



The OJ 287 Colors During a Multifrequency Campaign

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The Multiwavelength Campaign on OJ 287

In 2005 we secured 2 guest-observer XMM-Newton pointings of the interesting blazar OJ 287, and a ground-based multifrequency campaign was organized. Radio, mm, near-IR, and optical data are obtained during an intensive and coordinated campaign of the Whole Earth Blazar Telescope (WEBT), during longer-term monitoring observations performed by the teams of the formerly ENIGMA network, and during other independent observing programs (like VLBA observations). An optical outburst, well matched by our WEBT data is claimed in the period Oct.-Nov. 2005, and the XMM-Newton X-ray observations are performed in correspondence with 2 active optical states (an intermediate flare and the outburst).

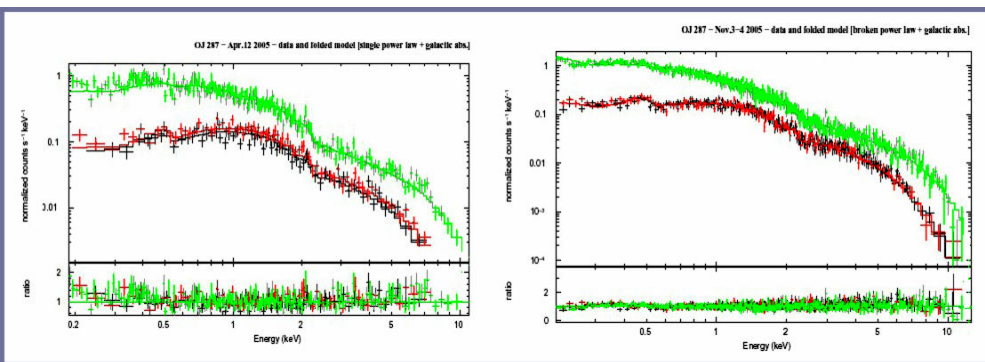


Figure 1. XMM-Newton combined EPIC (pn, MOS1-MOS2) X-ray spectra of OJ 287, belonging to the 2 observations performed on Apr. 12, and Nov. 3-4, 2005. Left panel: the Apr. 12 spectrum can be described by a simple power-law + galactic absorption ($\Gamma = 1.63 \pm 0.02$). Right panel: the Nov. 3-4 spectrum can be described by a broken power-law + galactic absorption ($\Gamma_1 = 2.65 - 0.07 + 0.12$, and $\Gamma_2 = 1.79 \pm 0.02$) with break at 0.7 keV. Such X-ray data indicates different flux intensity, spectral continuum slopes, and emission components (From Ciprini et al. (2007), Ciprini et al., in prep.).

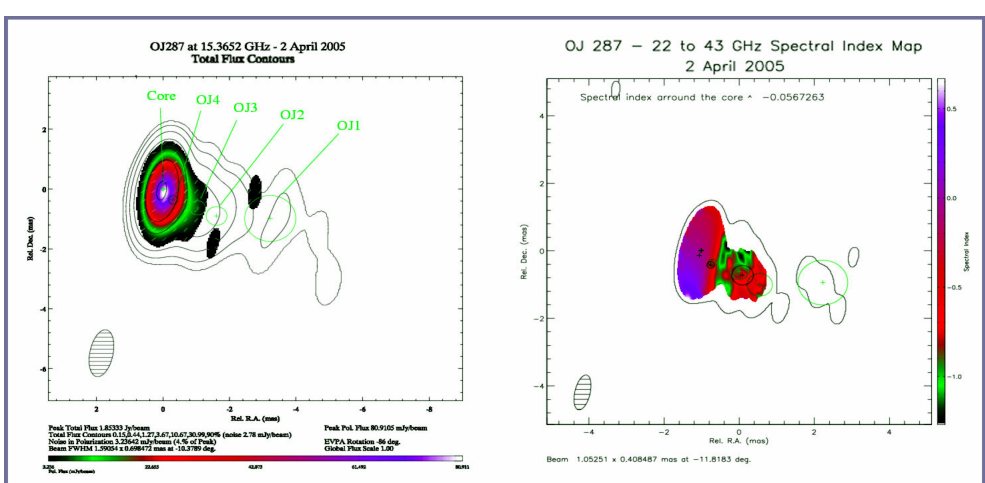


Figure 2. Left panel: VLBA radio map of OJ 287 at 15 GHz, obtained on April 2-3, 2003. Contours represent the observed total intensity, the colour scale the polarized intensity and the superimposed sticks the orientation of the polarization electric vectors. The positions of the fitted Gaussian components are indicated by the crosses, whereas the circles (of radius equal to the FWHM of each Gaussian) symbolize their size. Right panel: map of the spectral index of the OJ 287 jet from 22 GHz to 43 GHz. (From Ciprini et al., in prep.).

