulation of the MCG-6-30-15 spectrum, an AGN with a warm absorber. ***Top:*** The full spectrum. ***Bottom:*** Blowup of the 13-18 Å region, where the O VII edge is found. The edge is readily apparent at 14.4 Å in the CAT data but is difficult to discern using just the calorimeter. *A CAT grating spectrometer can resolve most of the weakest lines in the X-ray spectra of active galaxies' warm absorbers, needed for modeling the continuum under the relativistically broadened Fe-K line.*

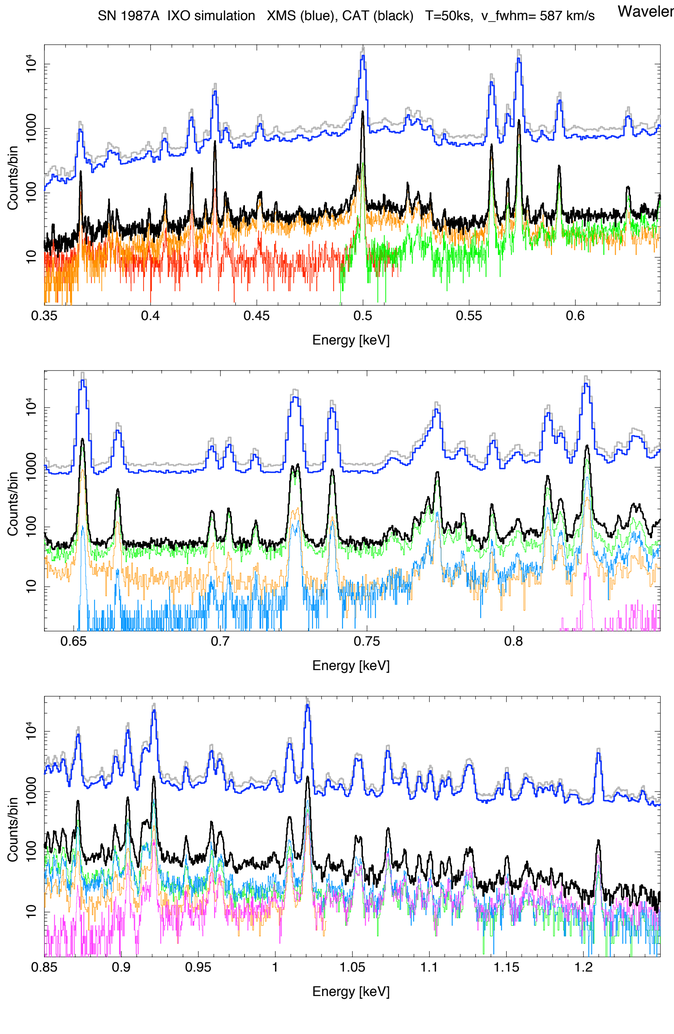
Simulations of SN1987A



The X-ray emission from SN 1987A is due to shocked material with a range of densities and shock velocities. Modeled with two vpshock components it is a good representative of similar emission from other SNe and GRBs. Because SN 1987A has a spatial extent of ~2” it will appear to IXO essentially as an unresolved point souce. Hence it can be observed with the IXO/CAT at the gratings' nominal resolving power.

Left: Simulations without velocity broadening. The top lines show the microcalorimeter spectrum with (blue) or without (gray) blockage due to the CAT gratings. The black line shows the CAT spectrum with all orders combined (shown in various colors).

Right: Simulations with 587 km/s velocity broadening added, modeling effects of bulk and turbulent motion. The IXO/CAT is very sensitive to the ion turbulent/ thermal velocity: note the very clear changes in the CAT observed line-widths. In contrast, the XMS response shapes barely changed. The broadening values used here in the simulations are only very roughly determined by current HETG observations (Dewey et al. 2008). *The ability to measure these ion Doppler velocities due to thermal and turbulent motions accurately is a capability that could be provided by the IXO/CAT grating spectrometer.*



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