Origin of the Characteristic X-ray Spectral Variation of the Narrow Line Seyfert 1 Galaxies

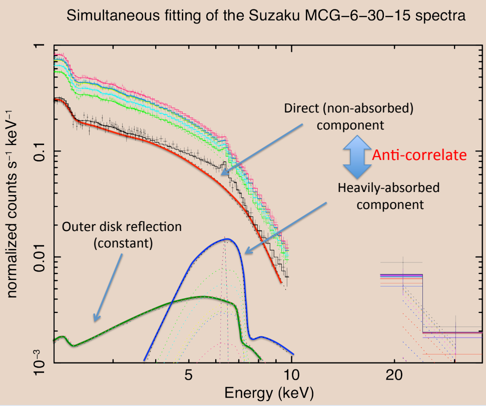
Ken Ebisawa[1,2], Hiroki Yamasaki[1,2], Misaki Mizumoto[1,2], Hiroaki Sameshima[1]

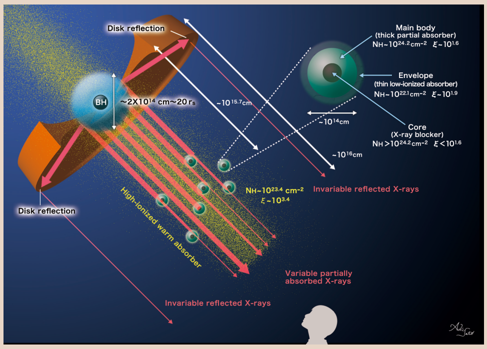
1: ISAS/JAXA, 2: University of Tokyo

We have proposed the Variable Double Partial Covering (VDPC) model to explain characteristic spectral variability of MCG-6-30-15 (Miyakawa et al. 2012, PASJ, 64, 140), 1H0707−495(Mizumoto,Ebisawa and Sameshima 2014, PASJ, 66, 122) and other 20 Seyfert galaxies (Iso et al.2015; PASJ, submitted). In this model, observed flux/spectral variations below 10keV within a ~day are primarily caused by change of the partial covering fraction of the central X-ray source by patchy absorbing clouds with internal structure. Here, we found the VDPC model is also successful to explain spectral variations as well as the Root Mean Square (RMS) spectra of IRAS 13224−3809,Mrk335 and Ark564. In addition to the well-known significant drop in the iron K-band, we occasionally found such intriguing iron L-peaks in the RMS spectra of 1H0707−495 and IRAS 13224−3809, that appear when iron L-absorption edges are particularly deep. This feature is naturally explained with the VDPC model, where the fluxes of the direct component (without absorption edges) and the absorbed component (with absorption edges) exhibit anti-correlation while the sum is hardly variable. The fractional variation thus peaks at the energy where the flux separation between the two spectral components is the widest, corresponding to the iron L-edge.

VDPC model

Intensity-sliced spectra of MCG-6-30-15 are fitted simultaneously *only* varying the partial covering fraction

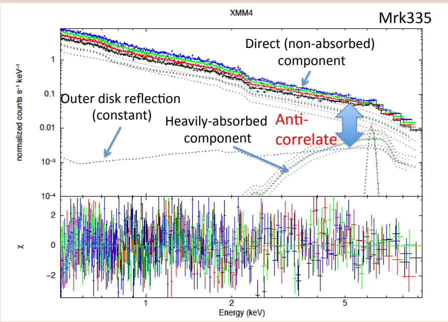




Miyakawa, Ebisawa and Inoue (2012), PASJ, 64, 140

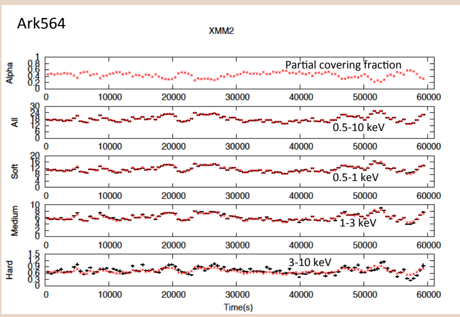
The heavy absorber in the line-of-sight is fragmented into many clouds, each of which is composed of two ionized zones, each of which is responsble for the iron K- and L-edge, respectively. Intrinsic luminosity and spectral shape of the X-ray source, as well as parameters of the ionized absorbers, are hardly variable. Most spectral variation is explained by only variation of the partial covering fraction.

Spectral variation



Most spectral variation is explained by only change of the partial covering fraction

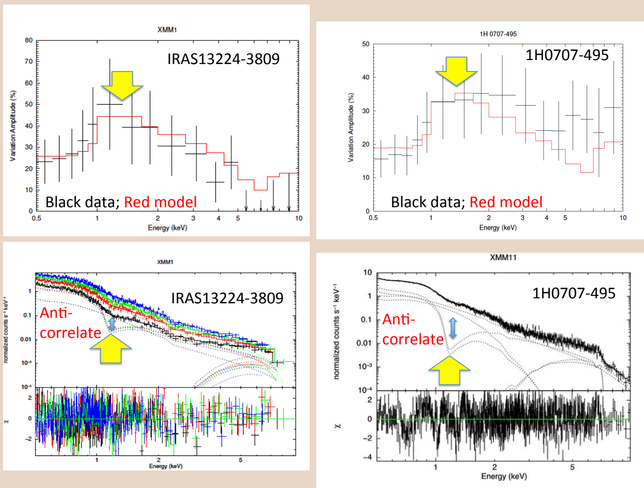
Light curve



Black data; Red model

Light curves below ~3 keV are almost completely explained by only change of the partial covering fraction. Small deviation above ~3 keV indicates intrinsic variation.

RMS spectra



Occasionally, strong peaks appear at iron L-edge in the RMS spectra, when strong L-edges are seen in the energy spectra. In the VDPC model, the direct (non-absorbed) component and the heavily-absorbed component indicate anti-correlation. Thus, the RMS peaks at the energy where the flux difference between the two components is the largest.