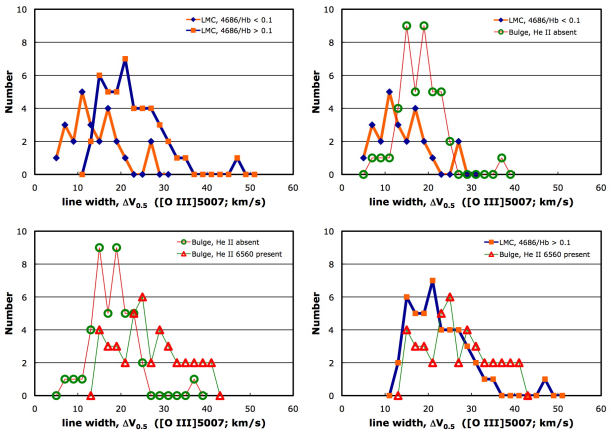

Fig. 1. On the left, the distributions of line widths are shown for bright planetary nebulae in the LMC (top; Dopita et al. 1985) and Milky Way bulge (bottom; Richer et al. 2008). On the right, the distributions of line widths are shown for young (top) and evolved (bottom) planetary nebulae in both environments. For both young and evolved planetary nebulae, the line widths are shifted to larger values in the Milky Way. The criteria to define young and evolved planetary nebulae in the LMC and Milky Way are equivalent.

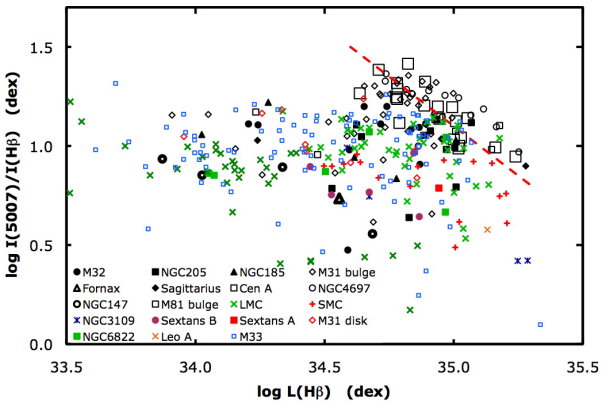

Fig. 2. The [O III]λ5007/Hβ ratio is plotted as a function of Hβ luminosity for extragalactic planetary nebulae with large [O III]λ5007 luminosities (for references, see Richer et al. 2010). Symbols in color represent galaxies with ongoing star formation; black symbols represent galaxies where star formation has ceased. The dashed line indicates a constant [O III]λ5007 luminosity. For these planetary nebulae, the Hβ luminosities decrease, on average, with time. The distribution of points differ for bright planetary nebulae in galaxies with and without star formation, indicating different evolutionary pathways.

Way (Figure 1, left), with the LMC having a larger fraction of evolved objects.

For planetary nebulae that are near their peak luminosity in [O III]λ5007, the Hβ luminosity is expected to decrease monotonically with time (Schönberner et al. 2007). Figure 2 presents the ratio of [O III]λ5007 to Hβ as a function of the Hβ luminosity. Bright planetary nebulae in galaxies with and without star formation occupy different loci in this plot, implying that their temporal evolution differs. In particular, the early evolution of bright planetary nebulae in galaxies without star formation appears to occur at a constant [O III]λ5007 luminosity, whereas the [O III]λ5007 and Hβ luminosities of their counterparts in galaxies without star formation are more closely correlated throughout their evolution. Since the planetary nebulae in galaxies with star formation typically have hotter central stars (Figure 1; Stasińska et al. 1998), they should be more evolved than their counterparts in elliptical galaxies and the bulges of spirals (they are also of lower metallicity).

Given that both the nebular shells and central stars of the brightest planetary nebulae are in different evolutionary stages in different galaxies, there must exist multiple pathways to produce the intrinsically brightest planetary nebulae.

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