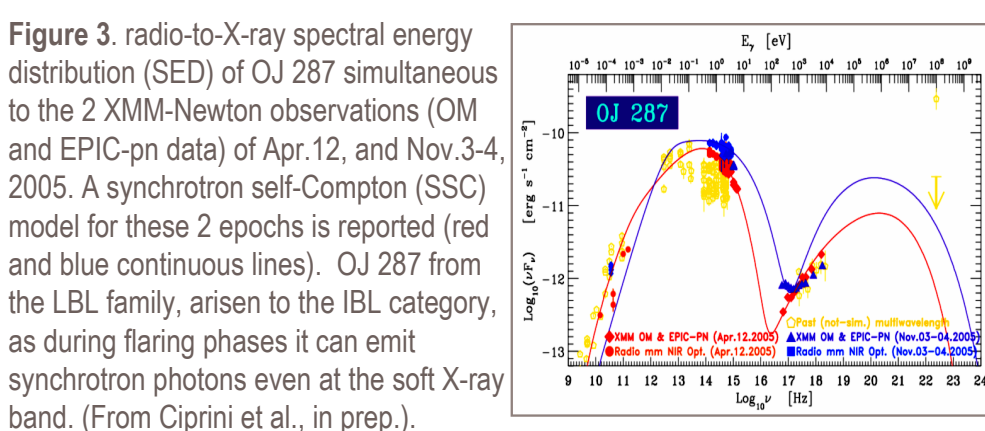


Figure 3. radio-to-X-ray spectral energy distribution (SED) of OJ 287 simultaneous to the 2 XMM-Newton observations (OM and EPIC-pn data) of Apr. 12, and Nov. 3-4, 2005. A synchrotron self-Compton (SSC) model for these 2 epochs is reported (red and blue continuous lines). OJ 287 from the LBL family, arisen to the IBL category, as during flaring phases it can emit synchrotron photons even at the soft X-ray band. (From Ciprini et al., in prep.).

Optical R-band Light Curves

OJ 287 ($z=0.306$) is a famous and optically highly-variable (>3 mag variations) low/intermediate-energy peaked BL Lac object (LBL/IBL). This source is historically among the best observed AGN in the optical/radio bands, having a nice database of past observations (e.g., Pursimo et al. 2000, Takalo et al. 1994). This allows a more significant and powerful statistical data analysis and a wider study of the parameter space of variability. Moreover it is one of the very few extragalactic sources, where a major periodical/quasi-periodical signature is claimed (e.g., Valtonen 2007, Nilsson et al. 2006). Therefore multifrequency campaigns and long-term variability monitoring are very useful here. In the following figures some radio and optical multi-color light curves from the 2004-2006 campaign are reported.

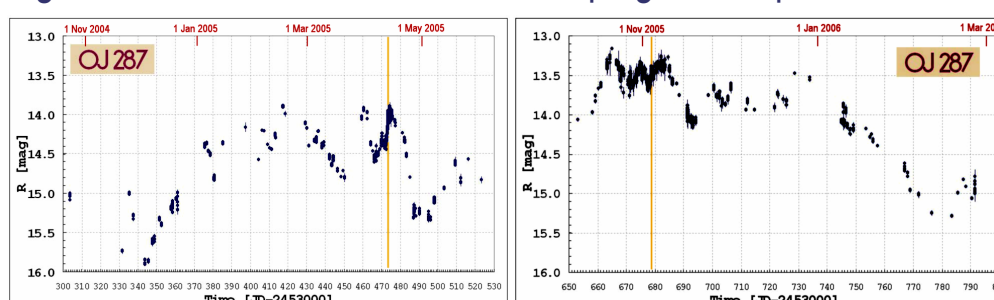


Figure 4. The whole October 2004 - April 2006 optical light curve in R-band of OJ 287 obtained during our multiwavelength campaign. Data from more than 30 observatories. Intensive-observation data of about 1 week around the first satellite pointing date, and from about 20 days around the second satellite pointing belongs to the international consortium WEBT. In particular an enduring outburst phase was observed at the beginning of the second season (see Fig. 5 below).

