Planetary Nebulae in our Galaxy and Beyond
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Kinematics and Dynamics of the Galactic Bulge through Planetary Nebulae

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Abstract. The discovery of ∼500 planetary nebulae (PNe) in the bulge region allows us to probe the bulge out to ∼ 8 kpc. This opens up the possibility to track bulge-disc interactions to unprecedented details. We present an exploration of bulge dynamics with Nbody models of a triaxial bulge embedded in an exponential disc (Peyaud 2005).

Keywords. Planetary Nebulae, Kinematics, Dynamics

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1. Rotation of the bar-bulge

∼500 MASH (Macquarie/AAO/Strasbourg Hα PN consortium) PNe were discovered over a 15 square degrees bulge region doubling the number of known PNe. Acker *et al.* (this volume) separate disk and bulge PNe : a total sample of ∼ 800 PNe should belong to the Bulge. By considering the number of GBPNe in dense $l - b$ regions, and using a de Vaucouleurs distribution law, we estimate the total number of PN in the Bulge to be about 3500. - Figure 1 shows longitude l versus mean velocity v and versus velocity dispersion for the whole GBPNe sample. The rotation curve is plotted in the $-3 < l < 3$ range, with a slope of 18km/s/deg, and an asymmetry at $l \sim -6$. For $l > 7$ and $l < -6$, the data become dominated by PNe of the inner disk. - A spatial structure of the bulge/bar was proposed by Babusiaux & Gilmore (2005), through the distribution of Red Giants in various windows and their position (variable with the distance) on the $K, J - K$ diagram. The 2MASS data of the GBPNe plotted on a similar CMD appear comparable to the RG CMD for each window, allowing us to consider that these stars lie at the same distance as the targeted PNe. Therefore we are able to constrain the kinematics of these small regions (Fig.1). A dissymmetry appears at $l \sim -8$: could this be a second structure (inner ring), or a possible torsion ?

2. N-body model of the triaxial structure of the bar-bulge

We compared the data with an N-body model composite galaxy constructed using the public domain code Magalie (Boily *et al.* 2001) run through the NEMO suite of software (Teuben 1995) with the following initial conditions: (i) a 10% cut-off of the kinetic energy in order to cool down the disk and create a bar instability, (ii) the following particle numbers for each component: bulge/disc/halo = 5k/20k/40k. The bar instability is triggered manually by reducing the (mainly) azimuthal velocity vectors by a small fraction which causes inward motion and an alignment of orbits causing a bar to form. Analysis is performed once the system has settled in equilibrium : a 10% perturbation

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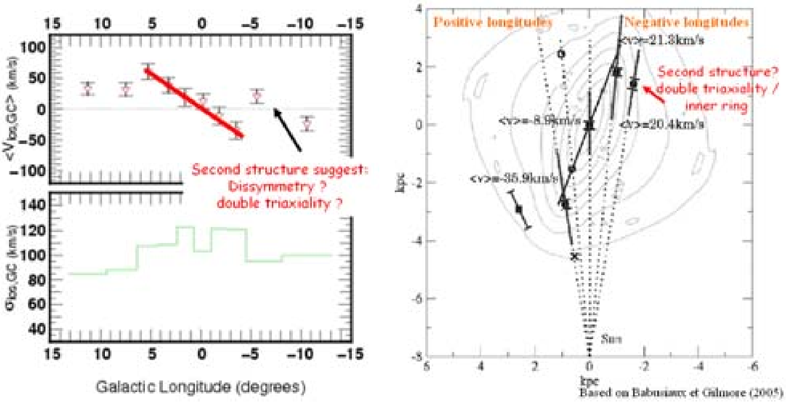

Figure 1. Left : Mean galactocentric velocities V_{los} (top panel) and velocities dispersion (lower panel) vs. longitude relations. Total (MASH + Cat) PNe are used for the mean rotation curve (10 bins of equal number of PNe in each bin). Right : Mean radial velocities of PN in windows $\mid l \mid = 5.7 \pm 1.5$ and $\mid l \mid = 9.7 \pm 1.5$ overplotted on the spatial model constrained by Red Giants (from Babusiaux & Gilmore, 1995)

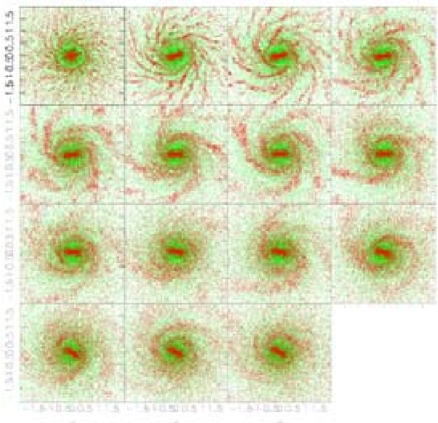

Figure 2. N-body model composite Milky Way galaxy time-integrated with gyrfalcON (Dehnen 2002). The integration was done over 15Gyr and each snapshot corresponds to 1Gyr (from top left to bottom right). The resolution on each snapshot is 50pc.

for the velocities leads to a bar in equilibrium matching (roughly) the ratio $3.5/8 \sim 1/2$ observed for the Milky Way (Fig. 2). Further details of the models will be reported elsewhere.

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