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Velocity Fields of Spiral Galaxies in z∼0.5 Clusters

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Abstract. Spiral galaxies can be affected by interactions in clusters, that also may distort the internal velocity field. If unrecognized from single-slit spectroscopy, this could lead to a wrong determination of the maximum rotation velocity as pointed out by Ziegler *et al.* 2003. This parameter directly enters into the Tully–Fisher relation, an important tool to investigate the evolution of spiral galaxies. To overcome this problem, we measure the 2D-velocity fields by observing three different slit positions per galaxy using FORS2 at the VLT providing us with full coverage of each galaxy and an adequate spatial resolution. The kinematic properties are compared to structural features determined on the HST/ACS images to assess possible interaction processes. As a next step, the whole analysis will be performed for three more clusters, so that we will be able to establish a high-accuracy TFR for spirals at z∼0.5.

Keywords. galaxies: kinematics and dynamics, galaxies: spiral, galaxies: clusters: individual (MS 0451.6-0305)

Overview: We describe here the analysis of both gaseous and stellar kinematics of ∼20 spiral galaxies in the cluster MS0451-03 at $z = 0.54$ explaining the steps that have been done so far to get a Tully–Fisher relation for that cluster.

Gas Velocity Fields: Spectra of three slits parallel to the photometric axis of each galaxy were obtained using MXU masks with FORS2 at the VLT exhibiting several emission lines. For each line and for each slit position, a position-velocity diagram was extracted. This information was converted to a single coordinate system to construct the velocity field taking into account the small difference in the positioning of the 3 masks compared to each other (figure 1 (*a*)).

Kinematic Analysis: First, we determined the central coordinates, using the assumption that the velocity gradient is maximum at the kinematic center. The kinemetry method (Krajnović *et al.* 2006) then allows to derive the kinematic axis, that can be different from the photometric one (figure 2). We quantify deviations from circular motion in inclined disks using a high-order Fourier analysis.

Photometric Analysis: Structural parameters were derived on HST/ACS images in the I band fitting the 2D surface brightness of each galaxy using GALFIT (Peng *et al.* 2002). These are needed for the derivation of the maximum rotation velocities. For each galaxy we fitted a Sérsic bulge and an exponential disk. Residual images are analyzed to look for spiral arms, bars and tidal features. Exploiting additional ground based photometry, we determine the rest frame B band luminosity, the second parameter of the Tully–Fisher relation.

Analyzing Stellar Component: For some of the galaxies we were able to measure the strength and position of strong absorption lines. For these, we have also extracted the

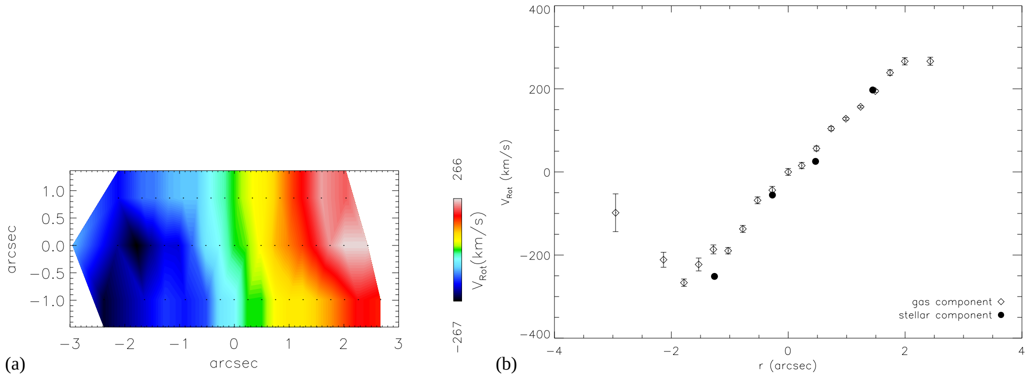

Figure 1. (*a*) The [OII] velocity map of a galaxy in cluster MS0451-03 constructed using the position-velocity diagrams obtained from 3 slits (*b*) Stellar and [OII] gas position-velocity diagrams of the same galaxy plotted on top of each other

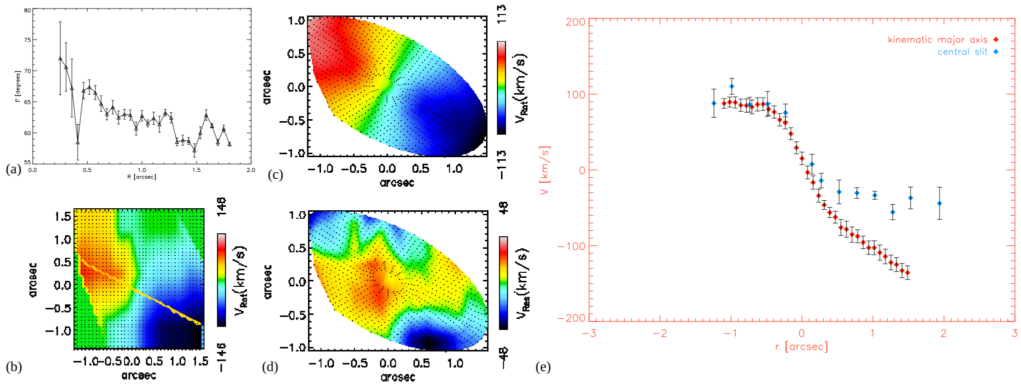

Figure 2. Some results from a kinemetric analysis of the Hβ velocity field of a background galaxy at z≈0.58. (*a*) The kinematic position angle as a function of radius (*b*) The kinematic major axis (defined as the median PA) plotted on the velocity map (*c*) A simple 2 dimensional kinematic fit (obtained fixing PA & ellipticity and excluding the higher order Fourier terms) (*d*) Difference between the observed velocity map and the simple kinematic fit (*e*) The position-velocity diagram extracted along the central slit together with the position-velocity diagram extracted along the kinematic major axis

stellar rotation curves (figure 1 (*b*)). This was done using the PPXF software (Capellari & Emsellem 2004) and the MILES stellar library (Sánchez-Blázquez *et al.* 2006). From the best fitting mix of stellar templates, we can also investigate the star formation histories (average ages) of the stellar populations of those galaxies.

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