High Energy Astrophysics

Current research activities of the group involve studies of the various cosmic phenomena associated with compact objects (i.e., black holes, neutron stars, and white dwarfs). Of interest to many research groups at ASIAA is the nature of flows in the vicinity of black holes in binary star systems and supermassive black holes in the centers of galaxies. As a result, members of the high energy astrophysics group study the nature of flows in an accretion disk, where a fraction of matter is accreted and a fraction of matter is ejected either via a relativistic moving jet of gas or an outflowing wind. Other areas of interest center on the formation of neutron stars and black holes in binary star systems, and the emission mechanisms of high energy radiation from isolated magnetized rotating neutron stars (known as pulsars) and the interaction of pulsar winds with a stellar wind from a companion star in a binary system. Similarly, the nature of high energy emission at gamma-ray and GeV energies, unexpectedly discovered, in recurrent novae and classical novae arising from thermonuclear outbursts from mass accreting white dwarfs in close binary star systems is also under investigation.

Spectral studies of active galactic nuclei (AGN) containing supermassive black holes provide insight into the geometry and nature of accretion flows in these systems. A disk corona evaporation model has been investigated, which provides a physical mechanism for explaining many observational phenomena in low luminosity AGN (LLAGN). In this model, evaporation leads to the formation of an optically thin inner disk and truncation of an optically thick outer disk. Such a model naturally accounts for the soft spectrum at high luminosities and a hard spectrum at low luminosities for high luminosity AGN and LLAGN respectively (for example, see Figure 1). Recently, the disk evaporation model was generalized to include the effect of a magnetic field. The critical transition mass accretion rate for which the disk is truncated is found to be insensitive to magnetic effects, but its inclusion leads to a smaller truncation radius in comparison to a model without its consideration. Based on these results, the truncation radii inferred from spectral fits of LLAGN published in the literature are found to be consistent with the disk evaporation model. The infrared thermal emission arising from the truncated geometrically thin accretion disks may be responsible for the red bump seen in such LLAGN.

Additional theoretical models for accretion disks surrounding black holes are under investigation examining the intrinsic differences between stellar mass black hole X-ray binary systems from the supermassive black holes in AGN. Of particular interest is the thermal state of the gas fueling the black hole. In the stellar context, the gas is cool as it originates from the photosphere of its companion. On the other hand, the gas in the central regions of galaxies can also have a hot component, which leads to the accretion not only of molecular gas, but also of coronal gas. Hence, the ratio of these two components, coupled with the disk evaporation/condensation model, will reveal differences in the spectrum and luminosity profile of such disks.

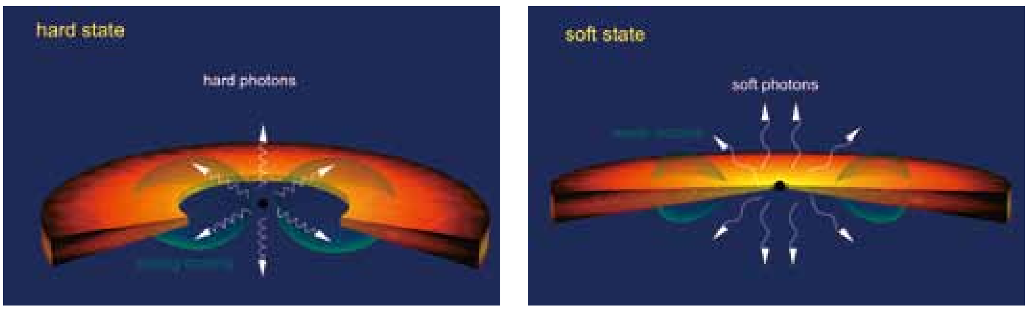

Figure 1. Accretion geometry of disks for LLAGN (left panel) and high luminosity AGN (right panel) corresponding to low and high rates of mass accretion, respectively. (Picture Credit: Ronald Taam & Yin-Chih Tsai)