A MODEL FOR RX PUPPIS

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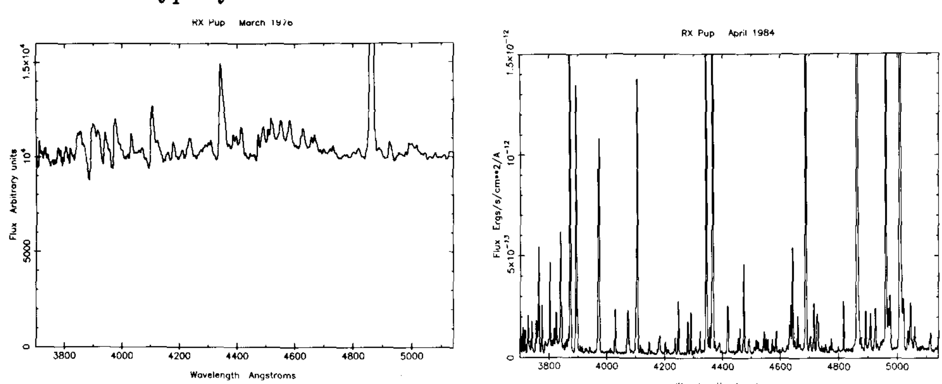
The dust-rich (D-type) symbiotic stars appear always to comprise a mira variable and a star of temperature $\sim 10^5$ K which ionizes the mira's circumstellar envelope. On timescales of decades they change little, save for the slow pulsation of the mira at infrared wavelengths. RX Puppis is a striking exception to this generalization, however, since it undergoes extraordinary changes.

RX Pup drifts between two extremes, exhibiting intermediate states. Table I summarises the known characteristics in the extreme states. Because of its variability, models of RX Pup are more highly constrained, giving us a chance to understand one of the D-type symbiotics.



Optical spectra of RX Pup from the Anglo-Australian Telescope. The breadth of the lines in 1976 may be due to lower spectral resolution.

We have developed a model that accounts for *all* the major observed properties of RX Pup in both of its states and during transitions. The key to our model is the wind from the hot star, which is strong enough to prevent it accreting from the mira's outflow.

In the low-excitation state the mass-loss rate from the hot star is so large that its wind becomes optically thick, generating a continuum at about 20,000 K. We estimate that $\dot{M} \sim 10^{-4}\ M_\odot\ yr^{-1}$. In the high-excitation state $\dot{M}$ falls by about one order of magnitude, the photosphere recedes, and the temperature exceeds 100,000 K. The

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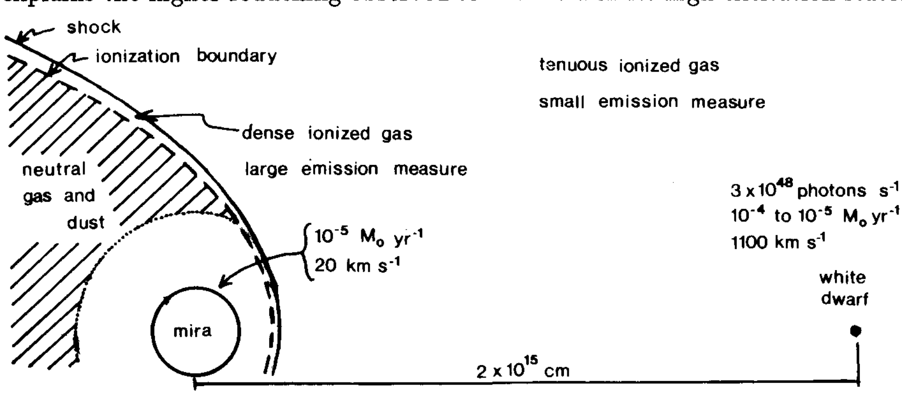
high mass-loss rate strongly suggests that the hot star is close to its Eddington luminosity, and is thus most credibly a white dwarf undergoing a shell flash.

TABLE I The extreme states of RX Puppis

	Low excitation	High excitation
Dates	1960-75	1905?, 1940, 1981-present
V	8.5	13
Optical emission	H, Fe II, [Fe II]	Range of emission to [Ne V], [Fe VII]
Radio spectrum	Flat, ~ 20 mJy	$S_\nu \propto \nu^{0.8}$, rising to > 500 mJy
Mira reddening	Very low	$A_V > 5$ mag
Dust emission	Weaker	Stronger
Evidence for wind	P Cyg, 1100 km s^{-1}	> 800 km s^{-1} from C IV doublet
Ultraviolet	?	Complex emission; strong C IV

Different radio spectra are seen in the two states. In its high-excitation phase RX Pup has a spectrum which is optically thick ($S_\nu \propto \nu^{0.8}$) to a frequency between 100 and 400 GHz. The separation of the stars can be inferred to be ~ 100*A.U.*, so the orbital period is many centuries. The dwarf must have accreted gas very slowly from the mira's outflow. Slow accretion is, in fact, necessary to produce a shell flash of duration approaching one century. The radio spectrum in the low-excitation state is flat and weak, and attributed to remnant free-free radiation from low-density regions of the mira's wind where recombinaton has yet to take place.

A standing shock forms where the wind pressures from the two stars balance. At times of high mass-loss from the white dwarf this is so close to the mira's surface that over much of the hemisphere facing the dwarf no dust can form in the mira's wind. When $\dot{M}$ falls, the shock recedes and the dust shell grows to surround the mira. We currently view the system from the hemisphere that contains the white dwarf, which explains the higher reddening observed to the Mira in its high-excitation state.



Cross section of RX Pup.

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