Astrophysical Sciences & Technology
Ph.D. Dissertation Defense

Billy Vazquez

Constraining the Size of the Dusty Torus in Active Galactic Nuclei, An Optical/Infrared Reverberation Lag Study

Advisor: Michael Richmond

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Abstract:

The dusty torus is the key component in the AGN (active galactic nucleus) Unification Scheme that explains the spectroscopic differences between Seyfert galaxies of types 1 and 2. The torus dust is heated by the nuclear source and emits the absorbed energy in the infrared (IR); but because of light travel times, the torus IR emission responds to variations in the nuclear continuum with a delay that corresponds to the size of the emitting region. In this dissertation, I present the results of a mid-infrared (MIR) Spitzer Space Telescope and optical ground based (B and V band imaging) observational campaign spanning over 2 years and covering a sample of 12 Seyfert galaxies. The aim was to constrain the distances from the nucleus to the warm dust within the torus at wavelengths of 3.6 and 4.5μm, regions that until now have not been measured. Optical and MIR light curves showing the variability characteristics of these AGN are presented and the effects of photometric uncertainties on the time series analysis of the light curves are discussed. Significant IR variability was observed in 10 of the 12 objects, with typical timescales ~100 days and relative amplitudes ranging from ~10% to ~100%. I determine the "reverberation lag" between the 3.6 and 4.5 μm IR bands for the entire sample and between the optical and MIR bands for NGC 6418, which exhibits the largest amplitude of variation. In NGC 6418, the 3.6- and 4.5-μm fluxes lagged behind those of the optical continuum by $47.5^{+2.0}_{-1.9}$ days and $62.5^{+2.5}_{-2.9}$ days, respectively. This is consistent with the inferred lower limit to the sublimation radius for pure graphite grains at 1800 K but smaller by a factor of ~2 than the lower limit for dust grains with a "standard" ISM composition. There is evidence that the lags increased following a factor ~2 increase in luminosity, consistent with an increase in the sublimation radius.