COMPTONIZED X-RAY EMISSION FROM THE ACCRETION DISK AROUND A MASSIVE BLACK HOLE

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We report the Monte Carlo simulation of the unsaturated Comptonization to probe the phyiscal state of the accreting plasma near a compact object. We calculate the emission spectrum and the Compton cooling rate of the plane-parallel hot plasma layer with the finite optical depth to the Thomson scattering, τ. The distribution of electrons is assumed to be a relativistic Maxwellian with the temperature T_e. The energy and angular distribution of the soft photons impinging on the plasma layer is taken to be Planckian with the temperature T_{ph}. We use the Klein-Nishina formula for the scattering between a photon and an electron.

For the two temperature disk model we have examined the cases $kT_e = m_ec^2$, $0.25\ m_ec^2$ and $0.0625\ m_ec^2$. The obtained spectrum turns out to be a power law if $y \equiv 4\tau 2kT_e/m_ec^2 \lesssim 3$. For $y >> 1$, it deviates from a power law and forms a bump near $h\nu \sim kT_e$. To fit the power law energy index α and the cooling rate per unit surface area, F_{compt}, to the observations of CygX-1 ($\alpha \sim 0.6$, $F_{compt} \sim 10^{22}$ erg cm^{-2}s^{-1}), we have found that the efficiency of Comptonization is rather low, i.e., $F_{compt}/F_{in} \approx 10 \sim 30$ and that an enormous flux of soft photons is needed to obtain the observed hard X-ray luminosity. It seems to be rather difficult to realize such a situation when one considers the geometry of the two-temperature disk.

As an alternative model we have also examined the hot corona model with $kT_e = m_ec^2$, $\tau \sim 0.03$, $kT_{ph} \sim 6 \times 10^{-4} m_ec^2$.

DISCUSSION

Schatzman: What are the two temperatures? What is the source of soft photons?

Takahara: "Two temperatures" means that the ion temperature and the electron temperature are different. For the two temperature disk model, the soft photon source is attributed to thermal emission from the cool middle of the disk.

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