Intra-night optical variability of the NLSy1 galaxy SBS 0846+513

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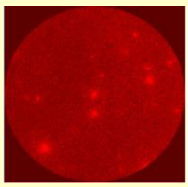
Abstract: Prior to the year 2008, only two classes of γ-ray emitting AGN are known, namely blazars and radio-galaxies. The launch of the *Fermi* Gamma-ray Space Telescope in late 2008, has led to the discovery of γ-ray emission from a new class of objects, namely, the Narrow Line Seyfert 1 (NLSy1) galaxies. About half a dozen γ-ray emitting NLSy1 galaxies are known to be detected with high significance by *Fermi* so far. This demonstrates that relativistic jets are present in these sources. However, it is generally thought that NLSy1 galaxies are hosted by spiral galaxies and as γ-ray emission is detected in them, it is clear now, spiral galaxies can also host relativistic jets which is against the "Elliptical – Jet paradigm". The extragalactic γ-ray sky is dominated by the blazar class of AGN, and one of the characteristics of blazars is that they show large amplitude and high duty cycle of intra-night optical variability (INOV). Since some NLSy1 galaxies are also detected by *Fermi* it is expected that they also must display large amplitude INOV. We have carried out a study on the INOV characteristics of the NLSy1 galaxy SBS 0846+513 using the Himalayan Chandra Telescope. It is found that the INOV characteristics of SBS 0846+513 is similar to blazars. Its broad band SED is also similar to the flat spectrum radio quasar (FSRQ) class of AGN.

What are Narrow Line Seyfert 1 (NLSy1) galaxies ?

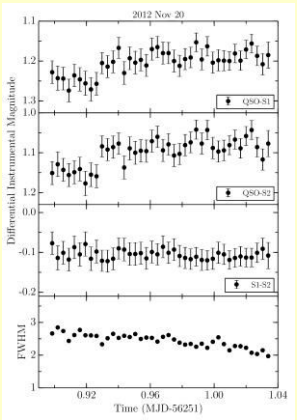
- In the optical spectrum, NLSy1 galaxies have narrow Balmer emission lines (FWHM < 2000 km/sec), [OIII/Hβ< 3 and strong Fe II lines
- They are hosted in spiral galaxies with low mass black holes ($10^6 – 10^8$ $M_\odot$) and generally have high star formation activity
- About 7% are found to be radio-loud compared the 15% we know in quasars
- They have high accretion rate and in the X-ray band show strong flux variability and a soft excess
- Radio-loud NLSy1 galaxies show strong optical polarization
- They are not known to be γ-ray emitters before the year 2008, however, six NLSy1 galaxies are now known to be emitting in the GeV range..

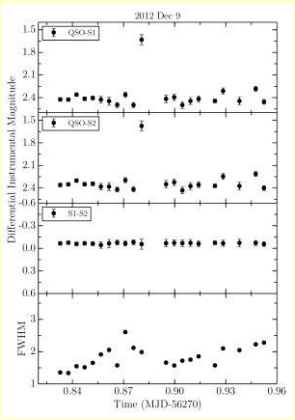


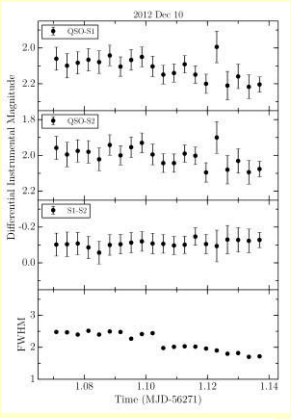
Fermi counts map of SBS J0849+5108

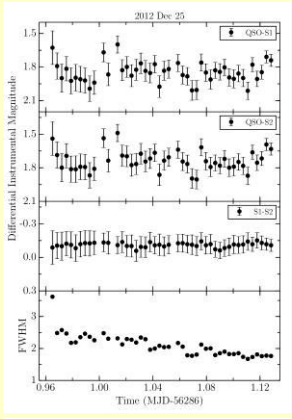
Motivation: In the radio band, SBS 0846+513 has flat spectra, show core jet structure and exhibit superluminal motion. It is also detected in the γ-ray band by *Fermi*. These properties are similar to blazars. But, it has two properties that are different from blazars. Firstly, it is thought to be hosted in a spiral galaxy, whereas blazars are hosted in elliptical galaxies and secondly it has a low mass black holes (< 10^8 $M_\odot$), whereas blazars are powered by high mass black holes (> 10^8 $M_\odot$). The radio and γ-ray properties undoubtedly argue for the presence of relativistic jet in SBS 0846+513. We have carried out INOV observations, as well as broad band SED modeling on this source to see if its overall properties are similar to blazars.

