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Structure and evolution of star-forming gas in late-type spiral galaxies

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Abstract. We study two dimensional Fabry-Perot interferometric observations of the nearby face-on late-type spiral galaxy, NGC 628. We investigate the role of the individual H II regions together with the large-scale gravitational mechanisms which govern star formation and overall evolution in spiral galaxies. Our kinematical analysis (reinforced by literature maps in HI and CO at lower angular resolution) enables us to verify the presence of an inner rapidly rotating inner disk-like component which we attribute to long term secular evolution of the large-scale spiral arms and oval structure. We find that gas is falling in from the outer parts towards the bluer central regions. This could be an early phase in the formation of a pseudo-bulge. We find signatures of radial motions caused by an $m = 2$ perturbation, which are likely to be responsible for the inflow of material forming the circumnuclear ring and the rapidly rotating inner structure.

Keywords. galaxies: evolution, galaxies: structure, galaxies: kinematics and dynamics, galaxies: ISM, galaxies: individual (NGC 628)

1. Introduction

The line-of-sight velocity and velocity dispersion (σ) are important parameters in determining the flattening of the various disc layers, the intrinsic shape of the dark matter component, and the nature and extent of disc-halo interactions. If the gaseous layers in the disc are isothermal, the atomic and molecular gas should have similar scale-heights. However, due to the collective effects of gravitational instabilities, dissipation, and feedback from star-forming regions, the atomic gas has been observed to have a distribution different from that of its molecular counterparts.

2. Our Programme

We have launched an extensive effort to analyse the processes that govern the ionized gas and compare them with those that control the neutral gaseous components in spiral galaxies (see Fathi *et al.* 2007). We use Fabry-Perot interferometry with instrumentation presented in Hernandez *et al.* (2003) and scan the Hα emission-line. Our observations yield the distribution and kinematics of the Hα-emitting gas. Quantifying the kinematic

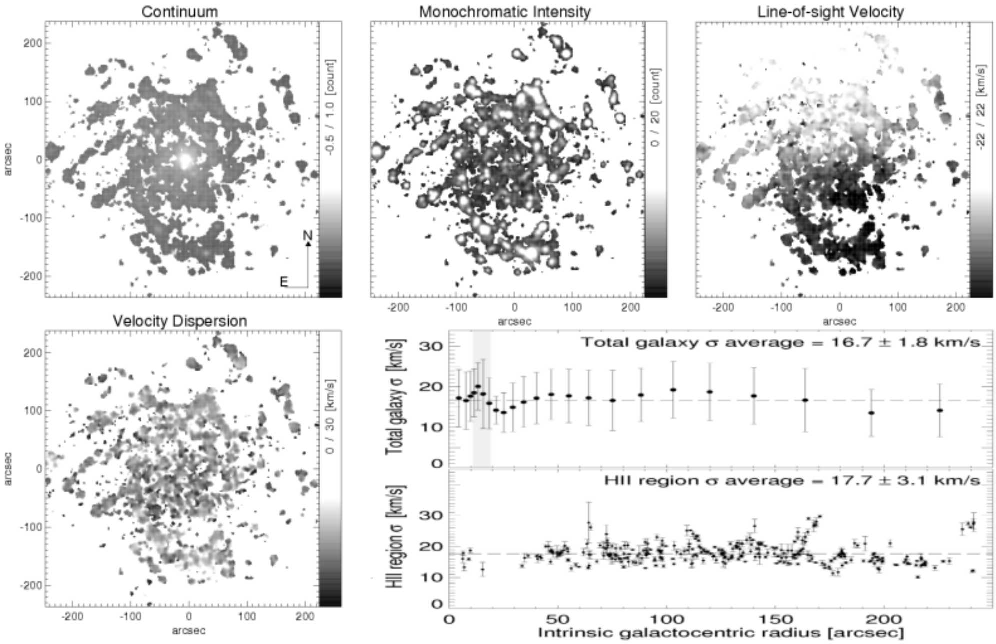

Figure 1. The distribution and kinematics of the Hα emitting gas in NGC 628 (top), and the velocity dispersion map with its galactocentric profile (bottom). The velocity field has been quantified using the harmonic decomposition technique, and the σ of the individual H II regions has been derived after using our H II region catalogue to identify them. (see Fathi *et al.* 2007).

parameters, and comparing with those of the neutral gas will constrain the dynamics of the star-forming regions.

We have chosen NGC 628 for a pilot study in which we demonstrate the power of our state-of-the-art methods to study the properties of the ionized gas (mainly H II regions but also diffuse ionized gas) and their relation with the global kinematic parameters (e.g., Zurita *et al.* 2004, Fathi *et al.* 2005). A key feature of the velocity field of NGC 628 is its regularity. The global effects of any asymmetries, such as the oval distortion, are small, and in any case not very easy to detect in a face-on system. However, our detailed kinematic analysis has revealed the presence of a disc-like component in the inner kpc around the nucleus. The σ map shows widely distributed star-formation in the disc plane, and that the emission from unresolved H II regions probably dominates any emission from the diffuse component. The radial σ-profile shows a nearly constant value of ≈ 17 km/s (more than twice that for the CO and H I) out to 12 kiloparsec. Our findings for NGC 628 are presented in Fig. 1, and summarized in the abstract of this brief article.

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