Progress in the Research of the Relativistic System SS 433

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Abstract. Spectroscopy reveals weak absorptions of an A-type star in the system of SS 433. Based on their radial velocities, its mass was measured of 10.4 solar mass. We extracted the energy distribution of the A star from the common light, and estimated its absolute magnitude of about $-5^m.45$ V, and mass of 9.8 solar masses. With the known Ginga mass ratio of $q = 0.1496$ based on the X-ray eclipse of the jet base, we have the mass of the jet source of 1.45 $\pm$0.2 solar mass and identify it as a neutron star. In this study, evidences of accretion onto the magnetic neutron star from the A star in dynamic mode were found.

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SS 433 (V1343 Aql) is a known relativistic binary with the moving components of hydrogen and helium lines in the spectrum. This motion is due to two oppositely directed precessing jets of the matter ejected with the velocity of $0.26c$. The star is an eclipsing binary with the orbital period of $13^d.082$. The period of jet precession is $162^d.28$. The weak absorption spectrum of the A3–A7 I–III star, the accretion donor was discovered by Gies et al. (2002) and Hillwig & Gies (2008). The best review of spectroscopic efforts, and the more accurate radial velocity measurements taken from Gemini and Subaru were described by Kubota et al. (2010). They got a mass of the accretion donor between 8.5 and 12.7 solar masses. Subaru spectroscopy, as well as observations performed earlier with the Russian 6-m telescope BTA were accompanied by UBV(RI)c

photometry. This unique material obtained during two eclipses made it possible to separate the energy distributions from different radiation sources in the system and to extract the energy distribution of the A-type donor. Its absolute magnitude M_V is in the range of $-5^m.9$ and $-5^m.0$, and its mass is in the range of 8.3 and 11.0 solar (Goranskij 2011). These photometric results are in good agreement with spectral ones. With the Ginga mass relation $q = 0.15$, the compact object may be surely identified as a neutron star. It is a remnant of a 10000 years old supernova along with the radio nebula W50.

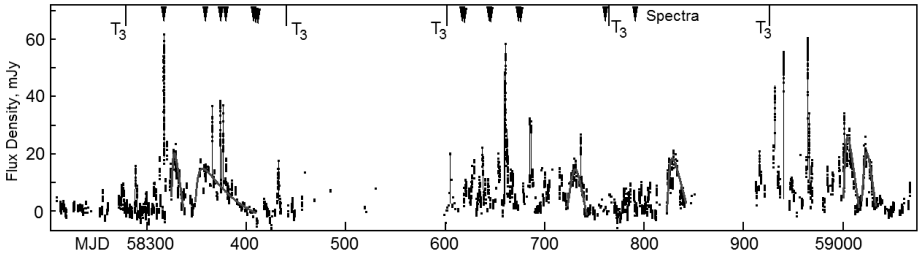

Fig. 1. Flares and active states of SS 433 in the Cousins R filter plotted in the linear scale over quiet low level of orbital and precession variations. The shell episodes (the envelope is seen over the circumstellar disk) are highlighted with gray lines.

To find evidences of neutron star in SS 433 and to trace its behavior, we carried out multicolor UBVRI photometry, spectroscopy, and synoptic monitoring in the R band. We used different telescopes equipped with the CCDs and an image tube with the microchannel plate, and analyzed archive data. The Color–Magnitude Diagrams plotted using data in VRI bands reveal two variable light sources, blue and red. We identified the blue source as the eclipsing binary system with jets, and red source as a precessing circumstellar disk early described by Barnes et al. (2006). As a result, numerous flares lasted up to 6 hours, temporary disappearance and renewal of jets and eclipses, the disturbances of precession and orbital cycles, prolonged bright states inconsistent with the precession cycle were found (the latter are considered as shell episodes). The observations of the last three years are presented in Fig. 1 as deviations from the low quiet-level light curve. We explain these phenomena in terms of the hypothesis of accretion from the evolving star onto young magnetic neutron star (magnetar) in the dynamic mode.

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