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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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