Planetary Nebulae in our Galaxy and Beyond
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The SPM Kinematic Catalogue of Planetary Nebulae

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Abstract. The San Pedro Mártir Kinematic Catalogue of Planetary Nebulae aims at providing detailed kinematic information for galactic planetary nebulae (PNe) and bright PNe in the Local Group. The database provides long-slit, Echelle spectra and images where the location of the slits on the nebula are indicated. As a tool to help interpret the 2D line profiles or position-velocity data, an atlas of synthetic emission line spectra accompanies the Catalogue. The atlas has been produced with the code SHAPE and contains synthetic spectra for all the main morphological groups for a wide range of spatial orientations and slit locations over the nebula.

Keywords. line: profiles, techniques: spectroscopic, Catalogs, ISM: kinematics and dynamics, ISM: planetary nebulae: general.

1. Introduction

The kinematics of planetary nebulae contain key information to understand their formation and evolution, as well as their role in galactic structure. For this reason, there have been a number of kinematic catalogues and compilations in the past. For example, Schneider *et al.* (1983) published heliocentric radial velocities for 524 PNe and Durand, Acker & Zijlstra (1998) increased the data set to 867 PNe. These works have been useful for statistical studies and to derive the galactic rotation curve from the PNe population. Sabbadin (1984) compiled expansion velocities for 165 PNe and Weinberger (1989) expanded that sample to 288 PNe. Those works allowed to identify the differences in expansion patterns among different morphological classes. All the works cited above compiled the available data at the time from sources with data of different qualities.

The growing high-quality data of the last decade on PNe has made clear the relevance of embedded collimated outflows, poly-polarity, point-symmetry and dense globules in their structural development. Unfortunately, detailed kinematic information can only be found for small samples or individual objects scattered in the literature. Furthermore, the need for comparing kinematic data at different wavelength ranges to test models has been raised often. Therefore, to understand the dynamics of PNe from an in-depth perspective a systematic and homogeneous set of high-quality, spatially resolved, kinematic information is required. This is what the SPM Catalogue attempts to provide.

2. The SPM Catalogue

The data for the Catalogue has been obtained over 34 observing runs at the San Pedro Mártir observatory (México), three additional runs have provided data from the

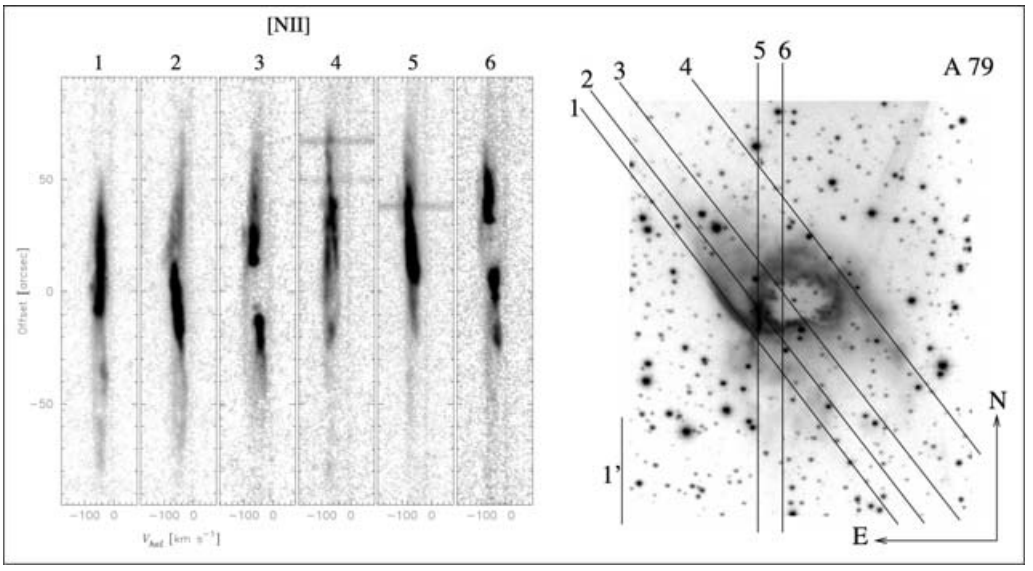

Figure 1. Sample data of the SPM Catalogue, here the case of A79 is depicted with the slit positions indicated and labeled on the image and the corresponding [N II] line profiles.

