# Abstract

Light echo studies, usually referred to as reverberation mapping in active galactic nuclei(AGN) is an indirect but powerful method for investigating the structure of the central engine. Instead of relying on spatial resolution, it makes use of time delays between variations at different wavelengths, which are generally interpreted as high-energy photons from the corona being reprocessed by the accretion disk. These so-called continuum lags are widely used to estimate disk sizes. However, many recent studies have reported lags that are larger, or more complex, than predicted by the thin-disk standard model. This thesis investigates the origin of these discrepancies by developing models that include additional sources of reprocessing.

The first part of the work focuses on building such a model, starting from the lamp-post geometry and extending it to include the contribution of the broad-line region (BLR). A series of simulations shows that scattering in the BLR can enhance the observed lag amplitude and produce signatures that closely resemble those generated by increasing the coronal height. This degeneracy complicates reliable disk-size estimates. We also find that the cadence and duration of monitoring campaigns strongly affect lag recovery, with short baselines in particular leading to underestimated values.

The second part of this work applies a physically motivated BLR model to the well-studied AGN NGC 5548. The model is based on the Failed Radiatively Accelerated Dusty Outflow (FRADO) framework of the physically motivated formation of BLR coupled with spectral calculations of BLR reprocessing from the radiative transfer code (CLOUDY). In combination with the accretion disk, this approach reproduces both the observed spectral energy distribution and the pattern of multi-band lags. As a further outcome, the model provides an estimate of the source distance and, from this, a tentative value for the Hubble constant.

The final part of this work looks at the effect of a vertically extended corona by adopting a two-lamppost setup. Our simulations show that reverberation signal of AGN is found to be very similar to that of a single source placed at the average height, with no clear distinction between the two cases. For systems that are both

very massive and slowly accreting, some differences do appear, although they remain small.

The results of the presented PhD thesis indicate that continuum reverberation is shaped by a combination of disk reprocessing, and BLR reprocessing. Including these effects in the models helps to explain why many measured lags differ from the thin-disk predictions. As a pilot study, the method was applied to NGC 5548, where the combined disk+BLR model reproduced both the spectrum and the observed lag pattern. The next step would be extend this approach to a larger set of AGN, which will make it possible to test the model more broadly and improve its use for studying accretion and cosmology.