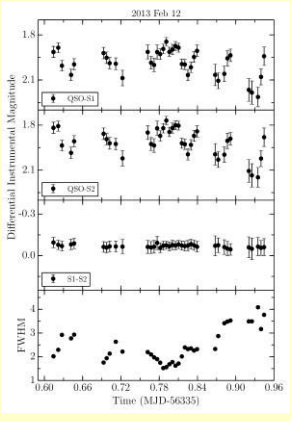
Intra-night optical variability (INOV)

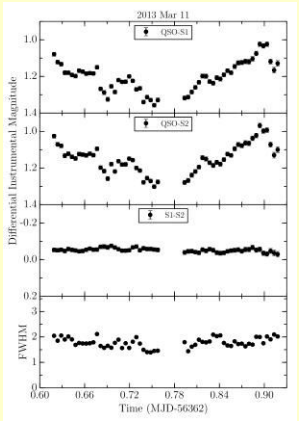






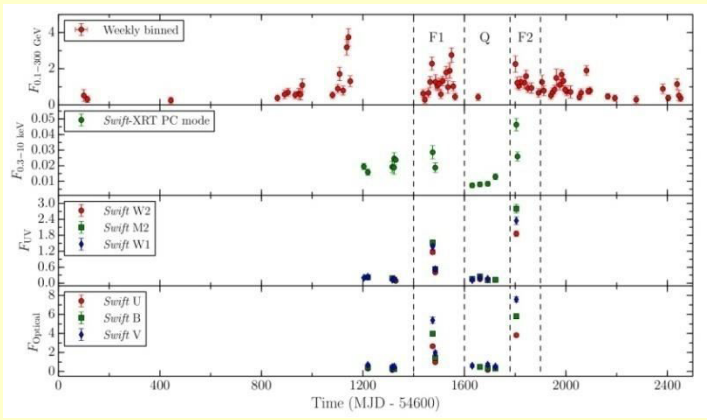




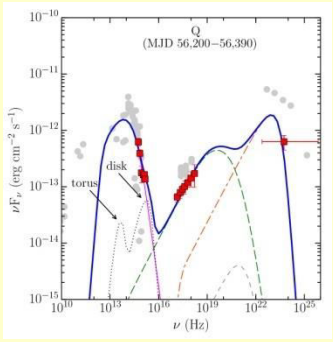


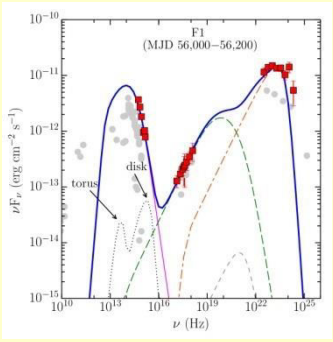
Based on INOV observations from HCT, we find that SBS 0846+513 shows large amplitude (>3%) and high duty cycle of variability similar to blazars.

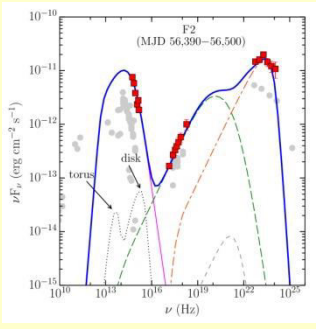
Long term multi-wavelength light curves



Broad band spectral energy distribution during different activity state







Broad band SEDs of SBS 0846+513. They are constructed for a quiescent state and two flaring states identified from the γ-ray light curves and indicated as Q, F1 and F2. Here, the red points are simultaneous observations and the grey points are the archival observations. The observed SED points are fitted using the one zone leptonic emission model. The optical part of the SEDs is explained by synchroton emission processes, the X-ray is well modeled by synchroton self Compton process and the GeV radiation is well fit by external Compton processes

Summary

- Optical observations of SBS 0846+513 show INOV similar to blazars
- Available long term observations show correlated variations over optical, X-ray and gamma-ray
- The broad band SED has the typical double hump structure similar to blazars
- The high energy component in the SEDs is well explained by EC processes similar to FSRQs
- The Compton dominance is greater than unity; again similar to FSRQs