Self-Consistent Determination of Distances and Central Star Parameters for a Large Sample of Galactic Planetary Nebulae

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The distances, central star parameters T_{ef}, *log* g, L_*, M_*, and optical thicknesses of the envelopes in the Lyman limits of hydrogen and helium are determined in a self-consistent way for 156 planetary nebulae (PNe) in our Galaxy (129, 22, and 5 PNe in the galactic disk, bulge, and halo respectively). For each nebula, the distance is adjusted in such a way that the theoretical evolutionary age of the central star (CS) should be equal to the dynamical age of the expanding nebular envelope (Malkov, 1994). This method combines the individual approach to each nebula with the possibility of application to a large sample of PNe. Some improvements have been introduced in the method as compared with its original version. The evolutionary tracks and time scales for CS with masses of 0.605, 0.696, 0.836, and 0.940 $M_{\odot}$ were taken from Blöcker (1995). The change of the nebular expansion velocity during the evolution of a PN was roughly taken into account. The effective temperature of the CS and related parameters were found by the generalized energy balance method (Malkov et al., 1995) or, in appropriate cases, by Zanstra methods. Observational data have been collected from 93 papers published in 1975–1995.

New distances support the "long" scale of PN distances and are in general agreement with recent individual and statistical estimates of PN distances available in the literature. The mean distance of Galactic bulge PNe is found to be 7.7 ± 0.4 kpc that is a quite reasonable value for the distance to the Galactic center.

It is confirmed that the well-known Zanstra discrepancy is caused merely by low optical thickness of many PNe in the Lyman continuum of hydrogen. The bulk of nebulae shows a good correlation between the optical thicknesses in the Lyman limits of H I and He I evidencing for the coincidence of the zones of ionized hydrogen and singly ionized helium in the envelope. The nebulae with either cool CS or high He^{++}/H^{+} ratio violate this correlation.

The CS masses corresponding to the new distances show a clear correlation with the N/O abundance ratio in a nebula (Golovaty and Malkov, this volume). The distribution of CS over their masses clearly demonstrates that the CS masses (and therefore the progenitor star masses) of the galactic halo PNe are the lowest on the average. The CS masses of the bulge PNe are intermediate between the halo and disk ones. Massive progenitors yielding massive central stars are encountered among the progenitors of the galactic disk PNe only.

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