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Scanning Fabry-Perot observations of multiple profiles of faint and extended gas in the center of elliptical galaxies

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Abstract. Some elliptical galaxies possess an extended gaseous disk which is usually detected from Hα and [NII] emission. 3-D "Cigale" observations of two of these objects, NGC 1052 and NGC 404, show the evidence of peculiar dynamics a nd in one case multiple profiles of faint extended gas which are probably from different origins. In NGC 1052, the decoupled kinematics of the gas and the stellar systems favors the hypothesis of an external origin of the interstellar matter, while in NGC 404, coherence of the stars and gas axis, as well as the low gas velocity dispersion favors an inner origin of the gas from the stars themselves.

1. Introduction

Gaseous disks have been detected within the last ten years in a number of elliptical galaxies (Demoulin et al., 1984; Trinchieri et al., 1991). An extended emission is frequently observed in the central region by using the CCD image substraction technique (Kim, 1989). Nevertheless, in comparison with spiral galaxies, the content of ionized gas and neutral gas is small, and doesn't fit with the enormous quantity of interstellar gas expected from the star mass loss process.

2. Observations

Previous observations of this type of objects were performed using long slit spectrographs (Demoulin et al., 1984; Bertola et al., 1991). We began an observational program by means of a Fabry-Perot scanning interferometer (FP) which is a very well adapted instrument to map kinematically this kind of objects. At the same time, we get both monochromatic images and emission line profiles. On another hand, spectral resolution of the FP (0.2 Å) allows to observe complex line profiles.

NGC 1052 and NGC 404 were observed in 1992 and 1993 with the "Cigale" scanning FP attached at the 6m of the Special Astrophysical Observatory (Russia). Basic scanning time was 20 seconds and the detector used was a photon counting device, magnetically focussed, which gave 512x512 pixels of 30 microns (Afanasiev et al., 1987). Limit of detection was $10^{17} ergs.cm^{-2}.s^{-1}$.

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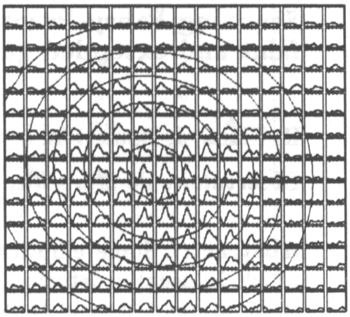

Fig. 1:

NGC 1052 observed of [NII] *6583 A line. One spectrum is 378 km/s wide, starting at 1270 km/s. Each spectrum is superimposed on a 1.25"x 1.25" location. Continum has been sustracted.*

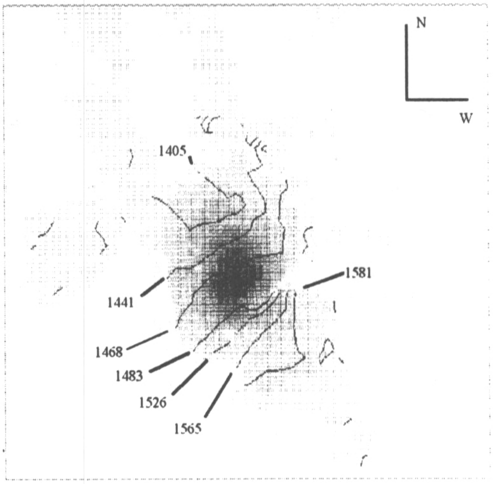

Fig.: 2

NGC 1052 monochromatic map in [NII] *6583 A line. Full image is 40"x40". Superimposed we show isovelocities.*

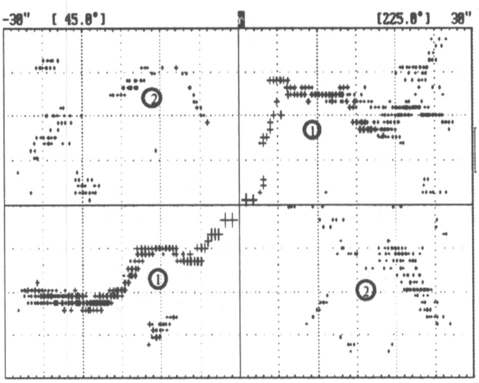

Fig.: 3

NGC 1052 [NII] *velocity cross section in angular sectors 20 ° wide. Two main components can be seen. The PA of this cross section is 45°.*

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3. NGC 1052

NGC 1052 is classified as E4 (RC2) and E3/SO (RSA). NGC 1052 is clearly a "boxy" type elliptical, as seen from the Fourier parameters of the isophotal shape analysis (Nieto et al., 1991). Such a type is likely the result of a strong environmental evolution as a merger (Nieto, 1989). The triaxiallity can be derived and from the apparent ellipticity and isophotal position angles curves with respect to the distance to the center (Nieto et al., 1991). Stellar ellipticity (1-b/a) and major axis position angle at 10" are respectively 0.26 and 113°(Jedrzejewski et al., 1987). A dust lane is also present toward the south direction. Minimum of intensity between these two spots corresponds to the strong dust lane.

Scanning in the [NII] 6583 Åput in evidence a several components of the gas (Fig.1). Such a phenomenum was already observed in NGC 7332 (Fisher and Illingworth, 1992), in which two gas components are counter-rotating with velocities completely decoupled from those of the stars. We can separate 2 main gas components in NGC 1052. None is following the kinematics of the stars.

