

kyconv: black hole accretion disc emission

This convolution model takes an input flux as a definition of the local flux across the accretion disc around a black hole. The broken power-law radial dependence and the limb darkening/brightening law for the emission directionality are used to define the local flux. The output is the total spectrum of an accretion disc. All relativistic effects are taken into account, see Dovčiak M., Karas V. & Yaqoob T. (2004) ApJS, 153, 205-221.

- par1 the black hole angular momentum ($0 \leq a/M \leq 1$)
- par2 the observer inclination in degrees (0° – pole, 90° – disc)
- par3 the inner edge of an accretion disc in GM/c^2
- par4 0 – means we always integrate from the disc inner edge, par3
 1 – if the disc inner edge, par3, is below the marginally stable orbit
 then we integrate emission from above the ISCO only
- par5 the outer edge of an accretion disc in GM/c^2
- par6 the inner power-law index for the radial dependence of the emissivity
 that scales as $r^{-\text{par6}}$ below the boundary radius, par8
- par7 the outer power-law index for the radial dependence of the emissivity
 that scales as $r^{-\text{par7}}$ above the boundary radius, par8
- par8 the boundary radius (in units of GM/c^2)
- par9 the overall Doppler shift
- par10 defines the emission directionality:
 0 – isotropic emission (local flux ~ 1)
 1 – Laor's limb darkening (local flux $\sim 1 + 2.06 \mu_e$)
 2 – Haardt's limb brightening (local flux $\sim \ln[1 + 1/\mu_e]$)
- par11 the number of grid points in the local energy
 (the energy resolution of the local flux)
- par12 defines how to normalize the spectra (see the norm below)
- norm if par12 = 0 then norm means photons/cm²/s in the line
 if par12 > 0 then norm means photons/keV/cm²/s at 1 keV
 if par12 < 0 then the spectrum is not renormalized

KYRH (the black hole horizon, r_h), KYRIN (the disc inner edge, r_{in}) and KYRMS (the marginally stable orbit, r_{ms} , ISCO) are added to the XSPEC internal switches. Use xset command to show their current values.

Note: there are several restrictions that arise from the fact that existing XSPEC models are used for definition of the local flux:

- only the energy dependence of the photon flux can be defined by local XSPEC models,
- only a certain type of radial dependence of the local photon flux can be imposed, a broken power-law radial dependence was chosen,

- there is no intrinsic azimuthal dependence of the local photon flux, the only azimuthal dependence comes through limb darkening/brightening law (emission angle depends on azimuth),
- the local flux can highly depend on the energy resolution, i.e. on the energy binning used, if the energy resolution is not high enough. This is because the flux is defined in the centre of each bin. A large number of bins is needed for the highly varying local flux.