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Kinematics in Seyfert Galaxies for testing the activity interaction relation

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Abstract. While it is largely demonstrated that interaction can trigger activity, it is not yet possible to estabilish whether there is a one-to-one relation between activity and interaction. Indeed the results of the statistical studies that show an excess of physical companions among Seyfert galaxies are still controversial. In this poster we present our project of a systematic investigation of the global kinematical properties of a sample of nearby ($z < 0.03$) isolated active and non active galaxies aimed at unveiling features caused by past interactions. We show preliminary results about two active galaxies of our sample, NGC 6300 and Mrk 1157.

Key words. galaxies: active – galaxies: kinematics – galaxies: individual (NGC 6300, Mrk 1157)

1. Introduction

In the last years several statistical studies of the large-scale ($\sim$ 100 kpc) environments of Seyfert galaxies have shown that they have an excess of physical companions when compared to control samples of normal spiral galaxies (Dahari 1985; Rafanelli, Violato, & Baruffolo 1995). But these results are still controversial because other studies say that this excess is not statistically significant (de Robertis, Yee, & Hayhoe 1998). This discrepancy is mostly due to the choice of the active and non-active galaxy samples, which is very critical, but problems can also arise from background galaxy removal or from bias in redshift between the compared samples (Laurikainen & Salo 1995). Nevertheless several other clues have been produced toward the evidence of a strong interaction-activity connection evidence by mean of the identification of major or minor mergers in Seyfert galaxies, even when apparently isolated (see eg. Rifatto et al. (2001); González Delgado, Arribas, Pérez, & Heckman (2002)). Therefore if it is generally accepted that interaction can trigger activity, it is still not possible to estabilish a one-to-one relation between activity and interaction, and further studies are required.

2. Our project

Our project consists of a systematic investigation of the global kinematical properties

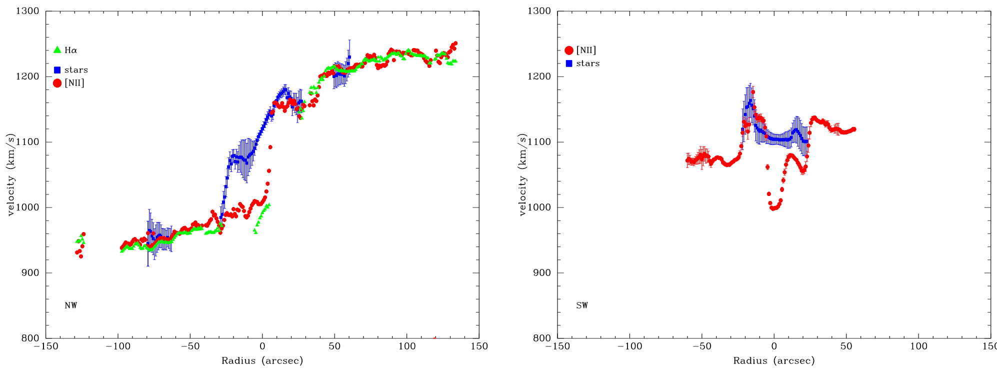

Fig. 1. NGC6300 rotation curves for gas and stars at PA=298° (left) and PA=208° (right)

in a sample of nearby ($z < 0.03$) isolated active and non active galaxies.

This kind of research, not carried out till now, is expected to unveil features likely caused by past interaction, as kinematical decoupling of gas and stars (Galletta 1996), presence of double nuclei, rings and asymmetries, etc. Since these features can be either restricted to the nuclear region or have kpc-scales (Bertola et al. 1996) , our study will take advantage from different and modern techniques of observation, which will support the classical long-slit spectroscopy, as Integral-Field and Fabry-Perot spectroscopy.

In the following we present preliminary results about two spiral galaxies: NGC6300 and Mrk 1157

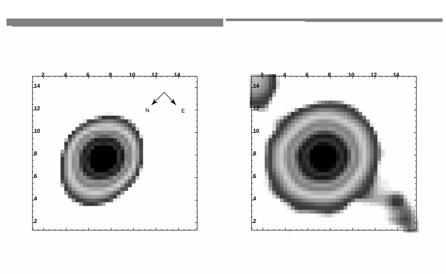

Fig. 2. Mrk1157. MPFS flux maps for [O III] λ5007 (left) and Hα (right)

3. NGC 6300

NGC 6300 is a nearby spiral galaxy ($z = 0.0037$) classified like SB(rs)-type and hosting a Seyfert 2 nucleus (Phillips, Charles, & Baldwin 1983). This galaxy is characterized by a relatively weak bar and a strong spiral inner pseudoring that is misaligned with the bar axis by nearly 80° . This misalignment is unusual for ringed barred galaxies and indicate a possible different pattern speed from that of the bar (Buta 1987; Buta et al. 2001).

