Abstract

The time-dependent phenomena in Active Galactic Nuclei are not yet well-understood. Those sources are massive, with a broad range of physical properties and available observations allow to explore their properties across the entire electromagnetic spectrum. The thesis presents a series of results on different timescales, from hours/days to the galaxy's chemical evolution over millions of years. Short-term variations are observed, for example, in the form of quasi-periodic eruptions (QPE) and Changing Look Active Galactic Nuclei (CL AGN), and none of the two have clear physical interpretation yet. I discuss the model of radiation pressure instability. Such a model basically predicts outbursts in timescales of hundreds of years. However, taking into account the narrow, unstable zone (in Paper I) or the reduced size of the accretion disk (in Paper II) gives a possibility of shrinking the timescales to those observed in CL AGN. In Paper III, I address the issue of whether large luminosity changes, in long timescales, couple with other AGN properties, and I show that highly accreting sources are more reach in metals.

Specifically, in Paper I, I explore the disc-instability outbursts at a relatively low Eddington ratio with the narrow radiation pressure instability zone, additionally limited by the inner hot flow. Our toy model gave the quantitative predictions for timescales and amplitudes for Changing Look AGN with multiple outbursts. We also discussed the possibility of modelling QPE using the radiation pressure instability model. However, such short timescales ($\approx$ hours) seem challenging to be reached using the model considered in this paper.

In Paper II we extended the model of radiation pressure instability from Paper I and using the time-evolution code GLADIS we explored the instability using a radially resolved, vertically averaged 1-D model. In this work, we focus on CL AGN phenomenon, and we explore different mass exchange scenarios between disk and corona, as well as the location of the outer radius of the accretion disk ($\approx$ 100 R_{schw}). The latter seems to be of the key importance in reducing the timescales of the outbursts. Such a small outer radius can imitate quantitatively event which causes the mass redistribution in the accretion disk, for example, a tidal disruption event. Similar effect of the disk radius reduction can be caused by the presence of the second black hole opening a gap in the disk.

Accretion disk instabilities can lead to large changes of luminosity also in long timescales, but it is not clear if they could consistently reproduce other luminosity-dependent AGN properties. Observations seem to shows the correlation between the observed accretion rate and the chemical composition. I address this issue by possibly accurately determining the metallicity of high accretion rate sources. In Paper III, we tested the physical properties of the broad line emitting gas for highly accreting quasars at redshift ≈ 2. This work highlights that those highly accreting sources seem to follow the same evolutionary trends and have similar values of ionization parameters and broad line region's density, as typical AGN. However, they show indication of strong outflows, and indeed high metal enrichment (above 10 times solar). This high metallicity may be explained by star forming events in those sources, particularly that we detect the enhancement of aluminium in comparison with carbon.