Abstract. Azimuthal profiles of the spiral NGC 7479 in the $B$ and $I$ passbands have been analyzed using a subset of the azimuthal parameters proposed by Beckman and Cepa (1989), to look for the presence of shock fronts in the arms, as predicted by the density wave theory. The sign of the skewness parameter, showing that beyond the corotation radius the concave side of the southern arm shows steeper profiles in both colours, is an indicator that the arm studied is a ‘leading’ structure. We also measure a colour gradient in the arm, with the $B$ intensity peak of the profile nearer to the shock front than the $I$ peak. The measured angular shift, when converted to time drift assuming that the bar ends near the corotation radius, is consistent with the drift expected for an ‘ageing’ stellar population.

1. Introduction

Spiral arms are the most characteristic non-axisymmetric features in ‘normal’ spirals. A full photometric analysis of spiral structure should involve azimuthal photometric profiles. However, azimuthal photometric profiles have not been so widely analyzed as radial ones. In fact, the only parameter usually employed in almost every study of this kind is the contrast parameter (Schweizer, 1976; Elmegreen and Elmegreen, 1984, 1985). Nevertheless, following Dixon et al. (1972), in the context of the Spiral Density Wave Theory (SDW), between the Inner and the Outer Lindblad resonances, where spiral density wave can exist (Athanassoula, 1984; Wielen, 1974), the gas, in its differential rotation around the centre of the Galaxy has a linear velocity with respect to the density wave which is in general greater than the sound speed in the interstellar medium (except at the corotation radius, where these velocities are equal). This causes a shock front to develop which should trigger star formation in the spiral arms. According to this model, a sudden luminosity increase due to the triggering is followed, in the drift direction, by a smoother luminosity decrease due to the evolution of the stellar population till the underlying disc luminosity is reached. In the models developed by Dixon et al. (1972) and Schweizer (1976) asymmetric azimuthal profiles are expected, together with colour gradients bluer towards the steeper edges of the profiles (redder in the drift direction). From photographic photometry of a set of galaxies Schweizer (1976) pointed out that most of the profiles were symmetric or that the asymmetries detected changed their sense at increasing radial distance from the centre. This was considered as a failure of the SDW theory predictions, instead of acknowledging that a change of the direction of the
asymmetries would be expected when crossing the corotation radius (see, for example, Johns and Nelson, 1986).

Neither asymmetric azimuthal profiles nor colour gradients in the arms are expected in the context of the Self-Stochastic Propagation of Star Formation (Seiden and Gerola, 1982), which is, together with the SDW (Lin, 1968), one of the most widely discussed theories of arm formation. The method of photometric azimuthal profiles could, in principle, be used to decide whether or not a density wave is triggering star formation in a given galaxy.

The contrast parameter does not provide direct evidence for the existence of shock fronts in the arms. Moreover, the measured colour indices are generally too noisy to detect colour gradients (Schweizer, 1976). For these reasons, and also because of the lack of information due to the use of only the contrast parameter to analyse the azimuthal profiles, we have developed (Beckman and Cepa, 1989) a set of parameters to quantify non-axisymmetric features in azimuthal profiles. We will proceed here to apply two of these parameters, the skewness and the separation of the peak positions of the arms in different bandpasses, to the spiral structure of NGC 7479 in order to look for asymmetric profiles and colour gradients across the arms.

2. Selected Parameters of the Spiral Structure

An azimuthal profile taken at a radial distance \( r \) from the centre of a galaxy represents the flux distribution \( F^\lambda_r \) at a certain wavelength \( \lambda \) of the points \( (i = 1, \ldots, n) \) located at that radius, in the plane of the Galaxy, ordered according to the angle \( (\theta^\lambda_i) \) that each point makes with respect to a defined origin in azimuthal coordinate.

For a particular feature characterized by a flux enhancement, we define \( S^\lambda \), the skewness of the feature by

\[
S^\lambda = \frac{\sum_{i=1}^{n} F^\lambda_i (\theta^\lambda_i - \bar{\theta}^\lambda)^3}{D^\lambda \sigma^\lambda 2^3},
\]

where

\[
F^\lambda \equiv \sum_{i=1}^{n} F^\lambda_i, \quad \bar{\theta}^\lambda = \frac{\sum_{i=1}^{n} F^\lambda_i \theta^\lambda_i}{F^\lambda},
\]

\[
\sigma^\lambda = \sqrt{\frac{\sum_{i=1}^{n} (F^\lambda_i - \bar{\theta}^\lambda)^2}{D^\lambda}}, \quad D^\lambda \equiv F^\lambda - \frac{\sum_{i=1}^{n} (F^\lambda_i)^2}{F^\lambda}.
\]