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Broad line emissions from an accretion disk in low mass-ratio binary supermassive black holes on a circular and eccentric orbit

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About 20% of broad lined radio galaxies (BLRGs) exhibits double-peaked emission lines in the broad line regions of their nuclei. This double peaked nature is attributed to the emission from an axisymmetric accretion disk around a single supermassive black hole. By the comparison with the large number of observed datas, however, it has been pointed out that the non-axisymmetric structure of the accretion disk is crucial to explain the difference of the amplitudes between two peaks. One of the promising mechanisms to make the disk eccentric is an eccentric instability that occurred when the disk size is larger than the 3:1 resonance radius. This is a well-known phenomenon in dwarf-nova systems where the mass ratio of the companion star to the white dwarf is less than 0.33. Here, we report the line emission profiles of an accretion disk in binary black holes with a low black-hole mass ratio on both a circular and an eccentric orbit by performing smoothed particle hydrodynamics simulations.

In a circular binary, we found that the disk is eccentric and precesses with time due to the eccentric instability. This produces the double-peaked emission line with a central peak, and such triple peak features are periodically seen. In a highly eccentric binary, the emission lines have an unusual shape because the disk is significantly disturbed by the approaching companion black hole. The double-peaked emission lines are seen only at apastron. We will also discuss the observation implications of this model.