Superluminous Transients at AGN Centers from Interaction between Black Hole Disk Winds and Broad-line Region Clouds

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We propose that superluminous transients that appear at central regions of active galactic nuclei (AGNs) such as CSS100217:102913+404220 (CSS100217) and PS16dtm, which reach near or super-Eddington luminosities of the central black holes, are powered by the interaction between accretion disk winds and clouds in broad-line regions (BLRs) surrounding them. Such transients have been suggested to be a kind of supernova (SN) explosions because of their similarities to Type IIn SNe. However, similar transients preferentially appear in AGN central regions with similar properties. This fact has motivated us to consider a possibility that these transients are related to AGN activities rather than SNe.

If the black hole accretion disk luminosity temporary increases by, e.g., limit-cycle oscillations, leading to a powerful radiatively driven wind, strong shock waves propagate in the BLR. Because the dense clouds in the AGN BLRs typically have similar densities to those found in Type IIn SNe, strong radiative shocks emerge and efficiently convert the ejecta kinetic energy to radiation. As a result, transients similar to Type IIn supernovae can be observed at AGN central regions. Since a typical black-hole disk wind velocity is $\simeq 0.1c$ where c is the speed of light, the ejecta kinetic energy is expected to be $\simeq 10^{52}$ erg when $\simeq 1\,M_{\odot}$ is ejected. This kinetic energy is transformed to radiation energy in a timescale for the wind to sweep up a similar mass to itself in the BLR, which is a few hundred days. Therefore, both luminosities ($\sim 10^{44}$ erg s^{-1}) and timescales ($\sim$100 days) of the superluminous transients from AGN central regions match to those expected in our interaction model. Figure 1 shows a schematic picture of our model to explain the superluminous transients from AGN activities.

If the superluminous transients from AGN centers are related to the AGN activities triggered by limit-cycle oscillations, we expect that the luminosity of the superluminous transients are correlated with the AGN central BH mass as demonstrated in Figure 2. Also, the limit-cycle oscillation repeats in the timescale of decades so the superluminous transients should become bright repeated in the timescale decades or so.

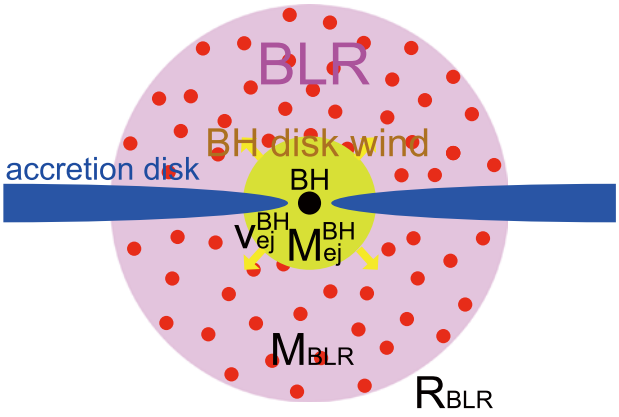

Figure 1: Schematic picture of our BH disk wind model. If the BH accretion disk ejects a wind with M_{ej}^{BH} and v_{ej}^{BH}, it is decelerated by the dense clouds in the BLRs (red dots) and its kinetic energy is efficiently converted to radiation [1].

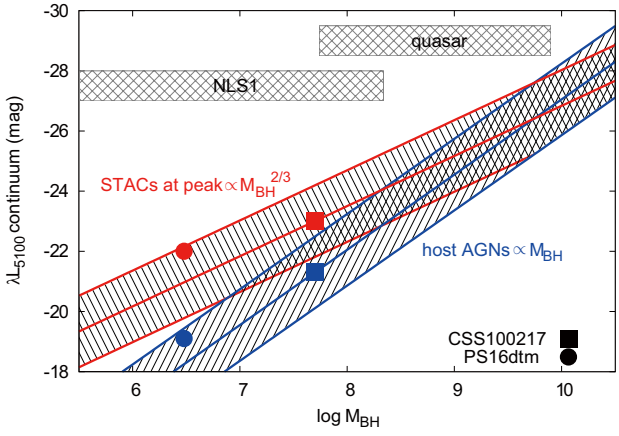

Figure 2: Luminosity estimates of the superluminous transients from AGN centers (STACs) by the BH disk wind model and their host AGNs [1].

Reference

[1] Moriya, T. J., et al.: 2017, *ApJL*, **843**, L19.