*Emission Lines in Active Galaxies: New Methods and Techniques*
*ASP Conference Series, Vol. 113, 1997*
*B.M. Peterson, F.-Z. Cheng, and A.S. Wilson (eds.)*

# Reprocessing Models and the ASCA Spectrum of Mkn 290

T. J. Turner,[1] I. M. George,[1] T. Kallman, and T. Yaqoob [1]

*Laboratory for High Energy Astrophysics, Code 660, NASA/Goddard Space Flight Center, Greenbelt, MD 20771, USA*

P. T. Życki

*Nicolaus Copernicus Astronomical Center, Bartycka 18, 00-716, Warsaw, Poland*

**Abstract.** We describe a warm absorber/emitter model that is used to model the complex X-ray spectrum of Mkn 290. The best fit to the data also includes a contribution from an ionized reflector.

A 40 ks *ASCA* observation of the Seyfert 1 galaxy Mkn 290 reveals that this source has a complex spectral form, with emission and absorption features due to oxygen and iron superimposed on an underlying power-law continuum with photon index $\sim 1.9$. Mkn 290 is also found to exhibit significant flux-correlated spectral variability, predominantly below 2 keV, on a timescale of $\sim 5 \times 10^4$ s.

The relatively strong spectral features observed in this source make it an interesting case to use for an investigation of models for reprocessing of the X-ray continuum by ionized material. We consider ionized reprocessors based upon the XSTAR photoionization code, for geometries in and out of the line of sight. Models in either geometry provide a vast improvement over a simple absorbed power-law model.

The warm absorber/emitter model provides a good explanation of the overall spectral shape, with a column density of $N^*_{\rm H,z} \approx 8 \times 10^{21}\,{\rm cm}^{-2}$ of ionized material (ionization parameter $\xi = 24$) most likely within $\sim 10^{17}$ cm of the central source. While the data do not allow us to unambiguously determine the origin of the spectral variability, it is consistent with a drop of $\sim 25\%$ in flux accompanied by a proportional drop in the ionization state of the warm absorber. The intense K$\alpha$ line of equivalent width $\sim$500 eV present in the source can be modeled as a broad Gaussian of FWHM $\sim 0.5$ keV or by a line profile expected from the inner regions of a relativistic accretion disk inclined at $\sim 30°$. In both cases, the rest-frame line energy is consistent with weakly ionized iron, and cannot be explained by the warm emitter.

An ionized reflector can also model the overall spectral shape, yielding $\xi_{\rm ref} \approx 80$, although it has some difficult simultaneously fitting both the iron K$\alpha$ line and the soft X-ray spectral features. This model offers no simple explanation for the observed spectral variability, and the intensity of the reflected component is

[1] Also Universities Space Research Association.

greater than that expected from a semi-infinite slab illuminated by an isotropic source.

A hybrid model featuring reprocessing in both the warm absorber/emitter and reflector may be the most realistic scenario. In this case, the preferred fit models the soft X-ray regime (and spectral variability) with the warm absorber/emitter, and the iron K$\alpha$ line with a weakly ionized reflector ($\xi \lesssim 20$).

Full details will be presented elsewhere (Turner et al. 1996).

## References

Turner, T. J., George, I. M., Kallman, T., Yaqoob, T., & Życki, P. T. 1996, ApJ, 472, in press.