



X-RAY ASTRONOMY 2019

Current Challenges and New Frontiers in the Next Decade

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AGN Fe-K reverberation lags explained by the outflow

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Fe-K reverberation lags are commonly observed in Seyfert galaxies.

If the observed short lag timescale (~100 sec) is literally interpreted as the light-travel time, an extremely compact X-ray emitting corona is hinted to locate at very close to the black hole.

Alternatively, the apparently short Fe-K lag may be a natural consequence of the much further reprocessing site where the light-travel time is ~1000 sec, such that the Fe-K photon lags are “diluted” by the direct photons which are not lagged and ~10 times more dominant in number in the Fe-K energy band.

We carried out a precise Monte-Carlo simulation of the Fe-K reverberation lags expected from AGN outflow. We assumed a realistic biconical geometry of the outflow which is highly photo-ionized. As a result, we have succeeded to quantitatively explain the short Fe-K reverberation lags observed from 1H0707-405 and Ark 564.

While these sources show very similar Fe-K lag features, the Fe-K spectral features are very different; 1H0707-405 shows a strong P-Cygni profile while Ark 564 shows a much weaker spectral signature.

These spectral differences are understood in the context of the outflow model, assuming a large outflow solid-angle in the line-of-sight in the former case, and a smaller outflow solid-angle out of the line-of-sight in the latter case.

The hot-inner outflow will eventually get fragmented into clumpy clouds due to instability. Such outer clumpy clouds cause partial covering of the central X-ray emitting region, and change of the partial covering fraction is responsible for observed spectral variations. Consequently, the “Hot-inner and Clumpy-outer Wind” model simultaneously explains both the Fe-K reverberation lags and spectral variations of Seyfert galaxies in 0.2-78 keV observed by XMM-NuSTAR, in terms of only changes of the partial covering fractions and intrinsic luminosities.

Topic

Active Galactic Nuclei: accretion physics and evolution across cosmic time

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