The main component, extending up to 30" from the center shows a clear rotation with an apparent major axis of 45° +/- 5° (Fig 2). If this component was lying in a thin disk, the apparent inclination will be 50° with respect to the plane of sky. Due to the SW dust lane, extension seems brighter on the NE side. HI rotation major axis is 44° (van Gorkom,et al., 1986), which confirms that ionized and neutral gas have similar kinematics.

A second component appears on velocity cuts through 30° sectors. This component is counter-rotating with respect to the main one (Fig.3) and is usually 10 times weaker. It is also mainly detected in the same directions, with an apparent major axis of 45° +/- 20°. In the center part, the second component is difficult to o bserve but is suspected.

4. NGC 404

NGC 404 is classified as E/S0 (RC2) and SO (RSA). This galaxy is mainly face-on: Barbon et al. (1982) founded an apparent ellipticity (1-b/a) of 0.05 and a major position angle of 100°. NGC 404 is also a galaxy with an important dust lane. Ionized gas was detected by Kim (1989). CO emission up to 20" from the center has been observed (Wiklind and Henkel, 1990).

Fig.4 shows monochromatic map obtained from the scanning in H_α [NII] and [OIII] lines. The [OIII] map presents two spots separated of 12".

Fig.5 is the velocity map of the [OIII] line. Observed Hα and [NII] rotations are similar. Morphology and velocity of this emission doesn't fit with CO observations.

5. Discussion

The two elliptical galaxies NGC 1052 and NGC 404 show similarities as extended ionized emission and dust lanes. They nevertheless differ largely. NGC 1052 presents a completely decoupled kinematics of the gas (ionized and neutral) and of the stars : apparent rotation axis are near ly perpendicular and several gas component are observed. On another hand, gas rotation amplitude is largely

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higher than the one of the stars. On the opposite, NGC 404 has a very slow rotation which is not only explained by the fact that it is face-on and no multiple component is observed. NGC 1052 is part of a cluster and is suspected to have some connection with two nearby spiral galaxies, NGC 1047, located 10' to the W and NGC 1042, located 15' to the SW. HI observations, which put in evidence some tail of the neutral gas to the SW, suggest that this two galaxies could have interact. The external origin of the gas in NGC 1052 could explain the different rotation axis as well as the presence of multiple components with peculiar kinematics each one. In addition higher angular momentum of the gas compared to that of the stars, favors the hypothesis of an external origin of the gas. On the contrary, for NGC 404, which is an isolated galaxy, the narrow profiles and the coherence between the gas and stars rotation axis suggests an inner origin of the gas from the interstellar medium. For NGC 404, Wilkind and Henkel (1990) give some arguments in favor of an origin of the ionized gas from ionization of the neutral gas : first, Bertola et al. (1982) observed that the gas velocity dispersion in ellipticals is systematically lower than that of the stars; second, Tolhine et al. (1982) noted that cold gas remains into a disk configuration only a short time, which can explain that the gas dispersion is lower than that of the stars from where the gas originated.

In conclusion, for NGC 1052, several lines of evidence, including the possibility of past interactions and the decoupling of the angular momenta of gas and stars, suggest the observed gaseous material is acquired from the outside. It the inverse, for NGC 404, which is isolated, different arguments are in favor of an origin of the gas from the evolved stars mass loss.

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Fig.: 4

NGC 404 Hα 6563 A, [NII] *6583 A* [OIII] *5007 A and continuum images. Minimum of intensity between these two spots corresponds to the location of the strong dust lane.*

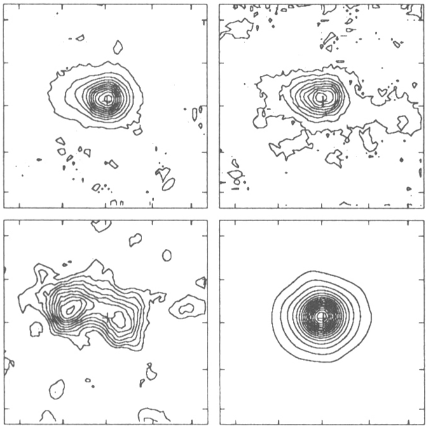
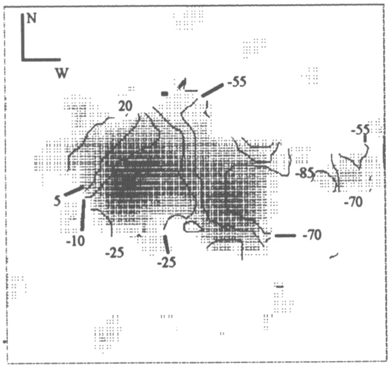


Fig. 5:

NGC 404 [OIII] *monochromatic map, superimposed is shown isovelocities. Full image is 48"48".*



Discussion

J.Bland-Hawthorn: It's important to look for evidence of oval orbit motion in your emission line data. Franx and de Zeeuw have shown that this is what one expects in triaxial potential. When combined with photometric data of isophotal twisting, you may have an interesting constraint on the central mass distribution.

H.Plana: In this paper Franx and de Zeeuw used Stăkel potential, this potential is very useful because it permits to derive analytically gas velocities and it gives oval orbits. The case of NGC 1052 is one of the most interesting because we have un strong velocity gradient and a significant isophotal twisting, and it's a good example for the confrontation with the theory.

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