OBSERVATIONS AND MODELS OF THE 'HELIX' NEBULA NGC 7293

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ABSTRACT. Long-slit IPCS 2-dimensional spectra in radial directions across the inner and outer shells and across some of the brightest cometary globules are presented. The spectra show the ionization structure of the nebula quantitatively, with He II λ4686 A strong in the inner regions and [N II] λ6584 A prominent in the outer shell, almost due east of the central star. The "[Ne III] anomaly", previously reported for NGC 6720 and 7293 by Hawley and Miller, is clearly seen. It, together with the [O I] λ6300 A flux, provide constraints on our photo-ionization models, as both depend on the concentration of neutral H in the background gas.

We find low electron temperatures, T_e = 7300-8300 K, and N_e < 300 cm^{-3}. The oxygen and nitrogen abundances are constant across the shells, with mean values O/H = 1.0×10^{-3}, N/H = 4.0×10^{-4}. The object is He-rich, with He/H = 0.13 so this is a marginal 'Type I' planetary. The average spectrum of the largest group of 'knots' (cometary globules) east of the central star is presented.

Photo-ionization models of the smooth background gas are given. In our initial models, the central star is represented by a non-LTE H-He model atmosphere with T_{eff} = 120 000K and log g = 8.0 (Bohlin *et al.* 1982), and either He/H = 0.10 or 0.01. The high gravity results in a large He^+ absorption edge at 228 A and a rather flat spectrum in the He^+ continuum. The resulting, rather hard, ionizing spectrum produces a model with a high concentration of neutral H (and thus neutral O) in the outer 2/3 of the nebular volume. The model reproduces the low electron temperature, 8000K, found from [O III] and [N II] line ratios. It suggests that [O I] λ6300 A emission should be strong in the background gas as well as in the knots. A correction of approximately 10% in the derived He/H ratio is needed to allow for neutral H in this nebula; corrections may also be needed in other Type I PN.

The implications of H^0, H^+ and electrons co-existing in a large volume are discussed, with special reference to the H_2 vibration-rotation line emission seen at 2 μm from many positions in this nebula (Storey 1984).

S. Torres-Peimbert (ed.), Planetary Nebulae, 223.