HOT ACCRETION DISKS WITH MAGNETIC FIELD AND THERMAL CYCLO-SYNCHROTRON RADIATION

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We study the structure of hot, two-temperature accretion disks around black holes, including the effects of thermal cyclo-synchrotron radiation and magnetic viscosity. This work is an extension of previous work by Björnsson & Svensson (1991a, b, 1992) and Kusunose & Mineshige (1992), which did not include those effects. Magnetic field, B, is assumed to be randomly oriented and determined by prescribing the ratio $\alpha = P_{\rm mag}/P_{\rm gas}$ or $\alpha = P_{\rm mag}/(P_{\rm gas} + P_{\rm rad})$, where $P_{\rm mag}$, $P_{\rm gas}$, and $P_{\rm rad}$ are the pressures of magnetic field, gas, and radiation, respectively. We find those effects do not change the qualitative properties of the disks, i.e., there are two critical accretion rates related to production of $e^{\pm}$ pairs, $\dot{M}^U_{\rm cr}$ and $\dot{M}^L_{\rm cr}$ ($\dot{M}^U_{\rm cr} > \dot{M}^L_{\rm cr}$), that affect the number of local and global disk solutions, as recently found for the case with $B = 0$ (Björnsson & Svensson 1991a, b, 1992). However, a critical value of the α-viscosity parameter above which those critical accretion rates disappear becomes smaller than $\alpha_{\rm cr} = 1$ found in the case of $B = 0$, for $P_{\rm mag} = \alpha(P_{\rm gas} + P_{\rm rad})$. If $P_{\rm mag} = \alpha P_{\rm gas}$, on the other hand, $\alpha_{\rm cr}$ is still about unity. Moreover, when Comptonized cyclo-synchrotron radiation dominates Comptonized bremsstrahlung, radiation from the disk obeys a power law with the energy spectral index of ~ 0.5, in a qualitative agreement with X-ray observations of AGNs and Galactic black hole candidates. The spectral index is weakly dependent on the mass accretion rate.

We also find that the hot disk solutions for $P_{\rm mag} = \alpha(P_{\rm gas} + P_{\rm rad})$ are extended to the effectively optically thick region, where they merge with the standard cold disk solutions, as was found for the case with $B = 0$ by Kusunose & Mineshige (1992). Finally, we find a region in the disk parameter space with no solutions due to the inability of Coulomb heating to supply enough energy to electrons.

References

Björnsson G., & Svensson R. 1991a, in Structure and Emission Properties of Accretion Disks (IAU Colloq. 129), ed. C. Bertout, S. Collin, J.-P. Lasota, & J. Tran Thanh Van (Gif-sur-Yvette: Éditions Frontières), 379

Björnsson G., & Svensson R. 1991b, in Relativistic Hadrons in Cosmic Compact Objects, ed. A. A. Zdziarski & M. Sikora (Berlin: Springer), 53

Björnsson G., & Svensson R. 1992, Astrophysical Journal, 394, 500

Kusunose, M., & Mineshige, S. 1992, Astrophysical Journal, 392, 653

T. J.-L. Courvoisier and A. Blecha: Multi-Wavelength Continuum Emission of AGN, 485.
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