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Detecting Triaxiality and Figure Rotation in Gaseous Elliptical Galaxies

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Abstract: We discuss the possibility of detecting triaxiality and figure rotation in elliptical galaxies with extended edge-on gaseous disks, using the method developed by Kuijken & Merrifield (1995) to detect bars in edge-on spiral galaxies.

1. Introduction

The ellipticity of most (giant) elliptical galaxies is not due to rotational flattening and is generally explained by velocity dispersion anisotropies, which means that most ellipticals are probably triaxial. While this is generally accepted, the question of whether their figure rotates (tumbles) remains open and almost untouched. Figure rotation has a profound effect on the dynamics of triaxial systems, so it is important to find a way to attack this problem from an observational point of view.

2. Detecting Triaxiality and Figure Rotation

Kuijken & Merrifield (1995) (see also Merrifield 1996) have shown that, due to the particular dynamics of a barred disk, the gas in an edge-on barred system will have a characteristic two-dimensional line-of-sight velocity distribution (LOSVD), markedly different from gas in near-circular motion in an axisymmetric disk. In a barred disk, resonances occur between circular motions and the bar pattern speed; with increasing radius, the orbits elongated by the bar change their orientation at each principal resonance (inner Lindblad resonance, corotation, outer Lindblad resonance). Because the gas is forced onto closed non-overlapping, non-self-intersecting orbits, a region around those resonances will be gas-depleted, creating gaps in the projected LOSVD (compared to an axisymmetric disk) and giving rise to a characteristic "figure-of-eight" (see the bottom diagram of Fig. 1a for a striking example). This feature is a signature of the non-axisymmetric potential in the disk.

In spiral galaxies, this method can be used to detect if a bar is present in an edge-on system. The bars in spirals are rapidly rotating and often the inner Lindblad resonance is not present. The major resonance is then corotation, far out in the disk. Because most spiral galaxies have extended gaseous disks

(particularly the late-type systems), this method can potentially be applied to a large number of objects.

We believe that the method of Kuijken & Merrifield (1995) can be used directly to detect if the figures of triaxial elliptical galaxies are rotating. Resonances depend only on the figure rotation and the form of the potential. Still, for the method to work, the presence of a gaseous disk is required. While most ellipticals are gas-poor, a significant fraction of them do in fact possess a gaseous disk. The question remains whether these disks extend out to the resonances. We argue that they do. The tumbling of the figure in triaxial ellipticals is believed to be slow. If this is correct, an inner Lindblad resonance should be present in the disk, and a relatively extended gaseous disk may well reach that far. From this argument, we suggest that it may be possible to detect figure rotation (and triaxiality) in elliptical galaxies possessing an edge-on gaseous disk.

3. Observational Examples

We illustrate the kind of gas LOSVD signature one might expect from a rotating triaxial galaxy with an edge-on gaseous disk, by showing observations of the almost edge-on (barred) spiral galaxies NGC 5746 (Fig. 1a) and IC 5096 (Fig. 1b). Fig. 1 shows the ionised gas LOSVD along the major axis of the galaxies, accompanied by Digitized Sky Survey images on the same scale. The line-splitting giving rise to the "figure-of-eight" is obvious in both cases and indicates that a bar is present in the disk of the galaxies.

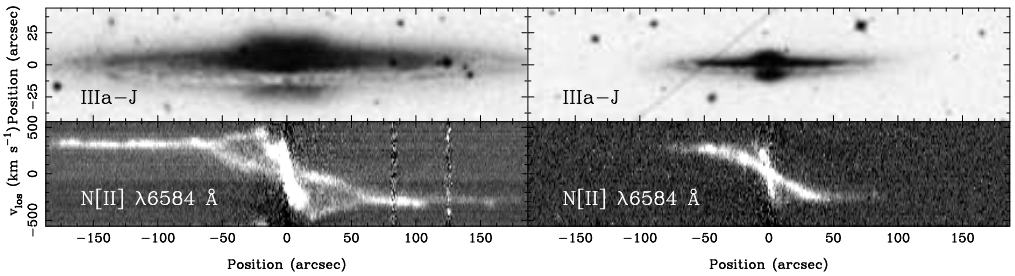

Figure 1. Structure and kinematics of a) NGC 5746, and b) IC 5096. Top: Blue image of the galaxy (DSS). Bottom: Line-of-sight velocity distribution (LOSVD) of the ionised gas (N II λ6584 Å) along the major axis of the galaxy.

We expect rotating triaxial elliptical galaxies to display the "figure-of-eight" gas LOSVD, analogous to what is seen in the inner parts of Fig. 1a and Fig. 1b (bottom diagrams). The detection of triaxiality and figure rotation in elliptical galaxies should therefore be straightforward if a sufficiently extended edge-on gaseous disk is present.

References

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