Preheated Advection Dominated Accretion Flow

Myeong-Gu Park
Department of Astronomy and Atmospheric Sciences
Kyungpook National University

Jeremiah P. Ostriker
Princeton University Observatory
Princeton University

Adevection dominated accretion flow (ADAF) has been quite successful in explaining a wide variety of accretion powered astronomical sources. The physical characteristics of ADAF complement the classical thin disk flow quite nicely, and extensive work has been done on ADAF. However, one important aspect of ADAF has not been fully appreciated: ADAF shares as much resemblence with the spherical flow as with the disk flow, and its two dimensional nature can lead to some interesting consequences. In this work, we adopt the two dimensional self-similar solutions of Narayan & Yi (1995a) and study the thermal nature of the flow by direct integration of energy equations, with special considerations given to Compton preheating by hot photons produced at smaller radii. When preheating is not considered, high temperature flow does not exist when the mass accretion rate is higher than $\sim 10^{-3.7}$ or $\sim 10^{-1.5}$ of the Eddington mass accretion rate, depending on the boundary conditions, and even below this mass accretion rate, a roughly conical region around the hole cannot sustain high temperature ions and electrons. However, we find that even above this critical mass accretion rate, high-temperature flow can be self consistently maintained via Compton preheating. These solutions consitute a new branch of solutions as in spherical accretion flow; high temperature ADAF flow can exist above the critical mass accretion rate in addition to the usual cold thin disk. Therefore, the Compton preheating could be the mechanism to trigger the phase change from the thin disk to ADAF.