INFLUENCE OF THE STELLAR WIND ON THE NEBULAR IONIZATION IN NGC 1535 AND 4361

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The high excitation planetaries NGC 1535 and 4361 were observed with IUE satellite in the short wavelength region at high dispersion. In NGC 1535 we found P Cygni profiles of NV 1238, 1242 and OV 1371 lines with a terminal wind velocity of about 2000 km/sec. In NGC 4361 these lines are narrow absorption lines (width 0.5 Å), probably of photospheric origin.

The observed nebular emission line spectrum, from our IUE data and published optical data, is compared with theoretical ionization models. The physical assumptions are: The ionizing flux is taken from NLTE model atmospheres (R.P. Kudritzki, private communication) which had been fitted to the photospheric hydrogen and helium line profiles of the central stars (R.H. Mendez et al., 1981, Astron. Astrophys. 101, 323). The nebulae are homogeneous and density bounded.

The observed UV continuum spectra agree well with the model atmosphere flux distributions.

With an effective temperature of 100 000 K which lies near the hot end of the error bar given by Mendez et al., the observed nebular spectrum of NGC 4361 can be reasonably well reproduced.

However, for NGC 1535 the central star with T_{eff} around 50 000 K does not provide enough He^+ ionizing photons. Thus, C IV, Ar V, Ne IV and Ne V lines also are predicted too weak. The electron temperature of the model is lower than observed, suggesting that the photon distribution between 13.6 eV and 54 eV, responsible for heating, is too cool.

The presence of NV and OV in the stellar wind of NGC 1535 indicates a wind temperature of about 10^5 K. A mass loss rate of 10^{-7} $M_\odot$ y^{-1} yields a sufficient number of He^+ ionizing photons to explain the nebular He II lines. We conclude that in NGC 1535 the hot stellar wind is an important source of photons ionizing the nebula.

HARRINGTON: I find your results quite interesting - we find the same need for additional flux below 54 eV in our study of IC 3568. It seems that those stars in the range $5 \times 10^4 \lesssim T_* \lesssim 8 \times 10^4$ K have this problem. The model atmosphere fluxes appear satisfactory for $T_* > 10^5$ K.

I would like to stress that the best objects in which to study stellar winds are PN. This is because the nebular spectrum gives information on the flux in the far ultraviolet emerging from the stellar atmosphere, particularly for $\lambda < 228$ Å. This information is not available for O-type main sequence stars.

PURTON: In addition to considering the effects of radiation from the hot wind, it may be useful to consider the direct effect of the wind on the nebular shell. The impact may have observable consequences for the ionization of the gas.

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