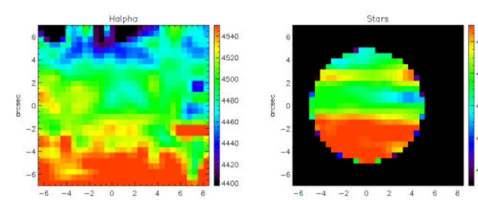

Fig. 3. Mrk1157.MPFS velocity fields inferred from Hα (left) and Stars (right)

Buta first noted that the kinematical center of this galaxy is displaced from photometric center. With HI observation Ryder et al. (1996) found the evidence of a warping in the outer H I disk. The galaxy was observed with the Double Beam Spectrograph mounted at the 2.3 m telescope of Siding Spring Observatory

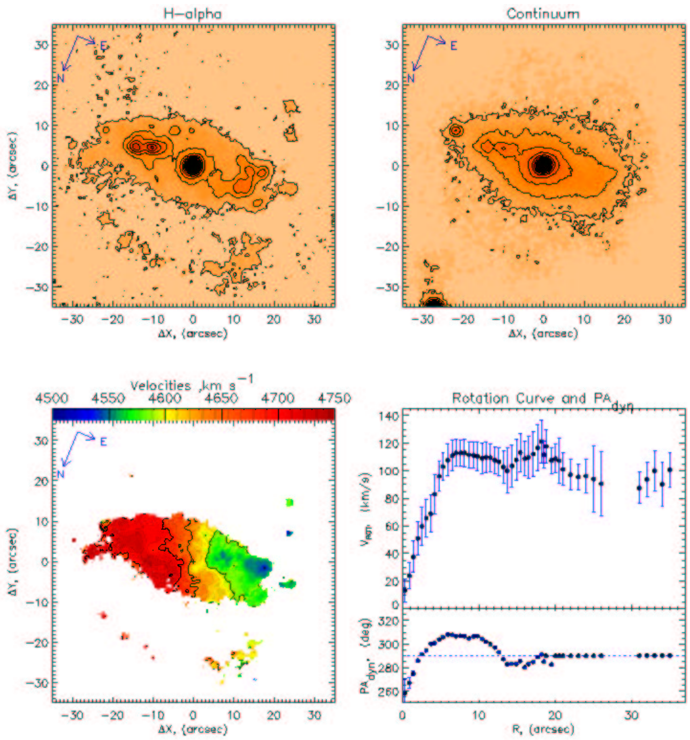

Fig. 4. Mrk1157. Flux maps and velocity field for IFP data

(Australia) in June 2000. The gratings for the blue and red arms gave a resolution of 160 km/s and 92 km/s respectively . We obtained data at four position angles (PA): 3x1500 sec at $PA = 163°$ and $PA = 208°$, and 2x1500 sec at $PA = 298°$ and $PA = 73°$. After standard data reduction, spectra were binned over 3 pixels (2.7 arcsec) along the spatial direction. The gas kinematics was carried out using semi-automatic procedures developed by us in IRAF environment. The stellar kinematics was carried out using the cross-correlation method Tonry & Davis (1979) implemented in FXCOR task of IRAF. Two stellar template spectra were correlated with the galaxy spectra in the wavelength range around MgI λ5175 absorption lines. The preliminar analysis shows that gas velocity curve is not symmetric with respect to the photometric center (Fig. 1a), where a clear difference of ∼100 km/s exists in comparison with values given by the stellar kinematics. Moreover around the minor axis strong non-circular motions of the gaseuos component are present (Fig. 1b).

4. Mrk 1157

Mrk 1157 is an early-type barred spiral galaxy classified as (R')SB0/a (z=0.015) hosting a Seyfert 2 nucleus. Broad-band color maps show a blue ring displaced along the bar and a large arc extending to the north (Mulchaey, Wilson, & Tsvetanov 1996). Our data were obtained with the Multi Pupil Fiber Spectrograph (MPFS) and Fabry-Perot Interferometer mounted at BTA 6 m telescope of Special Astrophysical Observatory (Russian Academy of Sciences). The MPFS has a 16 x 15 lenses array with sampling of

1 arcsec per lens, joined to a bundle of optical fibers . A group of 8 fibers displaced at 4 arcmin from the field of view is dedicated to the sky observation. Mrk 1157 was observed in September 2000 under 2 arcsec seeing conditions and with spectral resolution of $\sim$ 5Å. Data reduction was made by means of a dedicated software developed at SAO by the scientific group chiefed by Prof. V. Afanasiev (RAS). The intensity and velocity maps of ionized gas was reconstructed with routines developed by us in IRAF enviroment. The $H\alpha$ intensity map (Fig. 2b) cleary shows two emission regions at the end of the bar, likely site of star formation episodes, while the [O III] λ5007 map (Fig. 2a) indicates that this emission is limited to the nuclear regions with a slightly elongation toward North direction. Velocity field of gas (Fig. 3a) was obtained by means of gaussian fitting of Hα emission line in each spectrum where it was detectable.

For stellar kinematics we followed the same method applied to NGC 6300, but using as template a twilight sky-flat spectrum. The stellar velocity field was then recostructed (Fig. 3b). At first glance both gaseous and stellar kinematics seems to have a similar behavior, but further analyses are required. The Fabry-Perot data were obtained in September 2002. They were reduced recently and the data are still under analysis. The observed shift of about 100 km/s of systemic velocity with respect to MPFS data is an instrumental artefact. Non-circular motions of HII regions at the bar ends perturbed the gas velocities and produce a peak of rotation curve at radial distance r$\sim$ 18 arcsec.

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