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DISCOVERY of A HIGHLY POLARIZED OPTICAL MICROFLARE in BLAZAR S5 0716+714 during the 2014 WEBT CAMPAIGN

Bhatta G., Goyal A., Ostrowski M., Stawarz , Akitaya H., Arkharov A., Bachev R., Benítez E., Borman G., Carosati D., Cason A., Damljanovic G., Dhalla S., Frasca A., Hu S., Itoh R., Jorstad S., Jableka D., Kawabata K., Klimanov S., Kurtanidze O., Larionov V., Laurence D., Leto G., Markowitz A., Marscher A., Moody J., Moritani Y., Ohlert J., Di Paola A., Raiteri C., Rizzi N., Sadun A., Sasada M., Sergeev S., Strigachev A., Takaki K., Troitsky I., Ui T., Villata M., Vince O., Webb J., Yoshida M., Zola S., Hiriart D.

Kazan Federal University, 420008, Kremlevskaya 18, Kazan, Russia

Abstract

 The occurrence of low-amplitude flux variations in blazars on hourly timescales, commonly known as microvariability, is still a widely debated subject in high-energy astrophysics. Several competing scenarios have been proposed to explain such occurrences, including various jet plasma instabilities leading to the formation of shocks, magnetic reconnection sites, and turbulence. In this Letter, we present the results of our detailed investigation of a prominent, five-hour-long optical microflare detected during the recent WEBT campaign on 2014 March 2-6 targeting the blazar 0716+714. After separating the flaring component from the underlying base emission continuum of the blazar, we find that the microflare is highly polarized, with the polarization degree ~(40-60)% ± (2-10)% and the electric vector position angle ~(10-20)° ± (1-8)° slightly misaligned with respect to the position angle of the radio jet. The microflare evolution in the (Q,U) Stokes parameter space exhibits a looping behavior with a counterclockwise rotation, meaning the polarization degree decreases with the flux (but is higher in the flux decaying phase), and an approximately stable polarization angle. The overall very high polarization degree of the flare, its symmetric flux rise and decay profiles, and also its structured evolution in the Q-U plane all imply that the observed flux variation corresponds to a single emission region characterized by a highly ordered magnetic field. As discussed in the paper, a small-scale but strong shock propagating within the outflow, and compressing a disordered magnetic field component, provides a natural, though not unique, interpretation of our findings.

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Keywords

acceleration of particles, BL Lacertae objects: individual (S5 0716+714), galaxies: active, galaxies: jets, polarization, radiation mechanisms: non-thermal