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Optical-NIR variability of blazars on diverse timescales

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Abstract. To search for optical variability on a wide range of timescales, we have carried out photometric monitoring of 3C 454.3, 3C 279 and S5 0716+714. CCD magnitudes in B, V, R and I pass-bands were determined for ∼ 7000 new optical observations from 114 nights made during 2011 âĂŞ 2014, with an average length of ∼ 4 h each, at seven optical telescopes. We measured multiband optical flux and colour variations on diverse timescales. We also investigated its spectral energy distribution using B, V, R, I, J and K pass-band data. We discuss possible physical causes of the observed spectral variability.

Keywords : galaxies: active – quasars: individual: 3C 454.3, 3C 279, S5 0716+714

1. Introduction

Some of the brightest radio-loud Active Galactic Nuclei (AGNs), called blazars, are understood to have relativistic jets viewed at an angle of $\leq 10^{\circ}$ from the line of sight (LOS) (e.g., Urry and Padovani 1995). BL Lacs (Featureless optical spectra) and FSRQs (prominent optical emission lines) together form blazars class. Variability timescales in blazars are divided into three classes: flux variations over a timescale of few minutes to less than a day are called as intra-day variability (IDV; Wagner and Witzel 1995); those on timescale of days to few months are as short time variability (STV); while the changes from several months to many years are usually called long term variability. The key motivation of this work was to search for optical flux and colour variability of 3C 454.3, S5 0716+714 and 3C 279 on diverse time scales, including analyses of colour-magnitude variations, inter-band cross correlations, and optical/NIR SEDs.

2. Observations and Analysis

Our optical photometric observations of the blazars were performed in the B, V, R, and I pass-bands, using seven telescopes, two in India, one in Greece, and four in Bulgaria, all equipped with CCD detectors. The preliminary processing of the raw data was

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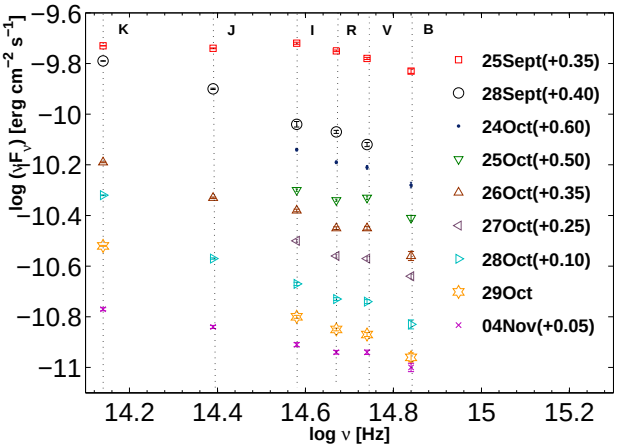

Figure 1. SED results for 3C 454.3 in near-IR-optical frequency range.

carried through standard procedures in IRAF software. We performed photometry of the data to find the instrumental magnitudes of the blazars and the comparison stars by concentric circular aperture photometric technique with the DAOPHOT II software. The IDV of blazars was examined employing both the popularly used C-statistic and the more reliable F-test (Agarwal and Gupta 2015). The percentage variation on a given night is calculated by using the variability amplitude parameter *A*, introduced by Heidt and Wagner (1996),

3. Results

During our 37 nights of monitoring for IDV we found flux variations, on intraday time-scales for 21 nights in B, V, R or I with amplitudes of variability up to 31% for 3C 454.3, 9.2% for 3C 279 and 13.5% for S5 0716+714. For each night, we calculated a linear fit of the colour indices, CI, against V magnitude: CI=mV + c. The linear Pearson correlation coefficient, r, and the corresponding null hypothesis probability, p, also calculated. A positive slope indicates a positive correlation between the colour indices and apparent magnitude of the blazar which implies the general trend of BWB. BWB trend was dominant during our observations. Such flattening may be interpreted as jet dominated synchrotron emission, where increasing flux is related to a hardening of non-thermal electron spectrum, possibly indicating an enhanced particle-acceleration efficiency (Diltz and Böttcher 2014).

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