

The Proto-Planetary Nebula Vy 2-2.

R.E.S. Clegg & M.G. Hoare
University College London, U.K.

J.R. Walsh
Anglo-Australian Observatory, Epping, Australia.

High and low-resolution optical and near-IR spectroscopy of the candidate proto-planetary (or very young PN) Vy 2-2 (P-K 45 – 2°1) is reported. This object has associated OH maser emission and an angular diameter of only 0.4 arcsec, found from VLA maser and optical speckle interferometry. Empirical analysis gives the values $N_e \approx 3 \times 10^5 \text{ cm}^{-3}$, $T_e = 11000 (\pm 1500) \text{ K}$. The electron temperature is quite uncertain because of the high density. Abundances of He, C, N, O, Ne and Ar are reported; the carbon abundance is uncertain as it relies on the C II $\lambda 4267 \text{ \AA}$ line, since the object is too highly-reddened ($c = 1.8 \pm 0.2$) to be observed with *IUE*. We find $\text{He}/\text{H} = 0.10$, $\text{O}/\text{H} = 4 \times 10^{-4}$ and $\text{C}/\text{O} = 0.8$. The HI Zanstra temperature is 38 000 K (for black-body). The spectrum shows broad stellar lines of He II $\lambda 4686$, C III $\lambda 4647$ and N III $\lambda 4640$; the central star may be of type Of.

A photo-ionization model is presented for this young, dense object. The central star is represented by a non-LTE H-He model atmosphere with $T_{eff} = 38\,000 \text{ K}$, $\log g = 3.5$. We adopt a distance of 2.5 kpc, based on a calibration for optically-thick Magellanic Cloud PN (Barlow 1987). Major constraints for the modelling include the observed angular diameter, the stellar continuous flux level, the absolute (optically-thin) 100 GHz radio flux and the [O III] 5007 & 4363 \AA line fluxes. The stellar luminosity is 3500 L_\odot for the adopted distance. We introduce silicate dust grains into this model together with the same grains in a neutral region surrounding the ionized zone. The dust parameters are adjusted so as to match the observed *IRAS* 4-channel photometry and the measured silicate emission feature at 9.7 μm .

It is concluded that Vy 2-2 is a bona-fide young planetary nebula. The stellar parameters are those of a post-AGB object and the nebula abundances are typical of disk PN.