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SEVERAL WAYS TO BRIGHTNESS

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RESUMEN

Las luminosidades máximas, los cocientes de abundancias químicas y la cinemática interna de las cáscaras nebulares de nebulosas planetarias extragalácticas brillantes no dependen fuertemente de las características de las poblaciones estelares progenitoras en una galaxia. Esta falta de variación sugiere que las nebulosas planetarias más brillantes tienen estrellas progenitoras similares en todas las galaxias, un resultado inesperado teóricamente dada las metalicidades y las historias de formación estelar. Sin embargo, existen diferencias pequeñas y consistentes en cuanto a las luminosidades y la cinemática que sí dependen de las propiedades de las poblaciones estelares en las galaxias huéspedes y de la metalicidad en particular. Estas diferencias sugieren que necesariamente observamos las nebulosas planetarias en distintas galaxias en distintos estados evolutivos, corresponden las pertenecientes a las galaxias elípticas y los bulbos de espirales a fases más tempranas. Entonces, deben existir múltiples vías para la producción de las nebulosas planetarias intrínsecamente más brillantes.

ABSTRACT

The maximum luminosity, the chemical abundance ratios, and the internal kinematics of the nebular shells of bright extragalactic planetary nebulae are all rather insensitive to the underlying stellar populations in any given galaxy. These similarities argue that the brightest planetary nebulae arise from similar progenitor stars, but this is not necessarily expected theoretically given the metallicities and star formation histories of their host galaxies. However, there are consistent, if small, differences in luminosity and kinematics that do depend upon the host galaxy's stellar populations, notably its metallicity. These differences imply that we necessarily observe the brightest planetary nebulae in different galaxies in different evolutionary stages, with the brightest planetary nebulae from elliptical galaxies and the bulges of spirals being observed in an earlier stage. Therefore, there must exist multiple evolutionary pathways to produce the intrinsically brightest planetary nebulae.

Key Words: planetary nebulae — stars: evolution

Planetary nebulae are the penultimate evolutionary phase for stars of low and intermediate masses, during which the progenitor star's outer envelope is driven off into space through the action of the wind and radiation from the remnant pre-white dwarf (e.g., Kwok et al. 1978). The distribution of luminosities for bright extragalactic planetary nebulae has a maximum luminosity that is insensitive to the host galaxy's stellar populations (e.g., Ciardullo et al. 1991; Merrett et al. 2006). Typically, the chemical abundance ratios observed in bright extragalactic planetary nebulae are similar (Richer & McCall 2008; Magrini & Gonçalves 2009; Bressolin et al. 2010), implying that the masses of their progenitor stars are similar, independent of whether the host galaxy is actively forming stars or not. Finally, the kinematics of the nebular shells in these bright planetary nebulae also similar, implying similar energy injection and, perhaps, masses for the progenitor stars. It is not clear that these similarities are expected theoretically, given the differences in stellar populations among galaxies (Perinotto et al. 2004; Schönberner et al. 2010).

In detail, the luminosities depend upon the metallicity of the progenitor stellar population (Ciardullo et al. 2002). Figure 1 compares the bright planetary nebulae in the LMC and the bulge of the Milky Way and similarly indicates that the kinematics of the nebular shell also depend upon metallicity, with smaller line widths at the lower metallicity of the LMC, in spite of its potentially larger progenitor masses. Presumably, the lower initial expansion velocity of the envelopes of the stellar progenitors at lower metallicity is responsible (Marshall et al. 2004), even though these nebular envelopes are expected to suffer greater acceleration (Schönberner et al. 2010). Similar differences were found within the disc of M31 (Richer et al. 2010). Apart from the line width distributions at a given evolutionary stage (Figure 1, right), the distribution of evolutionary stages differs between the LMC and the Milky

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