J09c Investigation on The X-ray Spectra of The ULX NGC 5204 X-1 in Quest of the slim disk signatures

○ Kiki Vierdayanti，嶺重 慎 (京都大学)，海老沢 研 (JAXA/ISAS)，渡会兼也 (大阪教育大学)，川口俊宏 (国立天文台)

It still remains an open question if the Ultraluminous X-ray Sources (ULXs) really contain intermediate-mass black holes (IMBHs), or if they are simply super-critical accretors onto stellar-mass black holes. To settle down this issue, we investigate the XMM-Newton EPIC spectra of an ULX, NGC 5204 X-1, whose X-ray luminosity is $L_{\rm X} \sim (2-6) \times 10^{39}$ erg s^{-1}. We first try the standard spectral model of disk blackbody (DBB) + power-law (PL), finding a good fit to the data (reduced chi-squared is 0.99) with the innermost temperature, $kT_{\rm in} = 0.30 \pm 0.02$ keV, and the photon index, $\Gamma = 1.7 \pm 0.1$. The low temperature apparently supports the IMBH interpretation of ULXs, in agreement with Roberts et al. (2005).

Next, we tried to fit the data by the p-free disk model alone, assuming effective temperature profile of $T_{\rm eff} \propto r^{-p}$. Surprisingly, we also obtained a good fit (reduced chi-squared is 1.10) with a higher innermost disk temperature, $kT_{\rm in} = 2.87 \pm 0.54$ keV. More importantly, we obtained $p = 0.50 \pm 0.03$, just the value predicted by the theory of super-critical accretion (slim disk), rather than $p = 0.75$ expected by the standard-disk model. That is, NGC 5204 X-1 should shine at about (or above) the Eddington luminosity, indicating that its black hole mass is about 10 $M_{\odot}$ (for which Eddington luminosity is 1.3×10^{39} erg s^{-1}).