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SPIRAL STRUCTURE IN NGC 1566

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RESUMO: É feita uma análise de Fourier da distribuição de regiões H II de NGC 1566 em termos de espirais logarítmicas. Primeiramente, o método é usado para determinar o angulo de posição P.A. e a inclinação ω da galáxia. A decomposição em componentes espirais revela que a componente de 2 braços é dominante. Calculamos as superfícies de densidade para reconstituir a galáxia usando as componentes mais importantes.

ABSTRACT: A Fourier analysis of H II regions distribution of NGC 1566 in terms of logarithmic spirals is done. Firstly, the method is used to determine the position angle P.A. and the inclination ω of the galaxy. The decomposition into individual spiral components shows that two-armed component is dominant in this galaxy. We calculate the surface density to reconstitute the galaxy using the most important components.

Key words: **GALAXIES-PHOTOMETRY – GALAXIES-SPIRAL – GALAXIES-STRUCTURE**

I. INTRODUCTION

H II regions are considered good tracers of structures in discoidal galaxies, although the interpretatic of their distribution is not always straightforward, as happens in the case of NGC 4321 (Anderson *et al.* 1983, Elmegree and Elmegreem 1987). With respect to the spiral pattern suggested by the first sight analysis of many discoidal galaxie does it represent a real structure or does it show only a subjective evaluation of the observer? It is a major questic to understand the behavior of the prestellar matter and the processe of global star formation across and around disk Many authors faced this problem studying H II region distributions (Kennicutt and Hodge 1976; Boeshaar and Hod; 1977; Bonnarel *et al.* 1986; Sérsic and Calderón 1978; Simien *et al.* 1978; Comte and Duquennoy 1982 among other:

Kalnajs (1975) suggested the spatial Fourier analysis as an objective method of retrieving informatic about periodicities of H II regions distributions. Iye *et al.* (1982) and Considère and Athanassoula (1982, 1988, hereaft CA82 and CA88) used extensively this method.

We analyse in this paper the distribution of 418 H II regions of NGC 1566 (Comte and Duquennoy 198 using a 2-D Fourier routine following the algorithm outlined by CA82 and CA88.

In section II we present the mathematical formulation of 2-D Fourier method, and in section III we gi our results and discussion for the analysis of this galaxy. Finally, conclusions are given in section IV.

II. DATA PROCESSING

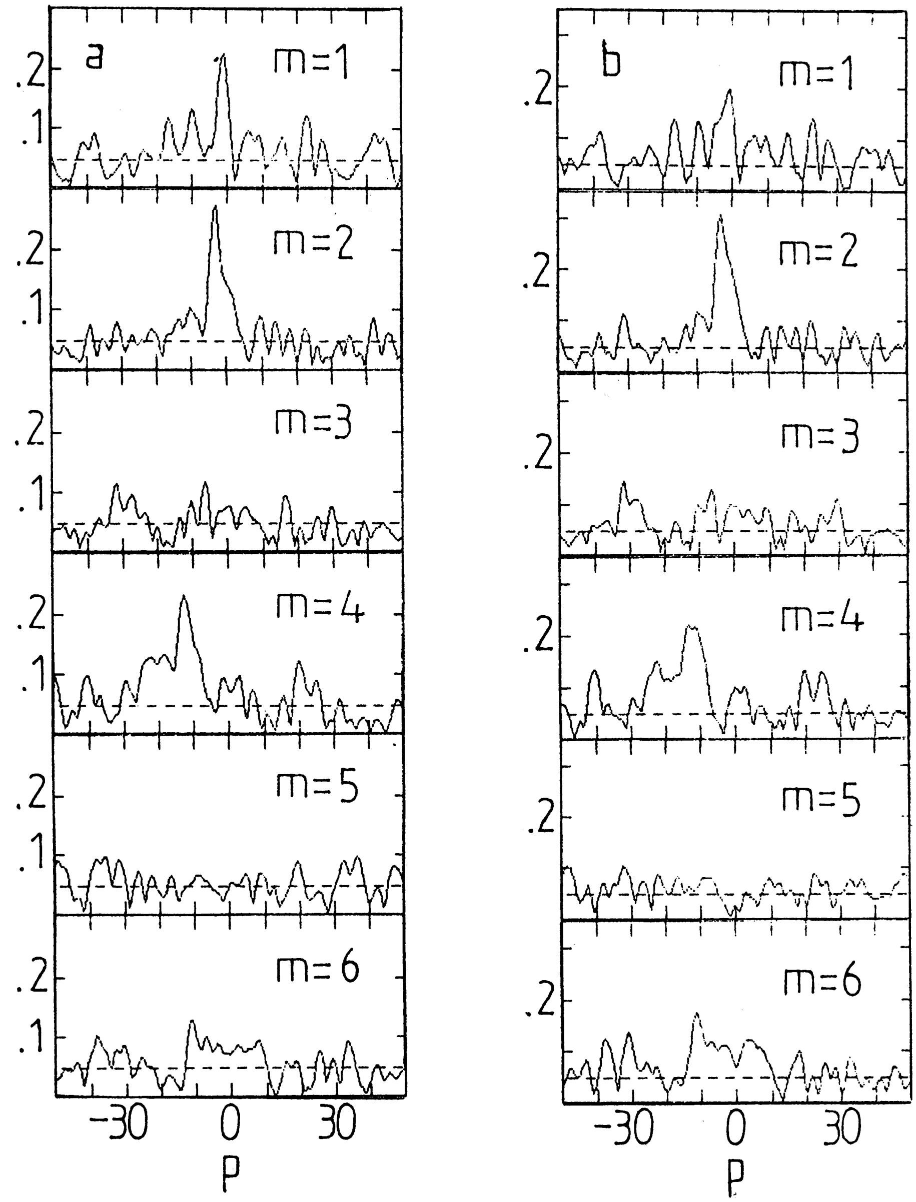
Following CA88 the Fourier transform of N coplanar points, with coordinates r_j and θ_j, and weight w is:

