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FOURIER ANALYSIS OF A SPIRAL GALAXIES SAMPLE: DETERMINATION OF KINEMATIC AND MORPHOLOGICAL PARAMETERS

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RESUMEN

Presentamos resultados parciales de un trabajo mas extenso que busca determinar las corrotaciones en una gran muestra de galaxias espirales del tipo *grand design*. Hemos buscado resonancias de corrotación (**CRs**) en cinco galaxias espirales del hemisferio norte: NGC 266, NGC 1520, NGC 1530, NGC 2543 y NGC 7479. Podemos descartar algunos de valores de **CRs** detectados cuando percibimos la presencia de bandas de polvo en barras, están asociados con características locales o simplemente existe una baja relación señal-ruido en tales regiones. Detectamos dos **CRs** en NGC 2543 y NGC 7479. Por medio de la transformada de Fourier bidimensional determinamos las componentes principales del espectro de Fourier y el ángulo de avance de los brazos espirales para 19 galaxias de nuestra muestra. En todas las galaxias el modo m=2 es el más importante. Sin embargo, detectamos la presencia del modo m=3 en 5 de tales galaxias (NGC 151, NGC 1241, NGC 4254, NGC 5427 y NGC 7753). No encontramos correlación entre el ángulo de avance de la componente principal de las galaxias y su tipo morfológico.

ABSTRACT

We present partial results of a larger work searching for corotations in a large sample of grand design spiral galaxies. We have searched for corotation resonances (**CRs**) in five northern spiral galaxies: NGC 266, NGC 1520, NGC 1530, NGC 2543, and NGC 7479. We can reject some detected **CRs** values in those galaxies when we perceive dust lanes in bars, we can asociate the (**CR**) with local features or simply there is a low signal-noise in these regions. We have detected two **CRs** in NGC 2543 and NGC 7479. Using the 2D Fourier technique we have determined the main spectrum components for the spiral pattern and the pitch angles of the spiral arms for 19 galaxies of our sample. In all the galaxies the m=2 mode is the most important one. However, we have detected the presence of strong m=3 modes in five galaxies of our sample (NGC 151, NGC 1241, NGC 4254, NGC 5427, and NGC 7753). We did not find correlation between the main pitch angle of the galaxies and the morphological type.

Key Words: **GALAXIES: KINEMATICS AND DYNAMICS — GALAXIES: SPIRAL — GALAXIES: STRUCTURE — METHODS: NUMERICAL**

1. INTRODUCTION

Shock-induced star formation in a stellar density wave scenario produces an azimuthal spread of ages across the spiral arms. At the **CR**, the angular velocity of the perturbation (Ω_p) and that of the stellar disk (Ω) coincide. A comoving observer at the **CR** will see outward and inward the shock front change from one side of the spiral to the other, consequently reversing the order in which young and older disk stellar populations appear in azimuthal profiles across the arm.

2. THE METHOD

In order to detect the shock front jump, we analyze the relative behavior of the spiral density wave and shock front phases, Θ_{dw} and Θ_{sf}, respectively, by means of the Fourier transform of azimuthal profiles $I_r(\theta)$ given by:

$$F_2(r) \;=\; \int_{-\pi}^{+\pi} I_r(\theta) e^{-2i\pi} d\theta \qquad (1)$$

The phase $\Theta(r)$ can be obtained for m=2 as:

$$\Theta_2(r) \;=\; tan^{-1} \frac{Re[F_2(r)]}{Im[F_2(r)]} \qquad (2)$$

where Re and Im mean the real and imaginary parts of the complex Fourier coefficients (Puerari & Dottori, 1997).

3. OBSERVATIONS

The galaxies presented in this work were observed in 1998 November at INAOE (Cananea) 2.11 m telescope. For each galaxy, one image in B and three images in I filters were taken. The standard reduction was carried out using the IRAF package.

