S27a X-ray reverberation lags due to AGN winds

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X-ray reverberation lags in the Fe-K energy band have been found in many active galactic nuclei (AGNs). The lags commonly have the following three features; (1) lag amplitudes are as short as several R_g/c, where R_g is the gravitational radius and c is the light velocity, (2) lag frequencies are $\sim c/100\,R_g$, and (3) lag-energy spectra have a broad feature in the 5–8 keV band. In the previous JAS meeting (S07a; 2017 autumn), we reported that an outflowing cloud is a possible origin to produce such lags. However, we assumed a neutral and partial-shell-like cloud, which is far from the realistic disc-wind geometry.

Here, we performed Monte-Carlo simulations to compute lags on the disc-wind-like geometry, including radius dependence of the ionisation state, density, and outflowing velocity. We adopted the biconical wind, which is used in Hagino et al. (2015, 2016). As a result, we found that the X-ray scattering mainly occurs around the launching point of the wind, at $\sim 50-100\,R_g$, which matches the required lag frequencies. The lags are diluted by primary photons, so that the amplitudes get shorter than the light-travel time by as much as one order of magnitude. Moreover, Doppler velocity of the wind produces the broad lag-energy feature. Consequently, we can reproduce the observed lag features with the biconical wind. Such an extreme condition that the source is close to the event horizon of a maximum-spin black hole, which is assumed in the disc-line interpretation, is not required.