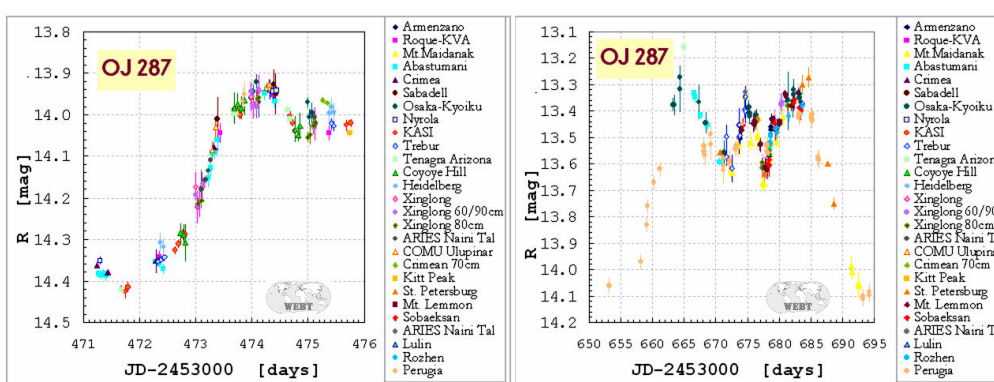


Figure 5. The detailed (and best sampled) R-band magnitude light curve corresponding to the intensive coordinated campaign performed by the WEBT consortium, around the two XMM-Newton pointing dates. In the right panel, in particular, an enduring (more than 20 days), symmetrical, and time-structured (we 3 major rather symmetric wiggles), optical outburst is evident and confirmed by many observatories in the period October-November 2005. The brighter R band magnitude detected here was $R = 13.2$. (From Ciprini et al., in prep.).

Multi-Band Radio-mm Light Curves

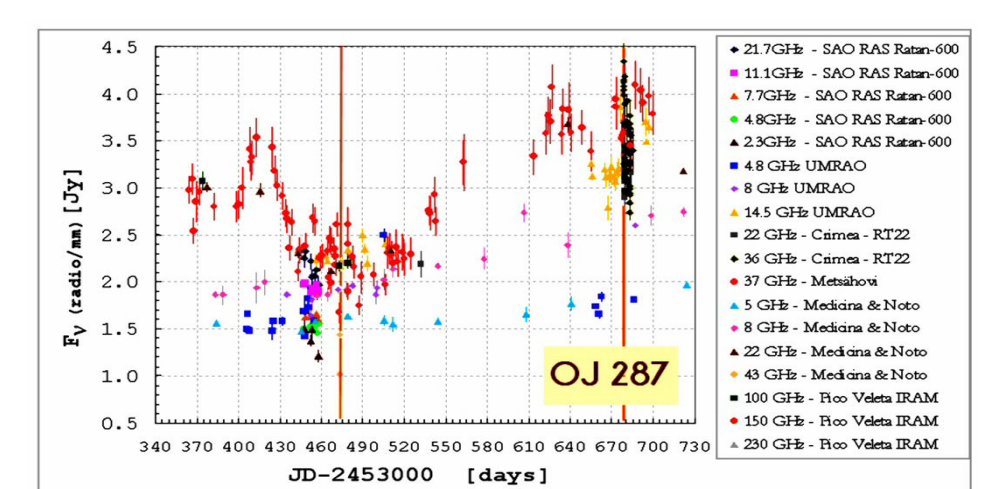


Figure 6. The radio-mm flux light curves of OJ 287 in different bands (frequencies span from 2.3 to 230 GHz), obtained during the extended monitoring campaign, and by independent observing programs. At a first inspection there is not a significant radio-optical correlation (From Ciprini et al. 2007, Ciprini et al., in prep.).

