

Optical Study of Bright FERMI/LAT Blazars



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Introduction

The history of the optical variability of Blazars truly begins with the identification of the radio source VRO 42.22.01 (McLeod & Andrew 1968; Schmitt 1968) with the “variable star” *BL Lacertae* discovered in the late of 1920s by Hoffmeister. Historically, almost all our information on γ -ray emission from blazars in the energy range 20 MeV-30 GeV has come from EGRET observations. The 3rd catalog of EGRET included 271 resolved objects of which 93 were identified, either confidently or potentially, as blazars. The AGNs, and in particular blazars, are the most prominent class of associated sources in 2FGL. In total, 2FGL contains 917 sources that are associated with AGNs, of which 894 are blazars, 9 are radio galaxies, 5 are Seyfert galaxies, and 9 are other AGNs. Active galactic nuclei were among the first sources detected at TeV energies and have remained the largest source population for TeV gamma-ray astronomy.

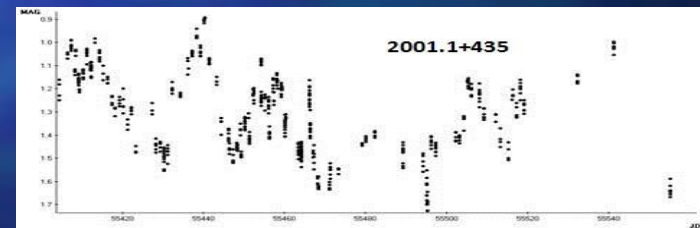
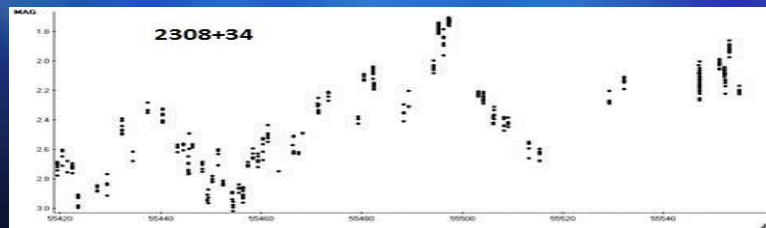
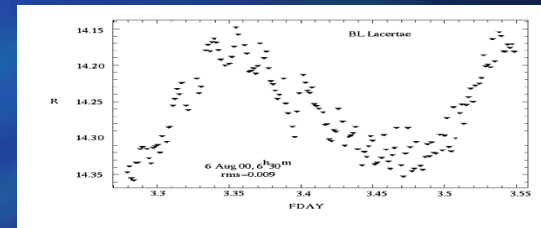
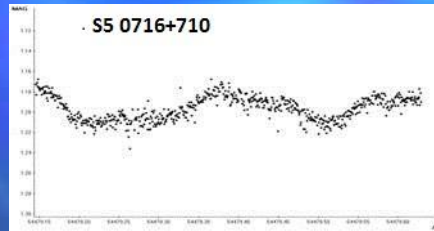
One of the distinguishing characteristics of the Blazars, which includes *BL Lacertae* objects, high polarization quasars (HPQ) and optical violently variable (OVV) quasars is that their flux densities are highly variable at all wavelength from radio to TeV. Blazars are also characterized by high apparent luminosities, short variability time-scales and apparent superluminal motion of jet components.

