SYMBIOTIC NOVA PU VUL (KUWANO-HONDA OBJECT): SOME RESULTS OF COORDINATED INVESTIGATIONS

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Since 1979 a team consisting of T.S.Belyakina, N.I.Bondar', K.K.Chuvaev, Yu.S.Efimov, R.E.Gershberg, V.I.Krasnobabtsev, E.P.Pavlenko, P.P.Petrov, I.S.Savanov, N.I.Shakhovskaya, N.M.Shakhovskoj, A.G.Shcherbakov and V.I.Shenavrin from the Crimea, Dr. V.Piirola from Finland and Drs D.Chochol, L.Hric and J.Grygar from Czechoslovakia are carrying out a coordinated study of pecular Kuwano-Honda (PU Vul) object, and this short report is made on behalf of the team.

PU Vul flared up from 14^m to 9^m in 1978 and up to date maintains the high brightness. Our studies include the optical and IR photometry, spectroscopy, spectrophotometry, polarimetry and UV observations with the space station Astron. The general character of brightness variations and time distribution of our observations are given in Fig.1.

The data analysis lead us to following conclusion: PU Vul is a binary consisting of a normal M giant and exploded component; in maximum (1983) the latter was not distinguishable from a supergiant F5 in respect of absolute luminosity ($-6\overset{m}{.}3$), physical conditions and chemical abundance of atmosphere. PU Vul is of about 5.3 kpc from the Sun and about 800 pc above the galactic plane. The deep minimum in 1980-81 was found to be due to an episode of a dust envelope formation and subsequent dissipation of the envelope around the exploded component similar to typical slow novae. Such a model explains many observed features of PU Vul in minimum: appearance of the TiO bands but very small U-B and B-V indices, IR fluxes, wavelength dependence of polarization.

In 1983 the photospheric temperature of exploded component reached a minimum, then the temperature began to increase and the size of the component began to decrease. As a results, during 1979-86 PU Vul traced a closed curve in the V, B-V plane - see Fig 2, plotted by Yu.S.

J. Mikolajewska et al. (eds.), The Symbiotic Phenomenon, 279–281.

https://doi.org/10.1017/S0252921100103628 Published online by Cambridge University Press

Efimov. Brightness variations occurred not monotonously but as a set of discrete "bluerings" with a duration of about a month. In 1982-86 we did not find quasi-periodical brightness variations with a characteristic time of about 80^d that existed before the dust formation episode but we found irregular variations with amplitudes up to $\Delta U \approx 0^m.2$-$0^m.3$. In the same period we had significant variations of parameters of intrinsic polarization of PU Vul radiation with an amplitude up to 1% and with a characteristic time of several days. Variations of polarization parameters are accompanied with strong changes in a shape of $p(\lambda)$ and are weakly correlated with brightness variations, therefore it is a hard task to offer a simple model for polarization feature of PU Vul.

From 1983 to 1986 the energy distribution in the PU Vul spectrum changed from F5 to A2. Simultaneously an excess in the Balmer jump region appeared; hydrogen, Ca II IR triplet and Fe II lines showed emission of a complicate structure involving the P Cyg profiles. The curve--of-growth analysis showed that excitation temperature of the hot component of PU Vul growed up from 6300 K in 1979-82 to 8000 K in 1984. At the same time the electron density increased by ten times and became similar to that in the atmospheres of giants. We found some indications on appearance of chemical anomalies similar to that of Am stars: Ca and Sc deficit and excess of the Fe group elements (excluding Fe itself) and heavier increasing on the average with the atomic weight -see Fig 3, prepared by I.S.Savanov.

The M giant brightness maintains at a constant level within 10-15% during this history of PU Vul.

Our studies permit to attribute the Kuwano-Honda object to extreme slow novae of the RT Ser type. We found an excelent agreement between the observed features of PU Vul and characteristics of an accreting hot white dwarf in the stage of quasi-stationary surface thermonuclear burning that have been calculated by Dr I.Iben (Ap J 259, 244, 1982) -see Fig 4. We have practically coincidence in M_V and T_{eff} for the time of temperature minimum and in flaring up time to the last 5^m. The loop in Fig 2 is in agreement with a prediction in Fig 4.

