Active Galactic Nuclei Variability With WISE: Wide-field Infrared Survey Explorer

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Introduction:

Active galactic nuclei (AGNs) show flux variations over the entire electromagnetic spectrum. These variations appear to be aperiodic and have variable amplitudes [1]. It is believed that the variability in the mid-infrared (IR) to far-IR is due to the reemission of the intercepted light from the AGN, by the surrounding dust cloud [2]. However, Blazars' (AGNs whose jets are aligned toward the observer) variability in this region is most likely due to non-thermal variations in the jet [3]. The light curves for our four sample objects (who are identified as Blazars by the SIMBAD database) show variability in the mid-IR region.

The WISE telescope can probe AGN variability on short time scales, ranging from hours to months. Whereas Kozlowski et al. (2010) investigated a large sample of variable AGN with the Spitzer Space Telescope in the mid-IR for the first time [2], WISE is an all-sky survey, and thereby scans a much larger spatial area. Hence, WISE is able to find more sources per unit time than a deep narrow survey [4].

Method and Analysis:

A comprehensive list of quasi-stellar objects (QSO) was generated using the NASA/IPAC Extragalactic Database (NED). The light curves of these 132,851 objects were obtained using WISE observations. Using the Interactive Data Language (IDL) programming software to perform the analysis for the mid-IR 3.4μm and 4.6μm channels, only objects that had at least 25 observations were selected. The standard deviation (σ) of each of these 10,743 objects, and their median magnitudes were calculated. Furthermore, a median curve was generated by calculating the standard deviation and magnitudes in 0.1 magnitude bins. The distance from this median curve gives us a measure of each object's variability. Finally, placing a selection criterion of 3σ or more away from from the median curve enabled us to identify the highly variable objects.

Results:

Figs. 1 and 2 represent a summary of our analysis. The light curves that are provided (Figs. 3, 4, 5, and 6) are just a sample from the selected highly variable objects, whose standard deviations are at least 3σ away from the median curve.

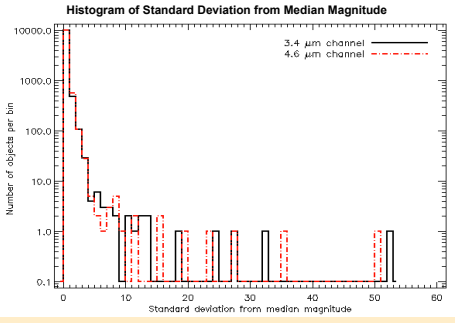

Fig. 1: Histogram of the distribution from the median magnitude curve. Bin size is 1σ. The two curves represent the two WISE mid-IR channels centered at wavelengths of 3.4 μm and 4.6 μm.

Results (cont'd):

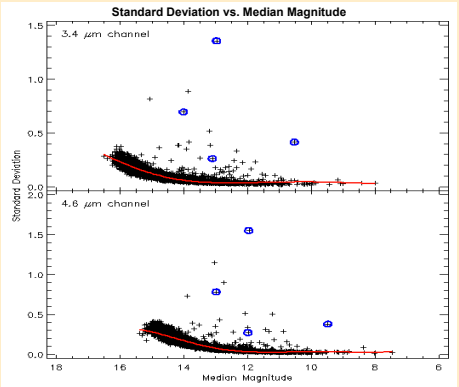

Fig. 2: Plot of the standard deviation vs. median magnitude for each object. The red curve is the median of the standard deviation and magnitudes in 0.1 mag bins. The light curves of the objects highlighted in the blue circles are provided below.

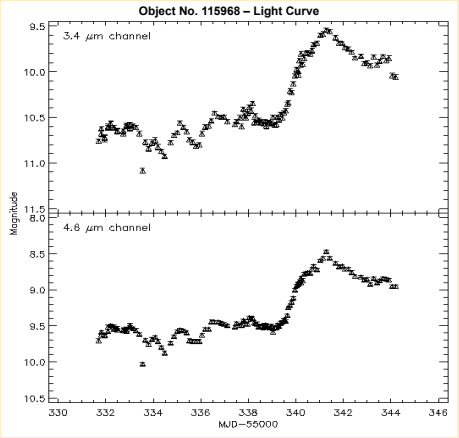

Fig. 3: Magnitude vs. Modified Julian Date (MJD = JD–2400000.5). The sharp increase in luminosity ~1 mag happened in ~5 days.

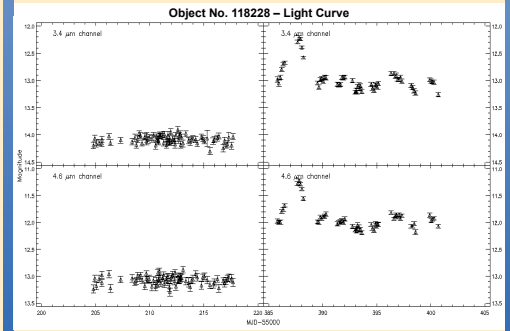

Fig. 4: Magnitude vs. Modified Julian Date. Observations over two different epochs are plotted.

Results (cont'd):

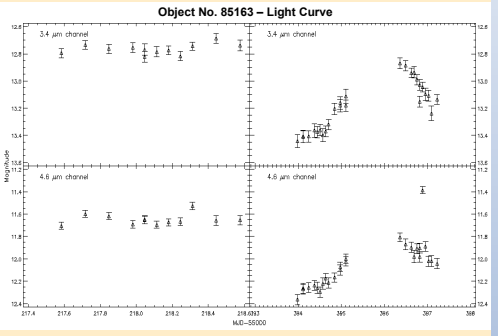

Fig. 5: Magnitude vs. Modified Julian Date. Epoch 1 spans a little over a day, whereas epoch 2 has observations for over 3 days.

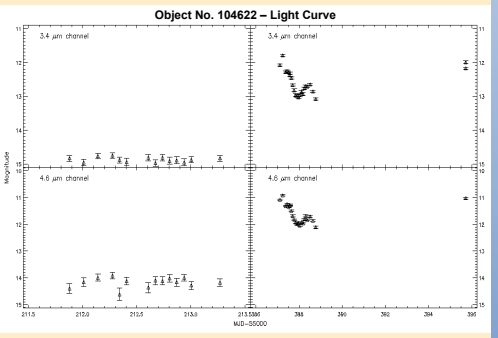

Fig. 6: Magnitude vs. Modified Julian Date. The difference in luminosity from epoch 1 to epoch 2 is as large as 3 magnitudes.

Conclusion:

The sample light curves provided show variations in luminosity that ranges from hours to months. Moreover, since these are identified Blazars, the variations are most likely due to the dominant non-thermal jet components. WISE has proved to be valuable at probing flux variations on short timescales, specifically of Blazars, which exhibit the most rapid and largest variations of all AGN [5,6].

References:

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