Polarization and Spectral Energy Distribution in OJ 287 During the 2016/17 Outbursts

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The full list of participants of the OJ287-15/16 Collaboration is listed in ApJL 819, L37, 2016.

Introduction

OJ 287 is one of the best candidates to host a SMBH binary. It has a high level of optical activity every 12 years, which has been observed since 1888 by using old photographic plates, and more recently, in optical photometry (Silknip et al. 1988, Ap. 43, 629, Hudec et al. 2018, A&A, 579, 20). One of the key features of this activity is the fact that it comes in pairs of outbursts which are separated by at least 1.1 years, with the separation being a function of the cycle number. This systematic behavior leads to a model of a high mass ratio (\( > 10^4 \)) binary black hole system where the high brightness-epochs arise from the impact of the secondary on the accretion disk of the primary (Lehto & Valtonen 1996, Ap. 481, 287, Valtonen 2007, Ap. 659, 3874). After the General Relativity Centenary flare, which began on November 21, 2015, OJ 287 has stayed at 30 year record levels in optical brightness, divided into two episodes in 2016. Here we report optical photometry and polarimetry showing its 2016-2017 behavior. While the Centenary flare was limited only to the optical/UV region, and had a lower level of polarization, the follow-up flares in 2016 had high polarization, and the outburst energy extends to X-rays with almost constant optical/X-ray spectral index of 2.7 ± 0.1. This type of separation in the properties of the outbursts was predicted within the coalescing binary black hole model of OJ287. While the Centenary flare arises directly as the result of the impact of the secondary black hole onto the accretion disk of the primary, the follow-up flares occur in the jet of the primary. They are induced by transport of perturbations from the site of impact to the center of the accretion disk. The new observations following the determination of the propagation speed. We also present the prediction of the blazar brightness in the coming years.

Observations: Photometry

Predicted by the SMBHs binary model, the Centenary flare in OJ287 was well covered in optical band by a campaign with more than 20 participating sites (Valtonen et al. 2016, Ap. 819, L37). After this event we continued the monitoring of the blazar at several sites including the SKYNET Robotic Telescope Network achieving almost daily coverage. Observations were stopped for the summer 2016 when OJ287 was in conjunction with the Sun and we resumed monitoring its brightness as soon as it became accessible at the end of August 2016, taking data in the wide band R filter. The observations were reduced soon after they were taken in a simplified way by calibrating the frames for bias, dark and flat-field.

Conclusions

We have observed the predicted two peaks in the follow-up light curve of OJ 287. Optically they are both highly polarized and the optical/X-ray spectrum is consistent with the synchrotron radiation. It is therefore likely that the emission originates in the jet of the primary black hole. The transmission time of the perturbations is confirmed as 1.5 years. Since distance is 15 000 AU, the speed is \( \sim (1 + z)/c \). It has been previously estimated that this is the sound speed in the corona of the accretion disk (Pihajoki et al. 2013, ApJ, 764, 5); thus it appears that the perturbations are transmitted via the corona to the inner parts of the accretion disk at about 3000 AU (\( \sim 8.3 \) Schwarzschild radii of the primary). From there, the perturbations appear to influence the jet without further delay.