PEM30-P03 Room:Poster Time:April 30 18:15-19:30

Magnetohydrodynamic and Radiation Hydrodynamic Simulations of Tidal Disruption Events by a Supermassive Black Hole

KAWASHIMA, Tomohisa[1] ; OHSUGA, Ken[2] ; MATSUMOTO, Ryoji[3*]

[1]Shanghai Astronomical Observatory, [2]NAOJ, [3]Chiba University

Gas clouds or a star approaching a supermassive black hole can be disrupted by its tidal force. Such tidal disruption events enable us to observe the luminosity variations and state transitions triggered by the increase of the accretion rate, and give us hints to understand the transitions between different types of active galactic nuclei. Furthermore, the interval between the state transitions restricts the angular momentum transport rate, which determines the time scale of viscous evolution of an accretion disk. In 2014, tidal disruption flares are expected in two objects. One is the Galactic center supermassive black hole Sgr A∗. A gas cloud named G2, whose mass is three times of the Earth mass is now approaching Sgr A∗, and its pericenter passage will be in March, 2014. Since the distance from the black hole is well inside the radius of the accretion disk around Sgr A∗, the tidally disrupted gas cloud will interact with the accretion disk. We carried out three-dimensional magnetohydrodynamic simulations of this interaction by applying a MHD code CANS+ based on the HLLD scheme. We found that the accretion rate increases more than 10 times during this outburst, and that magnetically driven jets are ejected. Increase of the X-ray and radio luminosity takes place within 1 month after the passage. The second object we expect an outburst is Swift J1644+57, which showed extremely high energy outburst in March 2011. This object locates at the center of a galaxy at redshift z=0.35. The energy released in this outburst indicates that the outburst was triggered by a disruption of a star. The luminosity of this source exceeded the Eddington luminosity for a 1-million solar mass black hole for period longer than a year but the X-ray luminosity decreased 100 times in August 2012. This darkening can be interpreted as the transition from a supercritically accreting slim disk state to a sub-critically accreting standard disk state. We carried out radiation hydrodynamic simulations of this event and showed that mass of the stellar debris is accumulating in the outer disk. When the surface density of the outer disk exceeds the threshold for the transition from a standard disk to a slim disk, the disk mass will accrete supercritically onto the black hole. Numerical results indicate that the luminosity of Swift J1644+57 may exceed the Eddington luminosity again in 1-2 years from the darkening.

Keywords: accretion disk, MHD, radiation hydrodynamics, black hole, tidal disruption, state transition