$$A(p,m) = \frac{1}{\sum w_j} \sum_{j=1}^{N} w_j \, exp - \left[i(pu_j + m\theta_j)\right] \qquad ($$

where $u_j = \log r_j$, p and m are the conjugated variables of u and θ and $A(p,m)$ are the complex Fourier coefficients.

The $|A(p,m)|$ for $m = 1$ to 6 and $-50 \leq p \leq 50$ (in 0.5 steps) are shown in Figure 1. The effect of weighting tl position of each H II region with its respective diameter is shown in the Figure 1*b*. The difference with an unweighte distribution (Figure 1*a*) is discussed in section III.

1. CNPq Fellowship.



;. 1. *a*) The Fourier spectra of NGC 1566 for unweighted H II regions. *b*) The Fourier spectra with the H II regions weighted by their ımeters. Note that larger pitch angles are favoured.

The complex functions $A(p,m)$ are used to calculate the complex surface density $S(u,\theta)$:

$$S(u,\theta) = \sum_m S_m(u) exp[im\theta] \qquad (2)$$

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$$S_m(u) = \frac{\sum w_j}{exp(2u)4\pi^2} \cdot \int_{-\infty} G_m(p) A(p,m) exp[ipu]\, dp \qquad (3)$$

and

$$G_m(p) = exp\left[-\frac{1}{2}\left(\frac{p - p_{max}}{25}\right)^2\right] \quad (4)$$

is a high frequency filter, being p_{max} the value of p for which the spectrum of a given m is maximum.

The function $S_0(u)$, which is θ independent, gives the radial distribution of H II regions (Figure 2).

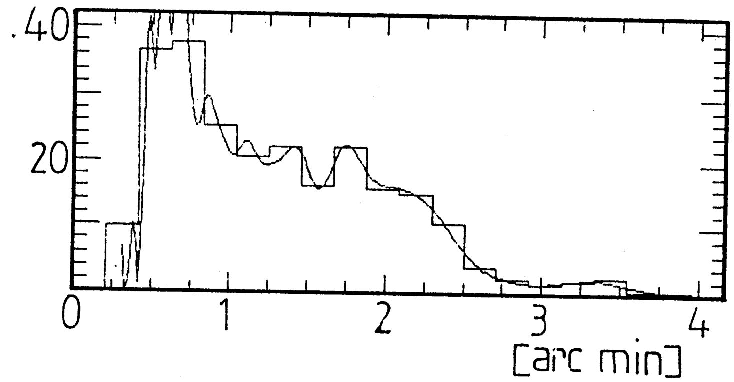

Fig. 2. The surface density function for m=0 plotted over the radial distribution in the plane of the NGC 1566 in number of H II regions pe square min.

