On the Strength of the Lyman Edge in Quasar Accretion Disks

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Thermal emission from a geometrically thin, optically thick accretion disk around a massive central black hole is one of the possible explanations for the continuum emission of quasars in the energetically dominant UV and EUV range. However the observations of a large number of Quasars indicate that the H I Lyman edge is weak or there is no observable Lyman edge at all. This fact has been considered as an argument against the presence of a geometrically thin, optically thick disk as the main source of the radiation in the optical and UV spectral ranges. However, the current theoretical models of the physical structure and the radiation emitted by such disks are far from being complete. More accurate models are necessary to settle the question if the thin disk approximation can be ruled out solely due to the lack of strong Lyman edges.

We have calculated UV/EUV (300 Å ≤ λ ≤ 1500 Å) continuous energy distributions of accretion disks in the centers of AGNs for disk luminosities in the range $0.1 \cdot L_{\text{Edd}} \leq L_{\text{acc}} < 1.0 \cdot L_{\text{Edd}}$ and central masses ranging from $10^8 M_\odot$ to $10^5 M_\odot$. The vertical gas pressure structure of the disk and the disk height is obtained analytically, the temperature stratification and the resulting continuum radiation fields are calculated numerically. We have included NLTE effects of both the ionization equilibrium and the level populations of hydrogen and helium. We show that small Lyman edges are an intrinsic feature of such disks. In the LTE models the Lyman edge is always in absorption. In NLTE we find that the edge can be in emission or absorption, depending on the disk parameters.

Small Lyman edges are, therefore, no contradiction to thin disk models. The crucial test rather will be: Do the observations show the presence of a Lyman edge at all, because all of the models predict at least a small edge.