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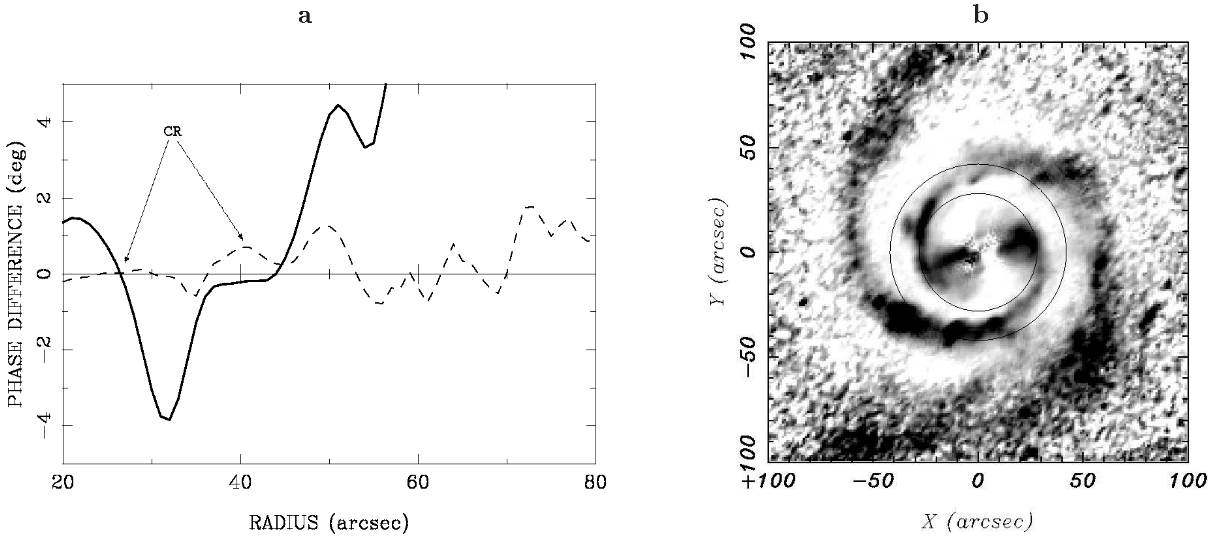

Fig. 1. NGC 2543. (a) azimutal profile phase difference (APPD). The two arrows shows the loci of the **CR**s. The dashed line represent the I noise. (b) B image with circles pointing the **CR**s.

Since our focus is morphology, no calibration was required. As first step, all images were centered using field stars. Thereafter, field stars were removed using IRAF imedit task, and then we deprojected the galaxy images. In order to enhance the perturbation over the galaxy disks, we substract the mean radial light profile and then we normalize the rms variation of the intensity at each radius to a constant value throughout the image (Vera-Villamizar et al., 2001, Elmegreen et al., 1992).

4. COROTATIONS

In Figure 1 we present the azimutal profile phase difference (APPD, see Vera-Villamizar et al., 2001) diagram and the B image of NGC 2543 showing the **CRs** radii. In this case we have two **CR**s located at 27 and 43 arcsec. We assume that an azimuthal profile phase difference that locally reaches values larger than 3σ constitutes a real signal. We present in Table 1 the **CR**s values for the five galaxies analyzed and the arm character (leading or trailing) at **CR**.

5. M=3 COMPONENT

We follow EEM92 (Elmegreen et al., 1992) procedure to detect 3-fold symmetries. In our case, we detect the presence of a strong m=3 component in five galaxies of our sample (NGC 151, NGC 1241, NGC 4254, NGC 5427, and NGC 7753).

TABLE 1

COROTATION VALUES

Galaxy	First **CR** (")	Second **CR** (")
NGC 0266	42^T	...
NGC 1530	77^L	...
NGC 2543	27^L	46^T
NGC 5020	48^L	...
NGC 7479	18^T	44^L

[L]Leading character at the **CR**.
[T]Trailing character at the **CR**.

6. PITCH ANGLES

We use the main pitch angle of the principal component obtained from the 2D Fourier transform computed in all the 19 galaxies of our sample to search for a correlation between the morphological type. We do not found a clear tendency showing that the later morphological types were more open.

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