S07a Fe-K short-time lags produced by distant clouds in active galactic nuclei

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Short-time (∼several R_g/c) X-ray reberveration lags in the Fe-K energy band have been found in some active galactic nuclei (AGNs), where R_g is a gravitational radius and c is light velocity. X-ray scattering on an absorbing medium, such as a BLR cloud or a disc wind, is one of the mechanism to produce the lags. Although its light-travel time ($\sim 10^{2-4}\, R_g/c$) are longer than the observed lag amplitude, the lag timescale is known to be reduced by the dilution effect, where the lag timescale is diluted by contamination of primary and scattered photons in the X-ray energy bin of interest.

We performed Monte-Carlo simulations to explain the short lag amplitude by a distant cloud located at $\sim 10^2\, R_g$, assuming an outflowing cloud around a black hole whose mass is 10^7 times of the solar mass. As a result, whereas the light-travel time of the cloud is 5000 sec, the produced lag timescale is $\sim$ 100 sec in the frequency range of 10^{-5} Hz to 10^{-4} Hz. The observed lag versus energy plot with a broad Fe-K lag feature can be explained by Doppler shift of the outflowing cloud. Consequently, we have found that the outflowing cloud is a plausible mechanism to produce X-ray reberveration lags.