Multi-Color Light Curves & Spectral Index

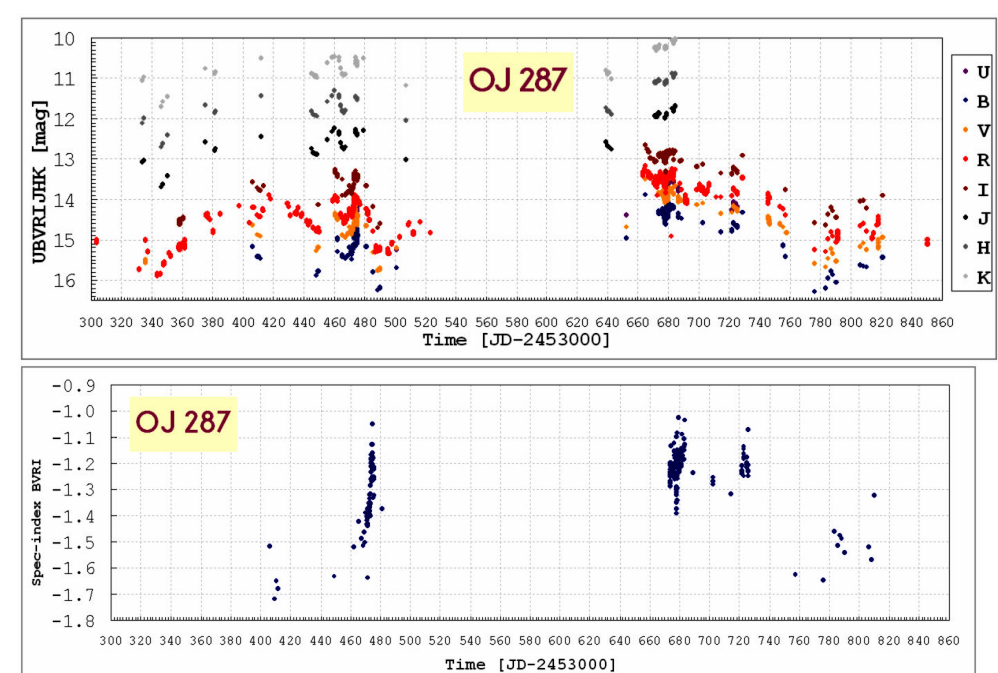


Figure 7. Upper panel: UBVRJHK multi-band optical and near-IR light curves of OJ 287 acquired during our long-term 2004-2006 campaign. Lower panel: the temporal light curve of the optical spectral index calculated with simultaneous 4-band data (BVRI). The flattening during the flaring stages is well visible. (From Ciprini et al., in prep.).

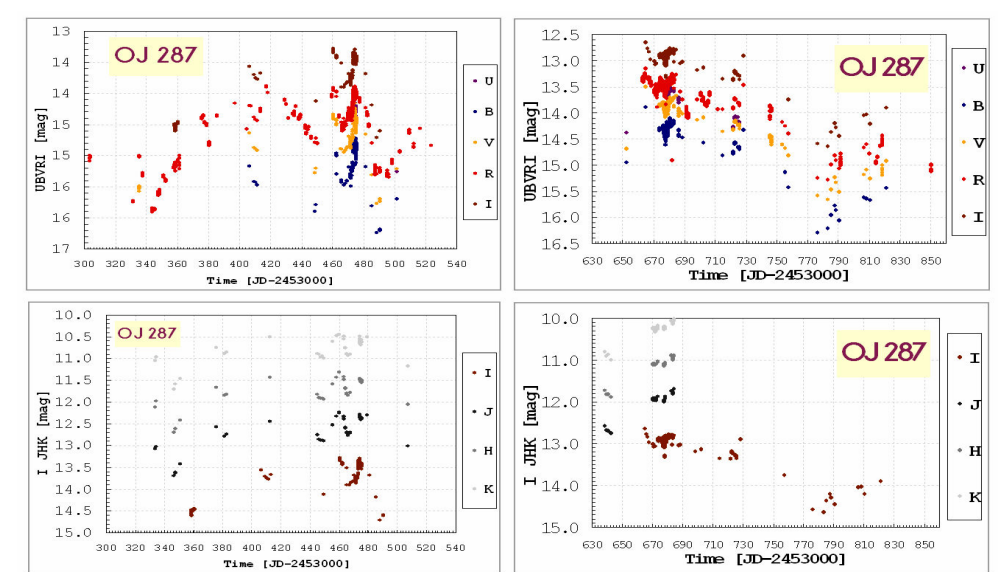


Figure 8. More detailed zooms on the UBVRJ and IJHK multi-color light curves described in the previous Fig. 7.

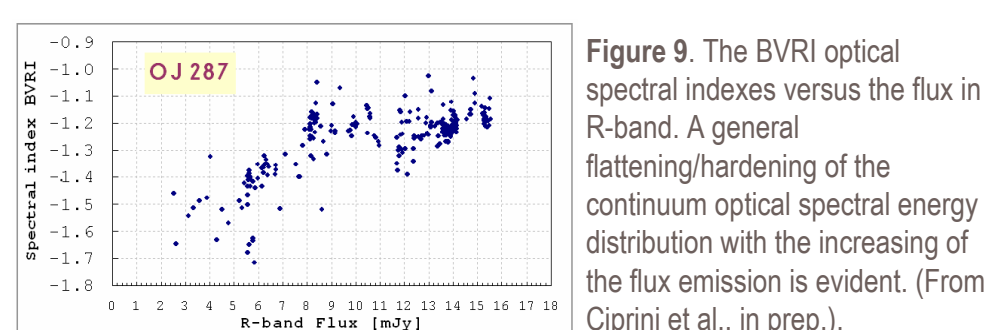


Figure 9. The BVRI optical spectral indexes versus the flux in R-band. A general flattening/hardening of the continuum optical spectral energy distribution with the increasing of the flux emission is evident. (From Ciprini et al., in prep.).

This considerable observing effort is still ongoing (a 4th XMM-Newton pointing is scheduled in April 22, 2008, for example), joined with further parallel "multi-monitoring" observing programs devoted to this interesting blazar (see, e.g., <http://www.astro.utu.fi/OJ287MMVI/>).

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