FINAL REPORT
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Spectral and Temporal Properties of Galactic Black Hole Systems
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Kusunose, Mineshige & Yamada (1996; hereafter KMY) extended the model of Kusunose & Mineshige (1995) to the Galactic black hole candidates by considering nonthermal electron injection with γ { EQ \o(,\s\up2(<),\s\do-1(_)) } 10. The effects of pair escape and advection on the disk structure and general relativistic effects on the emission spectrum were also examined. They found that the energy spectral index α_x of the power law X-rays is about –0.8 and –2.0 when $l_{soft}/l = 0.2$ and 2, respectively, where l_{soft}/l is the ratio of the compactness of the inejcted soft photons to that of the gravitational energy. The power law index was found to be nearly independent of the mass accretion which is consistent with the observed luminosity independence. The model with small l_{soft}/l (<1) shows promise for explaining the low state observed in Galactic black hole candidates. Model fits were provided for GX339-4 and Cyg X-1 data from COMPTEL and OSSE on the Compton Gamma Ray Observatory. The difference in emission spectra between thermal disks and the model of KMY appears only in the energy range > 100 keV.

Li, Kusunose and Liang (1996) studied stochastic particle acceleration to produce nonthermal particle distributions which then were used in the model of Kusunose & Mineshige (1995) to model the spectrum above 1 Mev from GBHC's. Under certain conditions, stochastic electron acceleration overcame Coulomb and Compton losses resulting in a suprathermal electron population. Good fits wre obtained by COMPTEL and OSSE observations of Cyg X-1 and GRO J0422+23.

Kusunose & Mineshige (1996a) examined the role of electron-positron pairs in advection-dominated disks. They found that the results for advection-dominated disks without pairs are not qualitatively changed by including pairs.

Summaries of work sponsored by this grant are given in Wheeler, Kim, Moscoso, Kusunose & Mineshige (1996) and Kusunose (1996)

Work was also done on developing a model for an $e^{\pm}$ pair wind from the inner disk region of a black hole. The model consists of three zones: a pair production/annihilation zone at the base of the wind, a pair annihilation zone slightly further out from the disk and a wind zone extending to infinity where no annihilation occurs. The model assumes an input X-ray / γ-ray power-law spectrum as a function of photon energy and angular distribution. Pairs are created in the pair production/annihilation zone via photon-photon , photon-particle and particle-particle collisions. The bulk velocity of the pairs is obtained from the momentum component perpendicular to the disk taking into account the radiation pressure acceleration of the pairs. Energy balance in the pair production/annihilation zone is calculated by assuming that the momentum component parallel to the disk is thermalized and by taking into account heating/cooling via anisotropic thermal Compton scattering along with the cooling processes of bremsstrahlung and synchrotron radiation. The pair density is also calculated. The outer boundary of the pair production/annihilation zone is where the optical depth for photon-photon pair produciton is unity. Beyond this point only pair annihilation will occur in the pair annihilation zone. When the pair density becomes small, pair annihilation will be negligible and the pairs will flow freely to infinity. In this model we have found that the X-ray power-law spectral index, α_x is the primary parameter

which determines the density, temperature and velocity of the pair production/annihilation zone (Moscoso, Kusunose & Wheeler 1996).

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