Stellar Rotation
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Hubble Space Telescope Ultraviolet Spectroscopy of Central Stars of the LMC Planetary Nebulae

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Abstract. In the quest to understand the origin of Planetary Nebula (PN) morphology, correlations have been sought between the nebular shapes and the evolutionary status of the central stars. Several of the mechanisms proposed to explain asymmetric shapes have a direct link with the central star's evolutionary status. Among the possible mechanisms invoked to produce asymmetric PNs, stellar rotation is certainly an effective one, as several hydrodynamics models have shown. In this work we present *Space Telescope Imaging Spectrograph* (STIS) UV spectra of a sample of bright LMC PNs and their central stars. LMC PNs distances are known, thus the observed characteristics of the stars translate into absolute physical quantities readily, and provide the safest dataset for theory-observation comparisons. We are planing to fit stellar models to the observed spectra using black-body SEDs and synthetic photometry to estimate stellar temperature and reddening. We are going to use the stellar evolutionary tracks to compare the post-AGB age with the dynamical age from the nebula. P-Cygni profiles will be analyzed in order to determine an approximation of the mass loss rate. Stellar characteristics will be related to the morphology of the nebulae observed by our group with *HST* STIS optical slitless spectroscopy.

The present work is based on observations designed to study the morphology and physical conditions of planetary nebulae in the LMC (HST proposals 8271 and 9120). Here we have selected 12 of the target nebulae, those that show a stellar continuum in the UV spectra.

The observations were made with the STIS, in ultraviolet slitless spectroscopy mode. The detectors used are STIS/NUV-MAMA and STIS/FUV-MAMA operating in the near ultraviolet (grating G230L, 1600-3100 Å) and far ultraviolet (grating G140L, 1150-1700 Å) respectively. Both detectors have $0.024'' \mathrm{pix}^{-1}$ resolution. The spectral scale is 1.58 Å pix^{-1} and 0.60 Å pix^{-1} for grating G230L and G140L respectively, which is degraded because the slitless spectroscopy mode to an average value $\sim$2.5 Å pix^{-1} in the range of 1600-3100Å.

Optical slitless spectroscopy of the targets is also available (Stanghellini et al. 2002) so morphology and nebular size at optical wavelengths are known.

The slitless spectrograms were calibrated with the standard STIS calibration pipeline module (McGrath, Busko & Hodge 1999). The extraction size aperture for each star was of 11 pixels, which is typical for a point source extraction. We calibrate the flux with special attention to the aperture correction.

Figure 1 shows the extracted spectrum in the case of LMC SMP 25. The shows the central star continuum with absorption and emission lines. The most remarkable stellar lines are H I λ1216, C II λ1335,36, Si IV $\lambda\lambda$1394,97,98, Si IV λ1403. Also present are resonant absorption lines with P Cygni profiles such as

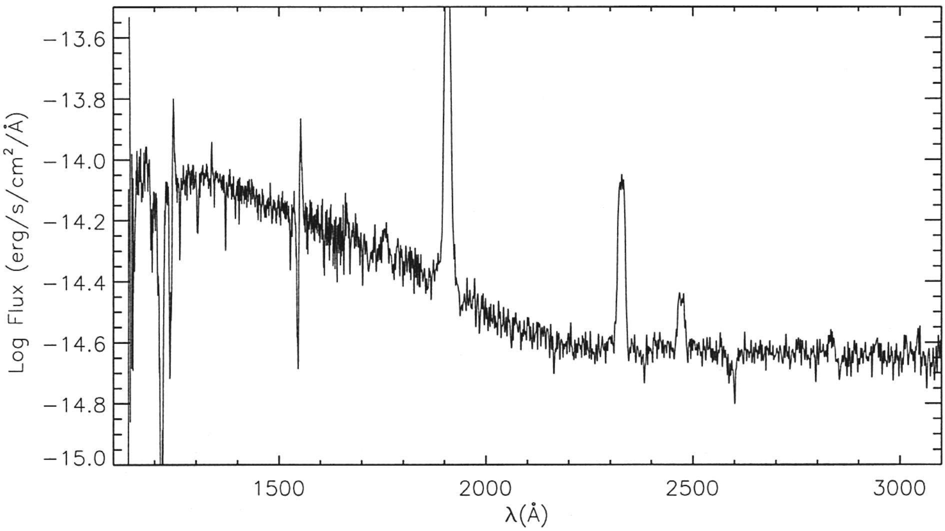

Figure 1. Spectra of the planetary nebula LMC SMP 25

the N V $\lambda\lambda$1239,43 and C IV $\lambda\lambda$1549,51 doublets. The nebular-subtracted spectrum still present some residual nebular emission lines, such as C III] $\lambda\lambda$1907,09, the C II] $\lambda\lambda$2324,25,26,28 multiplet and [O II] λ2471.

We plan to measure both the stellar continuum and the stellar lines in all the 12 central stars of our sample. For cases where the stellar spectra are especially bright, we will take great care to model and subtract the scattered starlight as well.

We plan to model the stellar spectra to find the interstellar extinction and the stellar temperature in all 12 central stars of our sample. Starting with the extinction constant and the Zanstra temperature derived from optical data, and assuming that the spectral energy distribution of the star is a blackbody (see, for example, Wolff et al. 2000), we will get the best fit by iteration and derive the extinction and temperature.

The P Cygni lines observed in some stars will be analyzed in order to determine the mass loss rates.

References

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