



Radiation MHD model of Changing Look AGNs

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Recent monitoring observations have found that some active galactic nuclei (AGNs) transit between type 1, in which bright, broad emission lines are observed, and type 2, in which dark, broad emission lines are not observed, which is referred to as Changing-Look AGNs [1]. Changing Look AGNs also exhibit transitions in the UV to X-ray bands. In the type 1 state, UV to soft X-ray emission from an optically thick cold disk is dominant, and in the type 2 state, hard X-ray emission from an optically thin hot accretion flow is dominant [2]. In addition, Changing Look AGNs have highly variable soft X-ray components, in which the origin is unclear. The appearance/disappearance of the soft X-ray emitting region is considered the essence of the changing-look state transition. It is a good probe to investigate AGNs' soft X-ray emitting region. The spectral state transitions in UV to X-ray are like those in our galaxy's black hole X-ray binaries.

Three-dimensional magnetohydrodynamic (MHD) simulations show that the accretion flow, initially hot and dominated by hard X-ray emission, undergo a state transition to a cool accretion flow supported by the magnetic pressure as the cooling instability growth, and the accretion flow contract vertically with an increase of the accretion flow [3]. Motivated by the MHD simulations, steady, axisymmetric accretion flow solutions are

constructed, including an azimuthal magnetic field, and it found that the magnetically supported accretion flow state appears during the hot and cool accretion flow solution [4].

To investigate the changing-look state transitions of accretion flows around a $10^7 M_{\odot}$ black hole, we performed three-dimensional radiation MHD simulations with a hard X-ray emitting hot accretion flow as the initial condition. As a result of the increase in accretion rate, the hot accretion flow is cooled by radiative cooling, and a Thomson-thick warm accretion flow emitting soft X-rays is formed outside the hot accretion flow in the vicinity of the black hole. The appearance of a warm accretion flow emitting soft X-rays corresponds to an increase in soft X-ray emission in the changing-look AGNs, and the warm region is found to be expressed by the magnetically supported disk solution. Furthermore, the azimuthal magnetic field with opposite polarity to the equatorial plane causes strong magnetic diffusion near the equatorial plane, which heats the accretionary flow and maintains the temperature in the warm region.

References

- [1] Shappee et al. 2014
- [2] Noda & Done 2018
- [3] Machida et al. 2006
- [4] Oda et al. 2009