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Stellar winds in central stars of LMC planetary nebulae

Anabel Arrieta,[1] L. Stanghellini[2] and L. Georgiev[3]

[1]Depto. Física y Matemáticas, Univ. Iberoamericana, Av. Prol. Paseo de la Reforma 880, Lomas de Santa Fe, México, D.F. C.P. 01210, México
email: anabel.arrieta@uia.mx

[2]NOAO, Tucson AZ, USA, [3]Instituto Astronomía UNAM, México, D.F.

Abstract. In this work we investigate the relation between wind momentum Π and the luminosity of the CSPNs in the LMC taking advantage of the less uncertain distances to these objects. We show that these winds obey the same relation as the Galactic O stars and therefore have the same physics.

Keywords. Central Star Planetary Nebula, Stellar Winds, LMC Planetary Nebulae, Wind momentum relation

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1. Introduction

The radiation driven wind theory states that the modified momentum $\Pi = \dot{M} V_\infty R^{1/2}$ is proportional to the stellar luminosity. This relation was first applied to Galactic CSPNs by Kudritzki *et al.* (1997). Tinkler & Lamers (2002) reanalyzed the Galactic CSPN data and did not find a clear relation between Π and luminosity.

2. Stellar and wind parameters

We used observations of LMC Planetary Nebulae with HST STIS in ultraviolet and optical slitless spectroscopy mode. The data are described in Stanghellini *et al.* (2005). For this work 8 of the targets, showing P Cyg profiles in C IV 1548/1551Å, were selected.

Further correction to the stellar extraction was provided by the nebular spectra themselves. The spectra were then corrected for galactic and LMC extinction. The central star luminosities, radii and masses were derived by Villaver, Stanghellini & Shaw (2003). We fit C IV 1548/1551 Å using a line transfer code together with a generic minimization algorithm Georgiev & Hernandez (2005). As a result we obtained mass loss rates and terminal velocities for these stars. For the mass loss rate determination we assumed all carbon is C IV. Carbon abundances were derived by Stanghellini *et al.* (2005).

3. Comparison with O Galactic stars

These CSPN wind momenta follow the same relation observed in galactic O stars (Figure 1(a)). We conclude the winds of the LMC PN central stars have the same nature as those of Galactic O stars.

Similar to the Momentum-Luminosity relation, the escape velocity of a star should be related to the terminal velocity of its wind: $V_\infty = aV_{esc}$. The Galactic massive stars show the so-called bi-stability jumps around temperatures where the opacity dominating ions change, increasing the value of the coefficient a from 1.3 below 21,000K to 2.6 for hotter stars. The Galactic PNs also show a similar relation with $a = 4.4$. Figure 1(b) shows

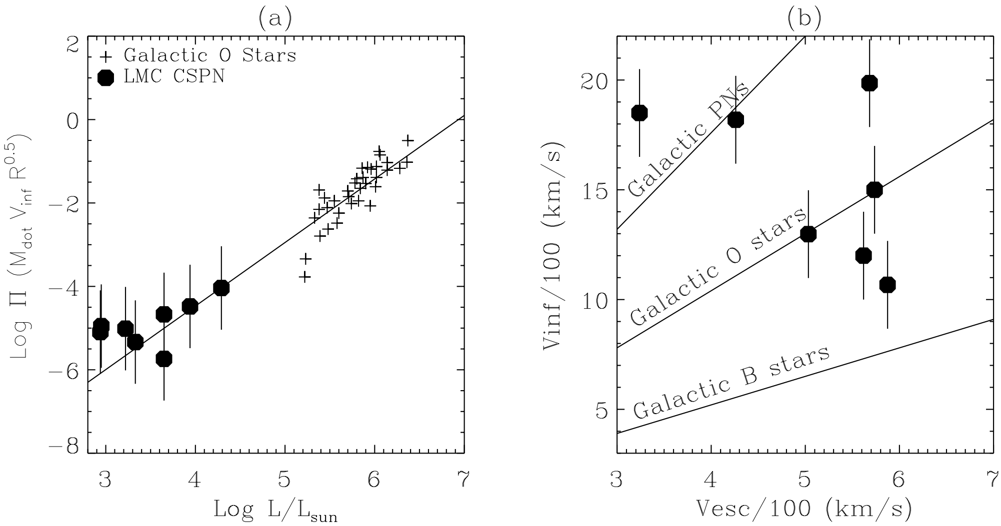

Figure 1. (a) Momentum luminosity Relation; (b) Escape velocity vs. V_∞ relation

the $V_\infty - V_{esc}$ relation for the LMC CSPN. The values lie around the O-stars line. This behavior points to an opacity source in these winds closer to the massive Galactic O stars rather than to the Galactic CSPNs. It is in agreement with the Momentum-Luminosity relation which is also a continuation of the one derived for the Galactic O stars.

4. Conclusions

The theory of stellar winds suggests that the acceleration of the wind depends on its opacity and therefore on its chemical composition. We presented analysis of the central stars of 8 planetary nebulae in LMC in order to check whether the winds in this galaxy differ from their Galactic counterparts. From the presented comparison we can conclude: 1) The LMC CSPNs follow the Momentum-Luminosity relation derived for the Galactic O-stars. One can conclude that the acceleration of these winds has a similar origin. 2) There is no clear relation between V_∞ and V_{esc} for the studied objects. Even so, they resemble more the behavior of the Galactic O-stars (or the WR stars) than that of Galactic CSPNs. 3) Combining the above, we conclude that the opacity sources of the LMC CSPN winds behave like those of massive O-stars. That does not mean that the opacity sources are the same, but the way the momentum is transferred from radiation to wind is similar to that of massive stars.

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