A Rotating Jet in the Quadrupolar Planetary Nebula NGC 6881

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Introduction

There is a renewed interest in the study of the possible precession of the central sources of planetary nebulae. Three different morphological features are considered the effect of precession:

1. Point-symmetric PNe: Objects whose morphological components are symmetrical with respect to reflection through the center.
2. Quadrupolar PNe: Characterized by two well-defined pairs of lobes which are symmetric, in pairs, with respect to two different axes. These PNe are very likely the result of two episodic nebular ejection processes, produced at different positions of the symmetry axis.
3. Bipolar, rotating episodic jets (or BRET's): Spectacular structures (López, Meaburn, & Palmer 1994) due to the precession of a symmetrical, collimated episodic outflow.

Here we report on the discovery of the remarkable nature of NGC 6881, where two different marks of precession (quadrupolarity and precessing episodic outflow) are present.

Results and Discussion

We present high-quality (sub-arcsecond) narrowband CCD images of the PN NGC 6881 which reveal a highly collimated bipolar structure. A careful examination of the [N II] image (Figure 1) and of the [N II]/[O III] and [N II]/Hα ratio images shows that NGC 6881 is a Quadrupolar PN (Manchado, Stanghellini, & Guerrero 1996a), that is, a twice bipolar PN, each pair of lobes having a different symmetry axis.

In addition, a striking knotty loop-like structure has been discovered in the southeast extreme of the nebula. Its appearance strongly suggests a precessing jet-like structure.

Kinematical information of the different morphological features confirms the proposed nature of this nebula. The bright core is a ring which is collimating the bipolar lobes, while the loop-like structure turned to be a precessing jet. Assuming a simple balistic model, an age of 7 400 $\times d$ yrs (d is the distance in Kpc) is worked out, which can be compared with the computed age of the inner lobes of 420 $\times d$ yrs. The precession period is of 3 800 $\times d$ yrs. A comparison of the observed and predicted position of the inner lobes indicates that the precession conditions (explicitly, the period and axis of precession) have not change significatively since the formation of the precessing jet to the formation of the quadrupolar system, thus indicating a stability of the precessing mechanism over a period $\geq$ 10 000 yrs.

An upper limit of the ionized mass ejected ($3.4 \times 10^{-4} M_{\odot}$) in the precessing jet has also been worked out.

A detailed analysis is being submitted to *Astrophysical Journal Letters*.

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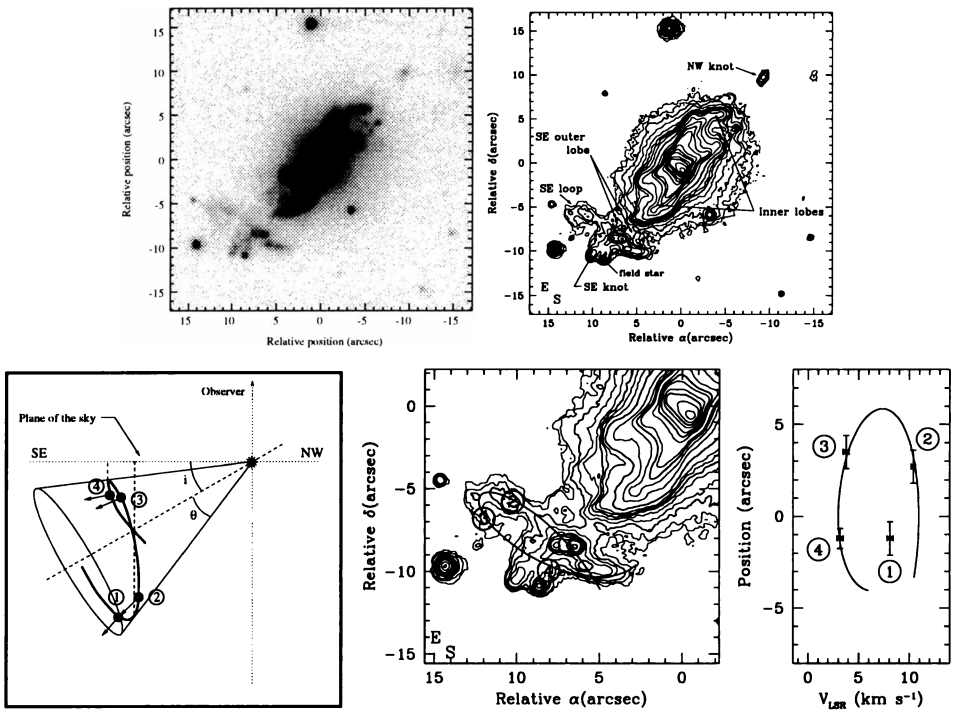

Figure 1: (top) Grey-scale (left) and contour map with logarithmic intervals (right) of the [N II] image of NGC 6881. The different morphological features are outlined. (bottom) Scheme of the proposed model for the loop-like structure observed in NGC 6881 (left). The ejection moves radially, forming an helix onto the surface of the precession cone. This model is convincingly compared with the morphology (center) and kinematics (right) of the NGC 6881 southeastern loop-like structure. Regions were kinematical information has been obtained have been labeled as 1, 2, 3, and 4.

REFERENCES

Guerrero, M. A., & Manchado, A. 1996, submitted to Astrophys. Journal Letters
López, J. A., Meaburn, J., & Palmer, J. 1994, Astrophys. Journal Letters, 415, L135
Manchado, A., Stanghellini, L., & Guerrero, M. A. 1996, Astrophys. Journal Letters, 466, 95

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