Masses of the Central Stars of Planetary Nebulae

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The aim of this study is to derive the masses of the central stars (CSPN) for a large sample of the planetary nebulae (PN). These masses, M_*, are derived from the observed PN positions in three diagnostic diagrams and their comparison with evolutionary tracks of model PN. Two of the diagrams, namely $L_{\rm Zan}(H)$ versus $T_{\rm Zan}(H)$ and $M_{\rm v}$ versus $R_{\rm neb}$, have already been used in numerous studies. The third one, $S_{\rm H\beta}$ versus $S_{\rm v}$, has recently been introduced by Górny, Stasińska & Tylenda (1996, hereinafter GST96). Here $S_{\rm H\beta}$ is the nebular surface brightness in Hβ and $S_{\rm v}$ is defined as $F_{\rm v}/(\pi\theta^2)$, where $F_{\rm v}$ is the stellar flux in the V band and θ is the observed nebular angular radius.

The model PN consist of a central star evolving according to the H-burning CSPN models of Blöcker (1995) and Schönberner (1983) and a nebula photoionized by this central star. The nebula is a spherically symmetric shell of a given mass, $M_{\rm neb}$, and expanding at a constant velocity, $v_{\rm exp}$. In order to derive the CSPN mass for a given object, its observed position is compared to a grid of PN models calculated for different M_*, in which $v_{\rm exp}$ is equal to the observed value for the object. In this way, $M_{\rm neb}$ is the only free parameter in our model. More details on the method can be found in GST96.

Our sample contains all objects for which the observational data that are necessary for placing them on our diagrams are available. In addition, the sample has been limited to PN with measured expansion velocity, since as shown by GST96, $v_{\rm exp}$ is a very important parameter in the evolution of the PN in the diagnostic diagrams. Binary central stars and H-deficient CSPN have been excluded. Our final sample contains about 180 objects.

We have analyzed our results and compared to other observational parameters. The distribution of the CSPN masses derived in this study has a mean value of M_* equal $0.617\,{\rm M}_\odot$ while the median value is $0.597\,{\rm M}_\odot$. As expected, we find that more massive CSPN are more confined to the Galactic plane. On the other hand, no clear correlation between M_* and nebular N/O abundance ratio is seen although the results are consistent with the theoretical predictions of Groenewegen (1995). Finally, there is a correlation (particularly tight for point-symmetric nebulae) between M_* and $v_{\rm exp}$ for $M_* < 0.65\,{\rm M}_\odot$. However, it has to be interpreted with caution as $v_{\rm exp}$ enters in the procedure of determining M_*.

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