W104a State Transitions of GRS 1739-278 During the 2014 Outburst

Sili Wang, Megumi Shidatsu, Yutaro Tachibana, Taketoshi Yoshii, Nobuyuki Kawai

We report on the X-ray spectral analysis and time evolution of a black-hole binary during its 2014 outburst based on the Swift/XRT and MAXI/GSC observations. This report extend the earlier report by Sudo et al. (W119b, ASJ Meeting Fall 2016) considering a spinning black hole and over the whole outburst period. In the outburst, transitions from the low/hard state to the high/soft state and then back to the low/hard state was seen.In the broad time scale, a transition from the low/hard state to the high/soft state and then back to the low/hard state can be seen. During the high/soft state, the innermost disk temperature mildly decreased, while the innermost radius was constant at $\sim 14.82\ (\frac{D}{7\ \mathrm{kpc}})\ (\frac{\cos i}{\cos 30^\circ})^{-1/2}$ km, where D is the source distance and i is the inclination of observation. Our analysis shows that the object is less likely to be a Schwardzschild black hole and more likely to be a Kerr black hole. Assuming that the obtained innermost radius represents the innermost stable circular orbit for a Kerr black hole whose spin is 1, we estimated the black hole mass to be $12.0 \pm 0.4(\frac{D}{7\ \mathrm{kpc}})\ (\frac{\cos i}{\cos 30^\circ})^{-1/2}$ $\mathrm{M}_\odot$, where the correction for the stress-free inner boundary condition and color hardening factor of 1.7 are taken into account. If the inclination is $20^\circ - 50^\circ$ and the November 2014 soft-to-hard transition occurred at $1\% - 4\%$ Eddington luminosity, the fitting of Swift/XRT spectra with a multi-color disk model derives a constraint on the black hole mass to be $9.7 - 17.6$ $\mathrm{M}_\odot$ corresponding to a distance of $6 - 8.5$ kpc. The spectral fitting with a multi-temperature blackbody model for a thin accretion disk around a Kerr black hole (`kerrbb`) also confirms that the mass constraint is an "upper limit".