Anglo-Australian observatory. The spectra have been obtained in both cases with the Manchester Echelle Spectrometer (Meaburn *et al.* 2003) except for the last AAT run when we used UCLES. Data acquisition continues.The Catalogue is divided in three parts, namely, the galactic PNe, the bright PNe from the Local Group and the atlas of 2D synthetic emission line spectra produced with SHAPE.

3. The galactic PNe

The data for the galactic PNe sample has been mainly obtained in the echelle order covering the Hα, [N II] λ6548, 6584 Å and He II λ6560 Å lines. Some objects have been observed also in the light of [O III] λ5007 Å and [S II] λ 6717, 6731 Å. The long-slit, spatially resolved spectra have been obtained at a spectral resolution R $\approx$ 11 km s^{-1} (0.1 Å/pixel) and 0.6″/pixel along the slit. For the brightest targets R $\approx$ 6 km s^{-1} has been obtained. Currently the data-set contains 300 galactic PNe, most of them observed at several slit position comprising approximately 2500 individual, deep, long-slit spectra. Images with slit positions indicated are provided for every object. The sample covers all morphological classes and stellar populations in our galaxy. A sample object, A 79, showing the basic lay-out of the Catalogue is shown in Figure 1.

4. The Local Group PNe

Line profiles in [O III] λ5007 Å have been obtained for 174 PNe for a number of Local Group galaxies. Some bright targets such as those in Sagittarius, NGC 6822 and Fornax have also been observed in Hα and [N II] λ6548, 6584 Å. These have been compared with bulge MW-PNe to assess the LG-PNe data, with satisfactory results. Mainly, we find that only $\sim$ 10% of the flux, corresponding to wings of the line profile is not accounted for in our sample and that the line widths of the [O III] and Hα line profiles convey the same velocity information, confirming that the [O III] emission reliably maps most of the nebular mass. For the current limited sample in the Catalogue it is found that

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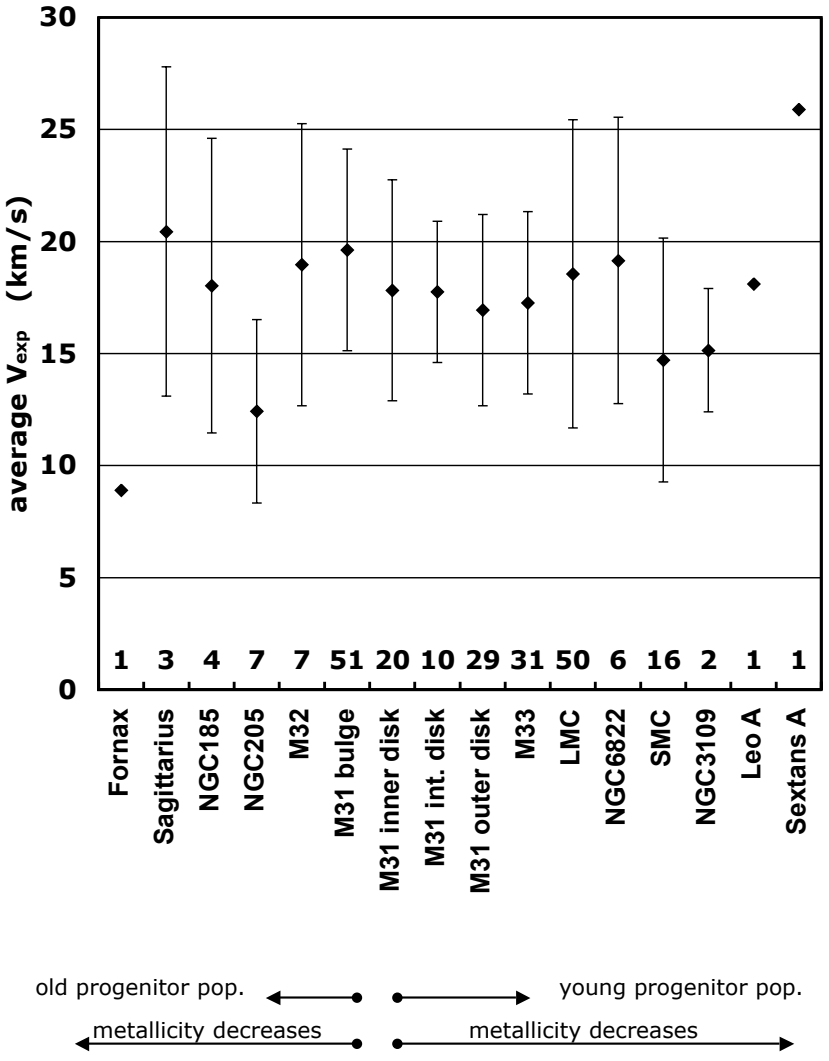

