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SPECTROSCOPY OF PLANETARY NEBULAE IN NGC 185, NGC 205, AND M32

Michael G. Richer[1] and Marshall L. McCall[2]

We have obtained new spectroscopic observations of planetary nebulae in the elliptical galaxy M32 and in the dwarf spheroidal galaxies NGC 185 and NGC 205 using the Multi-Object Spectrograph at the Canada-France-Hawaii Telescope. Our new data includes 14 planetary nebulae in M32, 13 in NGC 205, and all 5 cataloged in NGC 185. Almost all of these planetary nebulae are bright, within the first 2 mag of the planetary nebula luminosity function. We find that the planetary nebulae in M32, NGC 185, and NGC 205 have properties intermediate between those found for the planetary nebulae in M31 and the Large Magellanic Cloud (LMC). These new data support the suggestion that the chemical evolution of elliptical and dwarf spheroidal galaxies is regulated by supernova-driven galactic winds (Richer et al. 1998).

These data have significant implications concerning the evolution of both planetary nebulae themselves and galaxies.

The planetary nebulae in all three galaxies have weak emission lines from low ionization species, with [O II] 3727 and [S II] 6716,6731 often undetected, as is common for planetary nebulae in M31 (Jacoby & Ciardullo 1999). On the contrary, planetary nebulae in the LMC frequently have strong [S II] and [O II] lines.

The planetary nebulae in all three galaxies exhibit intensity ratios of [O III] 5007 intermediate between those seen in the LMC and M31. Consequently, the planetary nebulae in M31 must be less luminous in Hβ, though they presumably have ages similar to the planetary nebulae in NGC 185 and NGC 205.

The planetary nebulae in M32 have strikingly strong [N II] lines compared to those in NGC 185, NGC 205, and M31 (Richer et al. 1999; Jacoby & Ciardullo 1999). These data, for a largely independent sample, confirm the high N/O abundance ratios found by Stasińska et al. (1998), implying an enhancement of its stellar nitrogen abundances. M32 has a low oxygen-to-iron ratio that implies it formed stars over a very long period of time (Richer et al. 1998), evidence of which was first uncovered through studies of its stellar populations (Grillmair et al. 1996). Since intermediate-mass stars are substantial contributors to the enrichment of nitrogen, a long period of substantial star formation would better permit the incorporation of this nitrogen into its constituent stars.

The mean oxygen abundances we derive for the planetary nebulae in M32 and NGC 185 are in good accord with those derived previously (Richer & McCall 1995; Richer et al. 1998). Thus, the evidence in favor of supernova-driven galactic winds as the mechanism that regulates the chemical evolution of elliptical and dwarf spheroidal galaxies is reinforced by these new data.

For NGC 185, we find a dispersion in oxygen abundances similar to that found for its stellar iron abundances (photometric), confirming the large abundance dispersions previously noted for dwarf spheroidals. In turn, this implies that dwarf spheroidals likely suffered very substantial gas loss during their epoch of star formation (McCall et al. 1998).

[1]Observatorio Astronómico Nacional, Instituto de Astronomía, UNAM, P.O. Box 439027, San Diego, CA 92143-9027 (richer@astrosen.unam.mx).

[2]Department of Physics & Astronomy, York University, 4700 Keele Street, Toronto, Ontario, Canada, M3J 1P3 (mccall@aries.phys.yorku.ca).

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