Master thesis

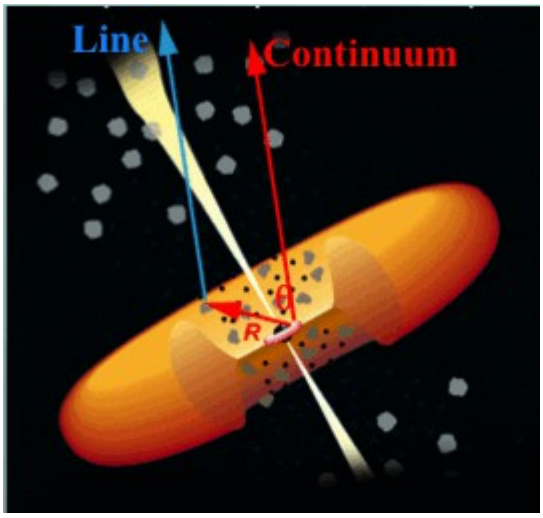
Topic: Estimating Black Hole Masses in Hundreds of Quasars

Start: any time

Where: at MPIA, Dept. of Galaxies and Cosmology

Advisor: Prof. Hans-Walter Rix, in collaboration with Kasper Schmidt

"Quasars" are brief phases in the lives of big galaxies, where mass is accreted rapidly onto a super massive black hole. The central accretion disk produces enormous luminosities that far outshine the entire galaxy. This radiation also ionizes and excites the diffuse gas surrounding the accretion disk, creating the so-called "broad (emission) line region" (BLR). Disk instabilities lead to variations in the accretion disk, and to changes in the BLR excitation and BLR luminosities. The BLR luminosity variations are expected to be delayed with respect to the accretion disk luminosity variation, because of the finite light travel time. If this delay between the accretion disk and the BLR light curve can be measured, the BLR size would be known. This measurement is based on the idea that the line-flux light curve trails the continuum light curve by some time lag τ: $\Delta f_{line}(t+\tau) \sim \Delta f_{cont}(t)$. If this size is then combined with the gas velocities in the BLR, a black hole mass estimate can be obtained: $M_{BH} \sim V_{BLR}^2 R_{BLR}/G$. This technique called "reverberation mapping" has been established for a small set of quasars.



The Sloan Digital Sky Survey has now obtained "light curves" (i.e. flux measurements at ~100 different epochs) in different filter bands (five bandpasses between 3500 Å and 9000 Å) for nearly 10,000 quasars . In all bandpasses the accretion disk emission (the "continuum") contributes much of the flux, but in some bands, the BLR line flux contributes ~ 20%. As the flux measurements are precise to 2%, reverberation mapping (and MBH estimates) should be feasible with such broad band measurements (rather than taking spectra for the emission line fluxes).

The masters thesis would entail fleshing out (and programming up) an existing approach to measuring the BLR time delay from existing broad band flux measurements at many epochs. This will entail spelling out a simple time delay model, implementing a likelihood estimation technique for the time delay and applying it to simulated data and to a pilot set of actual observations. If the approach is successful, it has the potential of greatly improving our black hole census in the early universe.

Prerequisites:

- Some programming experience (e.g. C++, IDL, PYTHON,…)
- Interest in and comfort with using analytical mathematical tools in real research problems.