A KINEMATICALLY DECOUPLED COMPONENT IN NGC4778

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We present a kinematical and photometrical study of a member, NGC4778, of the nearest (z=0.0137) compact group: Hickson 62. Our analysis reveals that Hickson 62a, also known as NGC4778, is an S0 galaxy with kinematical and morphological peculiarities, both in its central regions (r < 5″) and in the outer halo. In the central regions, the rotation curve shows the existence of a kinematically decoupled stellar component, offset with respect to the photometric center. In the outer halo we find an asymmetric rotation curve and a velocity dispersion profile showing a rise on the SW side, in direction of the galaxy NGC4776.

1. Introduction

1.1. Compact Groups

Poor groups of galaxies are the most common cosmic structures and contain a large fraction of the galaxies present in the universe. At a difference with rich clusters, they span a wide range of densities, from loose groups, to compact ones. For this reason, they are the ideal ground where to test all scenarios for galaxy formation and evolution and where to pinpoint the details of the physics controlling galaxy interactions.

Many factors converge in identifying compact groups as good candidates to be one of the regions where some of this preprocessing occurs. First, their high spatial density of luminous matter and small velocity dispersions imply dynamical lifetimes of the order of a fraction of the Hubble time. This leading to the possibility that the groups observed in the present time and in the local universe are second generation objects, just accreting new members from the loose groups of galaxies in which almost always they are embedded. Second, compact groups are numerous and contain a non negligible fraction of the baryonic matter in the nearby universe. Therefore, whatever is their ultimate fate, they are bound to have an impact on the observable properties of galaxies and cosmic structures.

Our understanding of the dynamical and evolutionary status of compact groups
still presents quite a few gaps. In this respect, to study the dynamical and evolutive status of a group two observables are crucial: the detailed kinematics of the individual galaxies and the structure of the diffuse hot gas halo. In this work we focus mainly on the peculiar kinematics and on the photometry of the dominant galaxy NGC4778 (Hickson 62a).

1.2. HCG62

Hickson 62 is a quartet of four accordant early type galaxies at a redshift of 0.0137. The group is dominated by the pair NGC4778 (HCG 62a) and NGC4776 (HCG 62b). NGC4778 formerly classified as an E3 galaxy, is now classified as an S0 with a bright compact nucleus, and subsequently discovered to be a low luminosity AGN (6 and 5). Both NGC4776 and NGC4761 (HCG62c) are classified as peculiar S0’s. Finally, NGC4764 (HCG62d) is a faint E2 galaxy.

The compact group is also embedded in a bright X-ray halo which extends out to 200 kpc, revealing the presence of a deep common gravitational well and showing the presence of large cavities in the gaseous halo due to the interaction with the central AGN (13).

Several studies show that the pair NGC4778/4776 is not interacting and the kinematical peculiarities observed in NGC4778 are likely due to an interaction with NGC4761. In fact, the velocity dispersion and rotation curves of NGC4776 are well behaved and appear unperturbed, while the velocity dispersion profile of NGC4778 shows a relatively sharp increase to the SE, suggestive of the presence of a perturber.

2. Results

2.1. Photometry

We have used ESO archive CCD images of HCG62 obtained with FORS1 at ESO VLT-UT1 in the Jonson B and R bands. Here we briefly describe and discuss the main features in the light distribution of NGC4778. The photometrical analysis shows the presence of a component with round isophotes for $2'' < r < 12''$. For $r > R_e$, $\epsilon$ increase and the P.A. changes of about 30°, suggesting that the isophotes are more crushed and non-coaxial with the outer one. Moreover, the diskiness has decreasing value with a minimum at 24'', corresponding to the maximum values of $\epsilon$ and P.A. In the nuclear regions the P.A. changes of about 15 – 20°, and $a_4/a > 0$, suggesting the presence of disky isophotes. The mean B-R color profile of the galaxy shows the presence of bluer region in the center of NGC4778. The mean color profile of NGC4778 is consistent with the range of values typical for early-type galaxies (7) and for spheroidal galaxies in compact groups (14).

2.2. Kinematics

The Line-Of-Sight Velocity Distribution (LOSVD) was then derived from the continuum-removed spectra using the Fourier Correlation Quotient (FCQ) method
The rotation curve and the radial velocity dispersion profile along the major axis of NGC4778 are shown in Fig. 1. The kinematic profiles reveal two important features: (i) a counter-rotation in the nuclear region, (ii) at large galactocentric distances (for $r > 2.5''$) the rotation curve and velocity dispersion are asymmetric with respect to the galaxy center.

On the whole, the galaxy presents significant rotation. At large radii the spectrum is contaminated by the light coming from the galaxy NGC4761, therefore the value of $200 \text{ km/s}$ detected for $r = 55''$ cannot be due to the typical motion of the stars in NGC4778. Looking in more detail the nuclear region, for $r \leq 2.5''$ we detect an inversion of the velocity gradient towards the center, with a maximum value of the velocity of $20 - 30 \text{ km/s}$, with respect to the outer radii. This inversion within the central regions with respect to the overall trend, reveals the presence of a counter-rotating decoupled core. In correspondence with the inversion of the velocity gradient, the velocity dispersion profile shows an hint for a local minimum.

Figure 1. Rotation curve and velocity dispersion profile derived for NGC4778 for the whole galaxy extension.

3. Discussion

We observe an inversion in the velocity profile gradient in the center, which also correspond to some anomalous photometric features, such as bluer colors, and twisting in the position angle of the isophotes. These features strongly suggest the existence of a small core ($\sim 600 \text{ pc}$) kinematically decoupled from the whole galaxy.

*Note that the central value is chosen in order to obtain the rotation curve symmetric within 3''.
The rotation curve of NGC4778 is not symmetric with respect to the center, and this is a feature observed in many other compact groups \(^3\). The simulations performed by Combes et al.\(^4\) show that the peculiarities observed in many rotation curves of galaxies belonging to compact groups are due to intrinsic effects and not to contamination along the line of sight.

The asymmetry and the shape of the rotation curve and velocity dispersion profile of NGC4778 do not find correlation with the photometric features of the galaxy, except for the bluer colors in the central region. The absence of correlation between the dynamical and the morphological peculiarities suggests that the dynamical properties of the HCG galaxies may be due to a minor merger event. In fact, as showed by Nishiura et al.\(^9\), weak galaxy collisions could not perturb the galaxy rotation curves, but morphological deformations could be induced in the outer parts of the galaxy (tidal tails, bridges etc), while minor mergers could perturb the rotation curves in the inner regions, especially for gas-poor early-type galaxies, without causing morphological peculiarities.

Acknowledgments

The authors very grateful to R. Saglia. M.S. also wishes to thank the INAF-Observatory of Capodimonte and N. Napolitano. This work was funded through a grant from Regione Campania (ex legge 5) and a MIUR grant. This work is based on observations made with ESO Telescopes at the Paranal Observatories under programme ID <169.A − 0595(C)> and <169.A − 0595(D)>.

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