In Figure 3 we plot the $S_m(u)$ function for m = 1 to 6, that shows at which radius each m component i dominant.

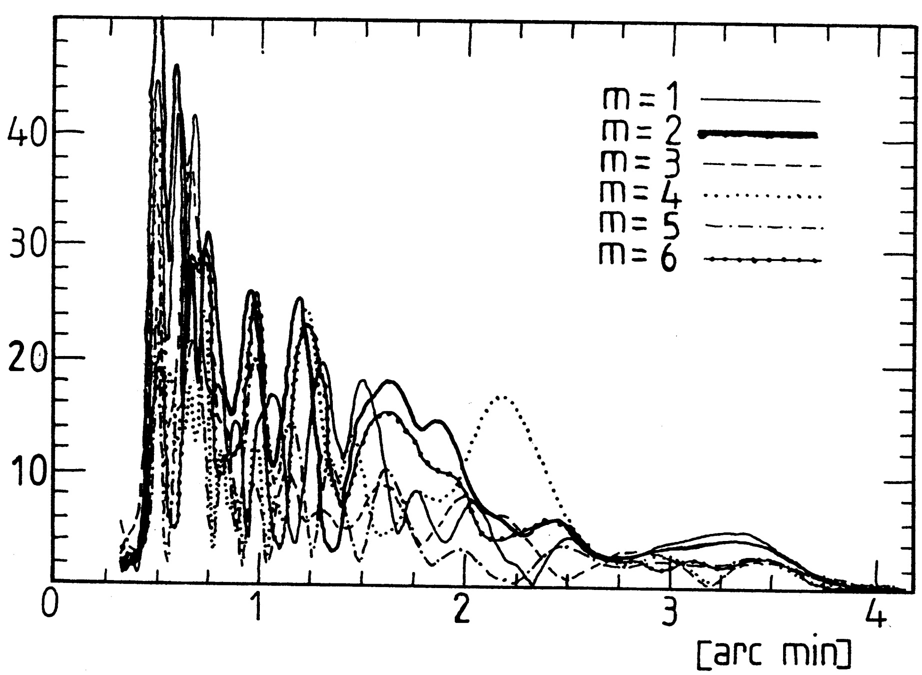

Fig. 3. The surface density functions of NGC 1566. Note that m = 1 dominates at larger radii (this component indicates the asymmetry of the southern arm).

The real part of $S(u,\theta)$ (equation 2) represents the distribution in the real 2-D space. In Figure 4*b* we illustrate the $m=2$ component of this function and in Figure 4*c* the sum of the main components, which can be compared with the real distribution of H II regions (Figure 4*a*).