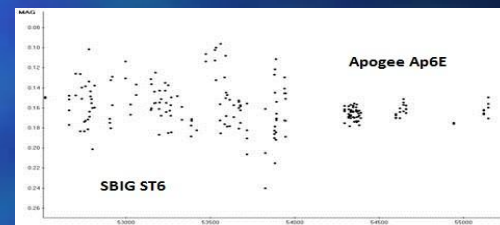
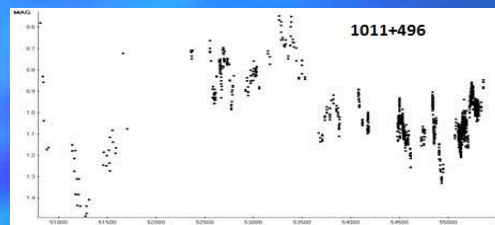
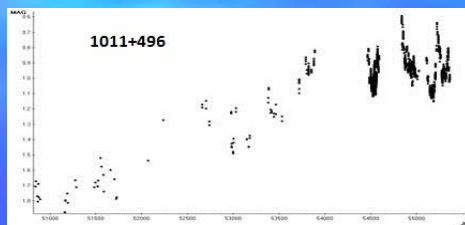
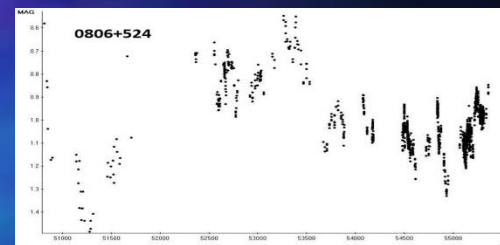
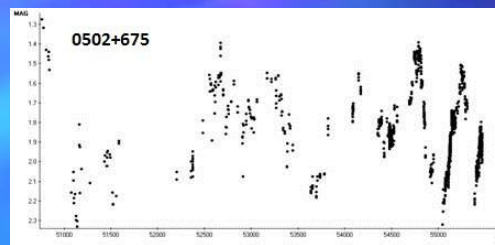
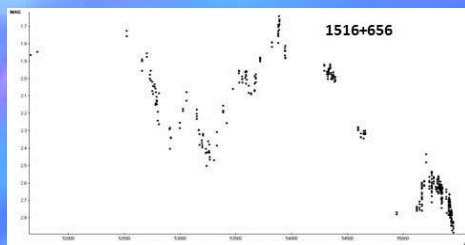
We started systematic multiband optical monitoring of blazars at *Abastumani Observatory* in the beginning of 1997. The aim of the program was to study IHV, IDV, STV and LTV variability of blazars and their correlations with that in radio, X-ray, gamma-ray and TeV bands. Most systematic optical monitoring campaigns to study VHE sources are conducted by ATOM, KVA in collaboration with *HESS* and *MAGIC*, respectively.

Observations and Data Reduction

Abastumani Observatory is located at a latitude of 41.8 deg. and a longitude of 42.8 deg. on the top of the Mt. Kanobili (1700 m, ~150 nights per year, 1/3 with seeing <1 arc sec). The mean values of the night sky brightness are B=22.0, V=21.2, R=20.6 and I=19.8. Monitoring Program was carried out with ST-6 CCD camera attached to the Newtonian focus of the 70-cm meniscus telescope (f/3, FOV is 15x11 sq. arc minute), Ap6E camera at 125 cm telescope (f/13, FOV is 5x5 sq. arc minutes). From September 2006 Ap6E camera was attached to the prime focus of 70-cm telescope. In Abastumani we are using combined filters of glasses that match the standard B, V (*Johnson*) and Rc, Ic (*Cousins*) bands well. Reference sequences in the blazar fields were calibrated by the Landolt's equatorial standard stars (*Landolt AJ 104, 340, 1992*).

In the frame of the Program from 1997 to 2017, during more than 3000 observing nights, about 350000 frames were collected for over 70 target sources. Most frequently observed sources are *BL Lacertae*, *1ES 1959+650* and *S5 0716+710*, *3C 454.3*, *W Comae*, *Pg 1553+113*, *Mrk 421*, *Mrk 501*, *3C 66A*, *OJ 287*, *PKS 1510-089* and others. All images were reduced using DAOPHOT II. The differential photometric accuracy is 0.02 mag. (rms, star like sources) during 180 sec exposure at R=15.0. The list of sources was compiled from different catalogues, while twelve X-ray BL Lac objects were selected from the catalogue of Perlman et al. (*ApJS* 104, 251, 1996). Later on, most of these X-ray sources were identified as TeV ones. During photometric monitoring most easily task is to study IH and ID variability. During FERMI/LAT mission we participated in many MW campaigns of following 16 selected [3C 454.3 (6), PKS 1510-089 (6), Mrk 421 (5), Mrk 501 (4), 3C 279 (2), S5 0716+710 (2), BL Lac, OJ 287, OJ 248, Pg 1553+113, B3 1633+382, 4C 71.07, W Comae, 3C 66A, AO 0235+164, 4C+21.35) bright Fermi sources resulted in a publication of 37 papers and 11 conference presentations. The LC of selected sources are presented below.





Conclusions. The observed variability amplitude of BL Lacertae objects is within 0.05-6.0 magnitude in R band. To obtain the full timescales and amplitudes of variability it is required to conduct much more denser coverage of selected sources with dedicated two meter class telescopes to achieve higher temporal resolution and photometric accuracy.

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