COMPOSITE SPECTRA OF SOME ACTIVE GALACTIC NUCLEI

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Recent years have seen some progress in the studies of the central engine of active galactic nuclei (AGN). On the observational side, past space missions such as HEAO-A, Einstein and EXOSAT have brought some considerable progress in the observations of X-ray spectra and time variabilities of AGN. More significant progress is expected in the immediate future due to the current and future space missions such as IUE, GINGA, the Hubble Space Telescope, ASTRO-D, ROSAT, and AXAF. Therefore, it would be important to continue parallel theoretical studies. In this report composite models are presented which naturally explain the observed continuum radiation from seyferts and radio-quiet quasars. Our aim is to explore the central engine of AGN. This class of AGN is selected because it is generally considered to give the most direct information on the central power-house.

A composite spectrum of typical seyferts and radio-quiet quasars may be divided roughly into three components - a power-law spectrum of slope $\alpha \sim 1 - 1.5$ from infrared to optical, a distinct "bump" in the ultraviolet region, and a power-law spectrum of slope $\alpha \sim 0.3 - 1$ in the X-ray window (see e.g. Elvis 1988, Sun and Malkan 1987, Lightman and Zdziaski 1987). In many sources there is evidence of another infrared "bump" (Ward et al. 1987). In some more luminous seyferts and a certain type of quasars, an extra soft X-ray excess is observed (e.g. Arnaud et al. 1985, Pounds, Turner and Warwick 1986, Elvis 1988). Very recently rapid X-ray variabilities have been observed from many of these objects (e.g. Barr and Mushotzky 1986).

Our models are constructed by adopting the hypothesis that the energy released through accretion of gas onto a supermassive black hole is responsible for the continuum emission from these AGN. Then, for the range of values of the black hole mass and luminosity which are relevant for these objects, it is possible that within a certain critical radius the accretion flow collapses to form a thin disk and an electron-positron pair corona, or it decomposes into a two-phase plasma of cool "blobs" imbedded in a hot gas with pairs (Tsuruta 1988, Tritz and Tsuruta 1988, Begelman, Sikora and Rees 1987). Both cases are very interesting because they would offer natural emission sites for the observed UV bump and X-rays. Therefore, we have been investigating these possibilities. An advantage of these models is

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that they can make specific predictions on such properties as flux changes and spectral behavior which can be tested by observations. In order to explore the first possibility, we have been calculating, by using the Monte Carlo method, the over-all radiation coming out of a corona of non-thermally produced pairs above a disk (Cooksey, et al. 1988). Our results show that by changing the environment of the pair corona we can naturally explain both the absence and presence of the soft X-ray excess.

Our preliminary studies show that qualitatively both models are consistent with the observed broad-band spectra of seyferts and radio-quiet quasars. For instance, the emission from the cooler component in the form of a thin disk or "blobs" in the central region is responsible for the UV "bump", and Comptonization of the soft photons from the cooler component by the energetic pairs in the hotter component produces the observed X-rays. When the source is sufficiently compact the soft X-ray excess appears. The synchrotron radiation from the outer uncollapsed portion of the accretion flow is responsible for the IR to optical power-law continuum. Depending on the different combinations of various key parameters, such as the accretion rate, black hole mass, magnetic field strengths, viewing angles, etc., different components dominate over others. The outcome is the various different forms of the composite spectra.

This general picture can be tested by the construction of detailed models and careful comparison with observation. In this connection it would be crucial to conduct simultaneous observations of temporal and spectral behavior of these objects. We successfully carried out such observations during May 13 - 17 1988, when NGC 4051 was observed simultaneously in the X-ray, UV, optical and infrared windows (Kunieda et al. 1988). The preliminary results, which will be discussed in this report (see also the contribution by M. Ward in this volume), are consistent with the disk-corona model introduced here. Hopefully, similar efforts would continue, gain strong support and prove rewarding.

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