Figure 2. The mean expansion velocities measured for PNe in the Local Group galaxies in the SPM Catalogue. The error bars represent the standard deviation of the V_{exp} distribution. The data for the Magellanic Clouds were taken from the literature (Dopita *et al.* 1988). Numbers along the bottom of the plot indicate the number of objects measured in each galaxy.

the expansion velocity of LG-PNe (determined from half the FWHM) seem to first order insensitive to metallicity effects or age of the progenitor stellar population. Figure 2 shows the results in this regard. However, see Richer (2006, this volume) for a discussion on M 31, the galaxy with more PNe observed and where some distinct differences are encountered between the PNe in the outer disk and those in the bulge.

5. The atlas of synthetic line spectra

The atlas of synthetic position – velocity profiles has been added as a tool to aid interpreting the observed emission lines in the Catalogue. It reproduces the main morphological groups at a number of orientations and slit locations over the nebula. The Atlas has been produced with the code SHAPE (see Steffen & López 2006, and this

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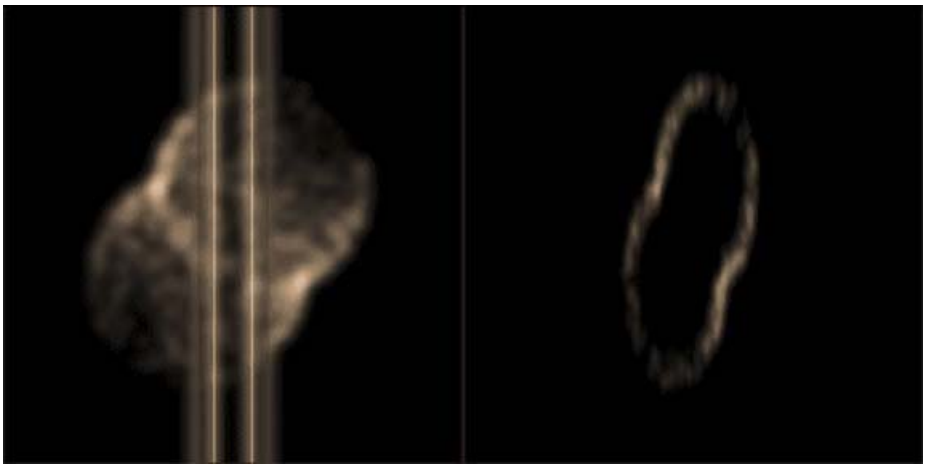

Figure 3. An example of a synthetic 2D line profile (P-V) for a tilted bipolar nebula. The generated expanding image is shown on the left panel with the position of the long-slit indicated. The resultant P-V line profile is shown on the right.

volume). The Atlas can help to interpret any expanding gaseous nebula, not just PNe. Figure 3 shows an example of the use of the ATLAS and SHAPE.

6. Conclusions

The SPM kinematic catalogue of PNe will provide wavelength calibrated, spatially resolved, high resolution, spectra for all main morphological classes and stellar populations in the galaxy. For every object a corresponding image indicates the slit positions on the nebula. The data-base will allow the inspection of groups with common characteristics in the image and spectral spaces. Enough detailed information will be provided to complement studies at other wavelengths, such as H_2 and CO and the comparison with theoretical models. For the Local Group PNe the data allow to compare the kinematics with properties of their host galaxy. The comprehensive set of synthetic line profiles facilitates interpreting the line profiles in the Catalogue and for any expanding gaseous nebula. The Catalogue will be shortly published in journal and www formats.

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