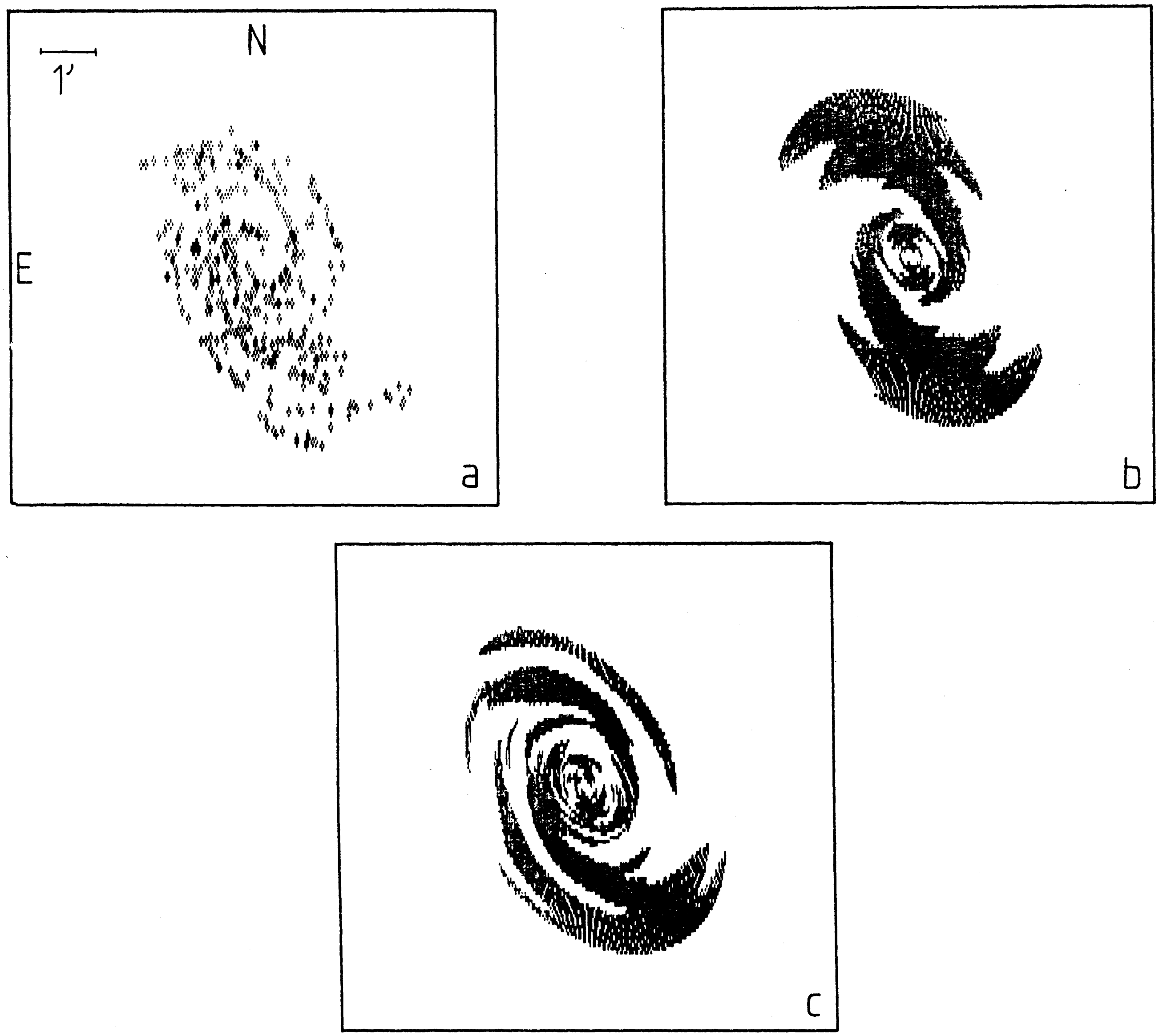

Fig. 4 *a*. The galaxy. *b*) $m = 2$ component. *c*) Sum of main components ($m = 1, 2$, and 4).

The inclination ω and the position angle P.A. for the disk were obtained by calculating the $A(p,2)$ spectrum for all possible values of ω and P.A. in 1° steps, choosing the values corresponding to the lower S/N of $A(p,2)$ spectra (CA82).

III.RESULTS AND DISCUSSION

We found for NGC 1566 ω=48°, P.A.=30° and the main component pitch angle i = 29.7° ($\tan$ i $= -m/p_{max}$ (C A82)). These values are in good agreement with Comte and Duquennoy (1982) determination.

By weighting the position of each H II region with its own diameter, we note that larger pitch angles are favoured, as can be seen in Figure 1*b* with respect to Figure 1*a*, that means that largest H II regions are located in the outer part of the arms.

As shown in Figure 3, $m = 1$ dominates the distribution at radii (r) larger than 3 arcmin, which indicates the asymmetry of the southern arm. For radii $3 \geq r \geq 1$ arcmin the even components are dominant, with particular detach for $m=2$ at $1.5 \leq r \leq 2$ arcmin and for $m = 4$ at $2 \leq r \leq 2.5$ arcmin. The zone $r \leq 0.75$ arcmin is very noisy without prevailing component, indicating probably the inner Lindblad resonance (ILR).

IV. CONCLUSIONS

We have used a two-dimensional Fourier transform to analyse the H II regions distribution in NGC 1566. It was found that:

1. $m = 2$ is the main component.
2. The largest H II regions are located in the outer part of the arms.
3. The southern arm asymmetry is indicated by the prevalence of the $m = 1$ component at larger radii.
4. Inner Lindblad resonance (ILR) is located at $r \approx 0.75$ arcmin.

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