Hα kinematics of KPG 390.

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Abstract. In this work we present scanning Fabry-Perot Hα observations of the isolated interacting galaxy pair NGC 5278/79 obtained with the PUMA Fabry-Perot interferometer. We derived velocity fields, various kinematic parameters and rotation curves for both galaxies. Our kinematical results together with the fact that dust lanes have been detected in both galaxies, as well as the analysis of surface brightness profiles along the minor axis, allowed us to determine that both components of the interacting pair are trailing spirals.

1 Introduction

Interactions and mergers of galaxies are common phenomena in the Universe. Isolated pairs of galaxies represent a relatively easy way to study interactions between galaxies because these systems, from a kinematical point of view, are simpler than associations and compact groups of galaxies, where so many galaxies participate in the interaction process, that it is difficult to discriminate the role of each galaxy in the interaction. In this work we present scanning Fabry-Perot observations, velocity fields and rotation curves of this interacting galaxy pair. The aim of this study is to perform detailed kinematic and dynamic analysis of NGC 5278/79 (Arp 239 KPG 390) using Hα kinematical data in order to study the mass distribution of this pair of galaxies and to determine the type of spiral arms (leading or trailing) in the galaxy members with the intention, in a future work, of reproduce both its morphology and kinematics with numerical simulations that could shed more light on the interaction process.

2 Velocity fields

The velocity fields of NGC 5278 (primary) and NGC 5279 (secondary) are shown in Fig. [Fig. 1]. The velocity field of NGC 5278 shows a rather smooth behaviour similar to the velocity field of an isolated disk galaxy, mainly in the northern part. This field has an elongated shape and is symmetric in the east-west direction. In the zone of the spiral arm of the primary galaxy of the pair the radial velocity profiles are slightly broader than those in the disk of NGC 5278. For NGC 5279 the outer zones of the disk show the presence of double profiles. This fact means
that the region of double velocity profiles is confined to the periphery of the
disk of NGC 5279. In the disk of NGC 5278 the radial velocity values are in
the range 7400–7860 km s\(^{-1}\). Inside the disk region of NGC 5279 the radial
velocity values are lower (7550-7650 km s\(^{-1}\)) than in the disk of NGC 5278. The
radial velocity of a bridge region next to the disk of NGC 5278 lies in the range
7550-7570 km s\(^{-1}\). Kinematical data and the morphological shape of the pair
indicate that there is a transfer of material between the two galaxies and suggest
that the sense of transference is from NGC 5278 to NGC 5279.

Figure 1. \textit{Left}: Velocity field of NGC 5278 obtained from the FP veloc-
ity cubes with the H\(\alpha\) image isophotes superposed. \textit{Right}: Velocity field of
NGC 5279 obtained from the FP velocity cubes with the monochromatic map
isophotes superposed. The numbers in the color scales are heliocentric sys-
temic velocities in km s\(^{-1}\).

3 Rotation Curves

Following Fuentes-Carrera et al. (2002, 2004) we obtain the rotation curve of
each galaxy. The rotation curve was obtained from the velocity field considering
the points within a given angular sector from the major axis. The main caution is
to exclude those points too close to the minor axis leading to a strong dispersion
of the points of the rotation curve. The rejection of those points guarantee us
the symmetry of both sides of the rotation curve. We can see from the velocity
fields that the inner parts of these two galaxies are not strongly perturbed by
the interaction process, at least up to the radius \(\approx 6\) kpc \((\approx 12''\) for NGC 5278
and \(\approx 5\) kpc \((\approx 10''\) for NGC 5279. Thus we can determine the rotation curve
of both galaxies considering a region of the velocity field within a sector of a
specified angle inside these radii.

4 NGC 5278/79: two trailing spirals

This kinematic study sheds light on the geometry of the galaxy encounter by
determining the real orientation in the sky of the galaxy members as well as
the kind of spiral arms they possess. This later point is not irrelevant in the case of interacting systems where a possibility of having leading spiral arms is open. Following [Sharp & Keel (1985)] there is a criterion that determines if any particular spiral galaxy has trailing or leading arms. This criterion is based on three main clues (receding-approaching side, direction of spiral arms and the tilt of the galaxy, i.e., which side is closer to observer). In our particular case, we have both the kinematic information in order to establish which side of the galaxy is receding and which side approaching, as well as very conspicuous morphological aspects such as well defined spiral arm patterns and the presence of dust lanes in both galaxy members running near the galaxy nuclei. We use this last issue by getting an intensity profile of the galactic nucleus along the minor axis. In this kind of profiles, the nearest side is the steepest one (because of the presence of the dust lane) [Väisänen et al. 2008]. In the case of NGC 5278, the receding radial velocities are in the south-western part, while the approaching radial velocities are at the north-eastern side. From Fig. 4 it is clear that the arms of NGC 5278 are clockwise and the dust lane is located at the concave side of the bulge, thus the northern side is the nearest. This fact is confirmed by the profile extracted along the kinematic minor axis of NGC 5278 (see Fig. 3). From these figures and the above criteria we have decided that NGC 5278 is a
trailing spiral because the sense of rotation is opposite to the direction of the arms. We were able to apply similar arguments to NGC 5279. In this case the receding radial velocities are at the north-eastern side of the galaxy and the approaching radial velocities are at the south-western part. The arms in NGC 5279 are clockwise and the nearest side is the southern side. As in the case of NGC 5278 this fact is confirmed by the profile extracted along the kinematic minor axis of NGC 5279 (see Fig. 3). We can conclude that NGC 5279 is a trailing spiral also because the sense of rotation is opposite to the direction of the arms. A schematic representation of the interaction process is shown in Fig. 4.

![Figure 4. HST image at $\lambda = 8230 \, \text{Å}$ with the F814W filter (Windhorst et al. 2002) together with a schematic picture of the interaction process for KPG 390.](image)

5 Conclusions

In this article we presented Fabry-Perot observations of the isolated pair of galaxies NGC 5278/79 (Arp 239, KPG 390) showing that for an interacting and asymmetric system it is important to have kinematic information of the entire field of the galaxies participating in the interaction process. We will use the kinematic information as a starting point to fit the dark matter component and for preparing future numerical simulations of this pair.

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