Thus, observations of the Kuwano-Honda object give us unique possibility to look at very rare process of a slow evolution of an exploded white dwarf. Many aspects of such a process is still hardly obscured and require new observational data and theoretical efforts.

In more complete form our results have been published in Astron.Astrophys. 132, L 12-14, 1984; Bull. Crimean Ap Obs 72, 3-72, 1985; Commun Konkoly Obs N 86,351-354, 1986.

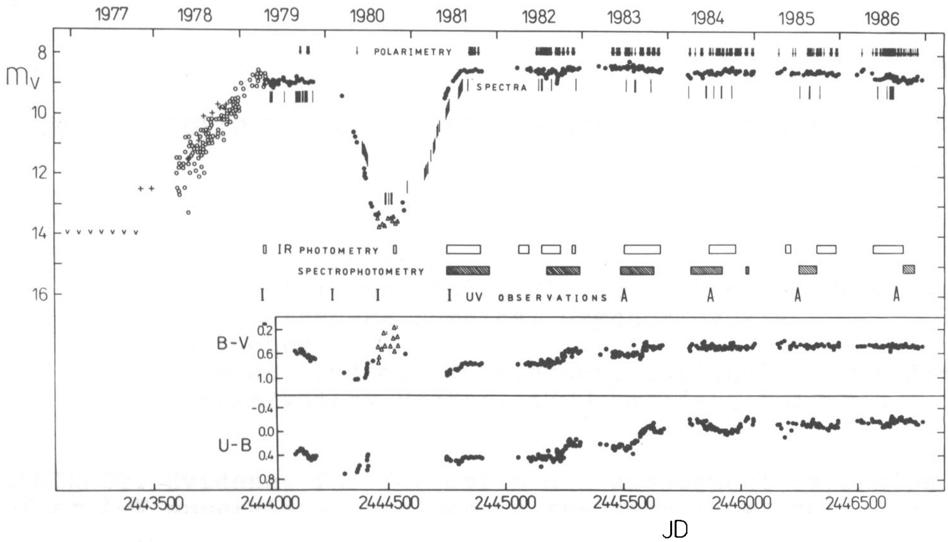


Fig.1. Light and colour curves and distribution of other observations of PU Vul.

Fig 2. The colour-magnitude diagram for 1979-1986 years.

Fig 3. Abundances of elements in the atmosphere of the exploded component of PU Vul.

Fig 4. Theoretical track of accreting white dwarf calculated by I.Iben and PU Vul's position at maximum (1983) in L,T plane.

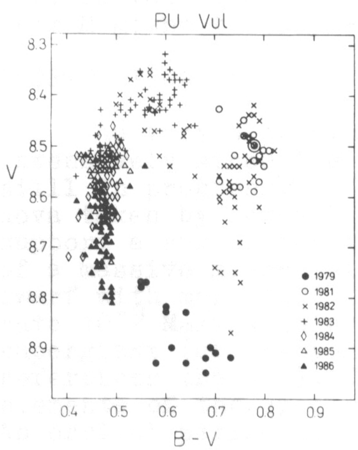


Fig 2

Fig 3

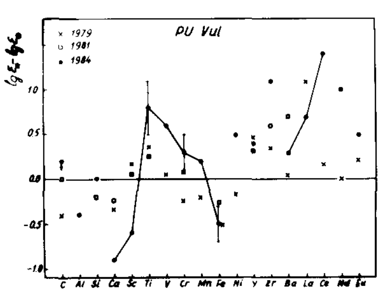
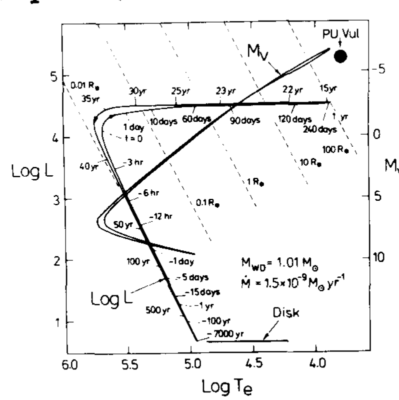


Fig 4



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