ARE ZANSTRA TEMPERATURES ALWAYS REAL?

L.H. Aller
Astronomy Department, University of California, Los Angeles

ABSTRACT. The classical Zanstra method compares a H Balmer line or He II λ4686 with flux from a limited region of the planetary nuclear (PNN) spectrum to obtain the central star temperature T(PNN). Long ago it was found that generally T(He II) > T(H I), a result attributed to differing optical depths at the Lyman limits of He II and H I; T(He II) often was regarded as the "real" temperature. Much attention has been paid to discordances between Zanstra temperatures and those found by other means, such as the energy-balance (EB) method. (see e.g., Preite-Martinez and Pottasch 1984).

Now T(PNN) may also be found from the excitation level of the planetary nebula (PN). We reproduce the spectrum of a given PN by a theoretical model; adjustable parameters include the energy flux of the central star, the truncation radius, the density and size of the shell, and its chemical composition. The body of line intensity and other observable data usually suffice to fix results within a range of solution, T(PNN)±ΔT. When this program is carried out, we sometimes find large discrepancies between Zanstra temperatures and those indicated by allowable stellar fluxes.

Yet another and very powerful method (when it can be applied) is to analyse the accurately observed PNN spectrum by non-LTE model atmosphere methods. This approach, due to Kudritzki and his associates (1987) gives a T-value which is independent of the structure of the surrounding nebula.

For some objects such as the PNN of NGC 2867, 6644, and 6741, T's by Zanstra, EB, or nebular model methods all appear to be reasonably accordant. For NGC 6891, the hydrogenic Zanstra method, the EB method, and nebular model method all agree with the effective temperature found by the Kudritzki *et al.* method.

The faintness of the PNN in the bright PN, NGC 2440 and NGC 7027 require Zanstra-method temperatures ∿ 350,000 K and 310,000 K, (Walton *et al.* 1987), respectively, vs. T(PNN) = 180,000 K and 190,000 K which seem to be required by the theoretical nebular models by Shields *et al.* (1981) and by Pequinot and Gruenwald (1987). A rapid fading of these PNN cannot account for the discordance as spectroscopic effects on these relatively dense nebulae would have been seen. Evidently, the far UV energy distribution must be modified in such a way as to cut down the UV flux in the region far shortward of 228 A. Otherwise the predicted intensities of [Ne V] and other highly excited ions would be too high.

REFERENCES

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