

The Corotation Radius and Other Resonances in NGC 7479

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1. Introduction

The luminosity profiles perpendicular to the bar of the galaxy NGC 7479 display “shoulders”, which are observationally identified as an increase in the brightness profile (see Figure 1, right). In the literature (see e.g. Buta 1986), the presence of these features in other barred spirals has been reported. The “shoulders” have been attributed to annular structures resulting from the presence of a bar (Schwarz 1981, 1984, 1985), appearing at the OLR. Their stability and the precise modelling depends on the structural parameters of the bar. We attempt to test the plausibility of this theoretical interpretation using 2D photometry of the barred galaxy NGC 7479. The key parameter is the corotation radius (CR), defined as the galactocentric distance at which the gas and the shock wave corotate. From the CR all other Lindblad resonances can be obtained. Some of the techniques used to derive the CR are:

1. The CR is obtained assuming that the surface brightness of some tracers (stars or neutral hydrogen) obeys the continuity equation (Tremaine & Weinberg 1984).
2. The CR is determined by the arm-interarm ratio of the efficiency of massive star formation (Cepa & Beckman 1990)
3. The CR and other resonances are determined from a study of optical symmetries (Elmegreen & Elmegreen 1990; Elmegreen et al. 1992).

2. The Method and Results

A description of observations and reduction of data presented here is given in Varela et al. (these proceedings). In this work we propose to determine the CR of NGC 7479 from the surface photometry by:

1. Color indices: The color index $B - I$ shows a minimum of star formation at a galactocentric distance of $60''$.
2. Bar morphology: The end of the bar is located at $60''$ from the center (see Varela et al. these proceedings).

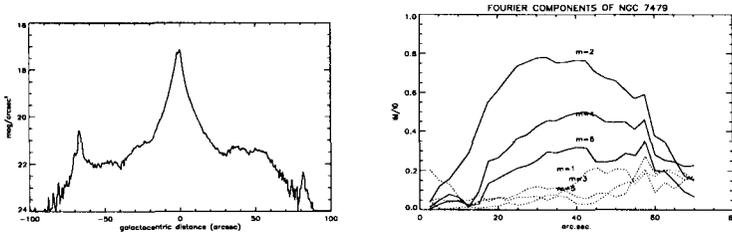


Figure 1. On the right, Fourier components of NGC 7479. On the left, radial profile perpendicular to the bar of NGC 7479.

Assuming a functional dependence of the rotation curve of the galaxy like $v(R) \sim R^\alpha$ (Elmegreen et al. 1992) and taking $\alpha = 0.079$ for NGC 7479, the resonances are located at: $R_{ILR} = 14.83''$, $R_{I3:1} = 29.66''$, $R_{I4:1} = 37.69''$, $R_{O4:1} = 85.9''$, $R_{O3:1} = 94.55''$, $R_{OLR} = 111.24''$.

Following Elmegreen et al. (1992), we have extracted the two- and three-fold symmetric parts, and the asymmetric-part of NGC 7479. An image of the first one is in Figure 2 (right). The derived locations of resonances are consistent with the different techniques (Aguerri et al., in prep.).

3. Fourier Analysis of the Azimuthal Brightness Profiles

To determine the structural parameters of the bar, we study the I band azimuthal profiles of NGC 7479. We decompose it into a Fourier series by:

$$I(r, \theta) = \frac{A_m(r)}{2} + \sum A_m(r) \cos(m\theta) + B_m(r) \sin(m\theta) \quad (1)$$

Following Ohta et al. (1990), we obtain the Fourier amplitudes by:

$$I_0 = \frac{A_0}{2} \quad (2)$$

$$I_m = [A_m^2(r) + B_m^2(r)]^{\frac{1}{2}} \quad (3)$$

In Figure 1 (right) the Fourier amplitudes ($\frac{I_m}{I_0}$, $m = 1, \dots, 6$) are presented. Even components are dominant and the region corresponding to the bar is dominated by the $m=2$ component. From that, and following Dubath et al. (1990), the structural parameters of the bar, (S_b , R_b , W_b) can be obtained. S_b is the bar strength, R_b a typical radius and W_b the radial extension of the asymmetrical deviation. For NGC 7479 these are: $S_b = 0.55$, $R_b = 36.325''$ and $W_b = 15.41''$. Given that the bar radius is $60''$, the axis ratio of the bar of NGC 7479 is $\frac{W_b}{r_{bar}} = 0.26$.

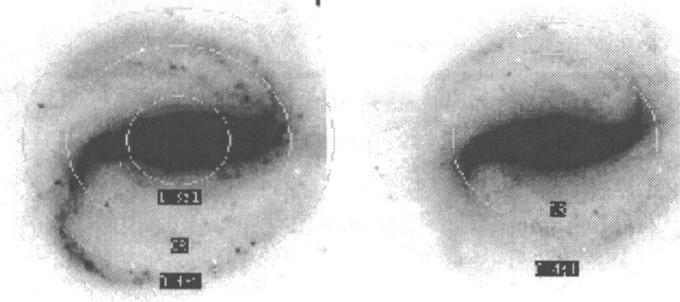


Figure 2. Left: resonances drawn on an I image of NGC 7479; Right: Corotation radius and O4:1 resonance marked on $m=2$ image.

4. Conclusions

The corotation radius of NGC 7479 is located at $60''$. The other resonances are located at: $R_{ILR} = 14.83''$, $R_{I3:1} = 29.66''$, $R_{I4:1} = 37.69''$, $R_{O4:1} = 85.9''$, $R_{O3:1} = 94.55''$ and $R_{OLR} = 111.24''$.

All used techniques to derive the CR give consistent results. The spiral arms of the galaxy are not located at the OLR but at the external resonance 3:1. The observed feature ("shoulder") in the luminosity profile of NGC 7479 perpendicular to the bar is centered in the region corresponding to the CR. It is then unlikely that it is related to the presence of an annular structure.

References

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