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Do Narrow-Line Seyfert 1 galaxies have smaller BH masses? Spectropolarimetry to the rescue

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Black hole mass measurements for Narrow Line Seyfert 1 (NLSy1) galaxies are based on *unexpectedly* short time lags seen in the reverberation mapping (RM) of the Broad Line Region (BLR) campaigns. Black hole masses are estimated under the assumption of the virial factor, which depends on the geometry of BLR and the viewing angle of the source. Spectropolarimetric observations of BLR would allow us to explore the full Keplerian velocity profiles due to the scattering of the line photons - via the polarized spectrum. This can then allow us to estimate the viewing angle for each source using the information from both polarized and unpolarized spectra and help improve the BH mass estimates.

We used Very Large Telescope - FORS2 spectropolarimetric observations of 3 NLSy1 galaxies to measure their inclination and black hole mass from the wavelength-dependent polarization spectra around the Halpha region. For all three sources, we estimated the viewing angle and the black hole mass. For the viewing angles, we obtained an almost face-on (IRAS 04416+1215, $\approx 4^o$), to an intermediate (SDSS J080101.41+184840.7, $\approx 31^o$), to the most inclined (Mrk 1044, $\approx 54^o$) source.
Moreover, we estimated the black hole mass for each source: $10^{6.97}$ solar masses (IRAS 04416+1215), $10^{6.40}$ solar masses (SDSS J080101.41+184840.7), and $10^{6.05}$ solar masses (Mrk 1044). Our measurements are consistent with the estimation from RM.

To infer the geometry and composition of the scattering media around the SMBH, we modelled the STOKES parameters using the polarization radiative transfer code STOKES. We then compare the modelled estimates with our observed spectral properties and find good agreement for the presence of polar scatterers in addition to regular equatorial scatterers.

We also performed a Principal Component Analysis (PCA) using the spectral parameters for our and other archival FORS2-VLT sources to check for potential drivers for existing correlations.

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