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Supermassive black holes and dark matter halos

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Abstract. Recently a tight correlation between the bulge velocity dispersion and the galaxy circular velocity has been found for a sample of spiral galaxies (Ferrarese 2002). Since bulge velocity dispersion and circular velocity are related to the masses of the central black hole and dark matter halo respectively, the correlation between velocity dispersion and circular velocity is equivalent to one between the mass of super-massive black hole and dark halo. We explore this correlation by using velocity dispersions and circular velocities derived from stellar and ionized-gas kinematics we measured for a sample of 17 intermediate-to-late type spiral galaxies. We plan now to apply the same analysis to a sample of low surface brightness galaxies.

Key words. galaxies: halos – galaxies: kinematics and dynamics

1. Introduction

Studying the interplay between ionized-gas and stellar kinematics allows to address different issues concerning the dynamical structure of disk galaxies, and to constrain the processes leading to their formation and evolution. These include the study of the mass distribution of the luminous and dark matter, the ubiquity of super-massive black holes, the discovery of kinematically-decoupled components, the origin of disk heating, and the presence of pressure-supported ionized gas in bulges. Recently it has been shown that masses of the central super-massive black holes ($M_\bullet$) and of dark matter halos (M_{halo}) are correlated with the stellar velocity dispersion (σ_c) of the host galaxy (Ferrarese 2002). All these issues (and particularly the relationships involving the measurement of σ_c) will benefit greatly from a survey devoted to the comparative measurement of ionized-gas and stellar kinematics in spirals.

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2. Observations and data reduction

In the past we obtained the stellar and gaseous kinematics for a number of S0's and early-to-intermediate spirals (see Vega Beltrán et al. 2001 and reference therein). Recently we considered intermediate-to-late spirals by selecting a sample of 17 bright and nearby Sb-Sd galaxies. We obtained long-slit spectra along their major axes at the ESO 1.52-m telescope (resolution of 60 km $\mathrm{s}^{-1} \times \sim 1''$). The ionized-gas kinematics was measured from the Hα and

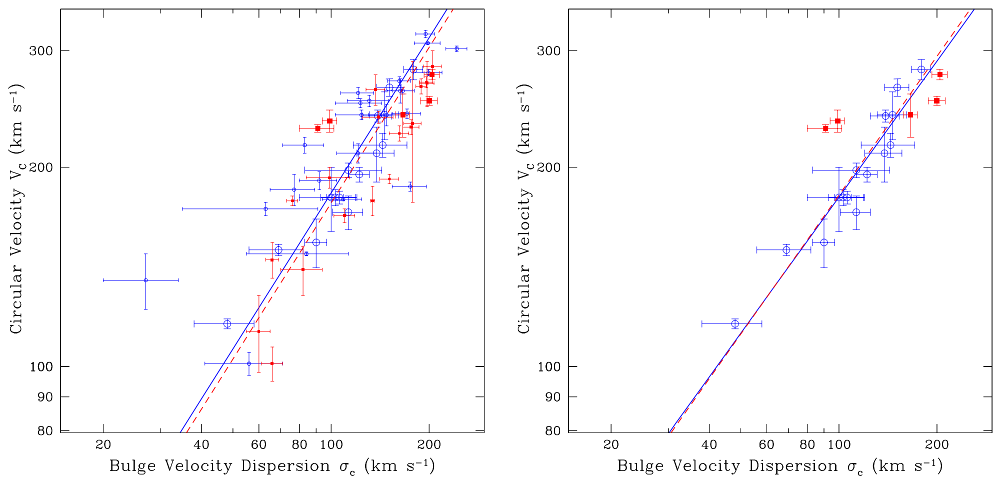

Fig. 1. The correlation between V_c and σ_c for the 37 galaxies of Ferrarese (2002, open circles) and our 17 galaxies (filled squares) is shown in the *left panel*. The solid line corresponds to a fit to Ferrarese's sample, while the dashed line corresponds to a fit to all 54 galaxies. Only galaxies for which the rotation curve extends beyond R_{25} (marked by larger symbols in left panel) are shown in *right panel*. The solid line corresponds to a fit to the 'best' 15 galaxies of Ferrarese's sample, while the dashed line corresponds to a fit including also the 'best' 5 galaxies of the our sample.

[N II]$\lambda 6548, 6583$ emission lines. The stellar kinematics was measured in the region of the Mg triplet (~ 5200 Å) with the Fourier Correlation Quotient method (details are given in Pizzella et al. 2003).

3. The $V_c - \sigma_c$ relation

We derived the disk circular velocity, V_c, and the bulge velocity dispersion, σ_c, as done by Ferrarese (2002). The $V_c - \sigma_c$ relation for a sample of 54 spiral galaxies, including the 37 galaxies studied in Ferrarese (2002) and the 17 galaxies of our sample is shown in Fig. 1 (left panel). The relationship obtained by considering only the 'best' galaxies with data extending at radii larger than R_{25} (and therefore ensuring a most reliable value of V_c) is given Fig. 1 (right panel).

The $V_c - \sigma_c$ relation we found for the extended sample is consistent within errors with that by Ferrarese (2002). The bulge velocity dispersion and the disk circular velocity are related to the mass of the central super-massive black hole $M_\bullet$ (e.g. Ferrarese & Merritt 2000) and dark halo M_{halo} (e.g. Bullock et al. 2001), respectively. This means that the $V_c - \sigma_c$ relation must imply a $M_\bullet - M_{halo}$ relation, i.e. a relationship between the mass of super-massive black hole and the gravitational mass of the host galaxy. We will soon apply the same kind of analysis to low surface brightness galaxies. This class of galaxies have experienced a different stellar formation history with respect to high surface brightness galaxies and therefore may show a different behavior.

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