

Preface

The topic of this thesis is the study of the morphology, kinematics, and star formation of nearby galaxies, aiming to clarify a number of long-standing open questions about their formation, evolution, and physical properties.

First, I have addressed the star formation and its distribution across the Hubble sequence of galaxies. In particular, I have studied massive star formation in elliptical, lenticular, and early-type galaxies. Although these galaxies have generally low gas content and low levels of star formation, there is a significant subset that shows evidence of ongoing star formation in the form of extended UV emission. I have obtained $H\alpha$ imaging of ten such galaxies, finding that in most cases, their star formation rates are comparable to those found in disk galaxies. This is probably because the sample selection is biased toward star-forming galaxies. I confirm that massive star formation causes the extended UV emission in our sample, in the form of outer spiral arms and/or outer (pseudo) rings.

This thesis has been developed in the context of the *Spitzer* Survey of Stellar Structure in Galaxies (S^4G), which has obtained mid-IR images of more than 2350 galaxies in the local Universe. These images and the studies within the S^4G collaboration have been complemented with the ancillary kinematic data obtained within the framework of this thesis. I present a kinematical study of 29 spiral galaxies included in the S^4G sample, using $H\alpha$ Fabry-Perot (FP) data obtained with the Galaxy $H\alpha$ Fabry-Perot System instrument at the William Herschel Telescope in La Palma, complemented with images in the R band and in $H\alpha$. The primary goal is to study the evolution and properties of the main structural components of galaxies through the kinematical analysis of the FP data, complemented with studies of morphology, star formation, and mass distribution. In this thesis, I describe how these data have been obtained, processed, and analyzed. This program of 3D kinematics enables the study of the motions of the ionized gas within the galaxies, including in-depth investigations of the rotation curves, velocity moment maps, velocity residual maps, and position–velocity diagrams.

Galaxy disks are supported by rotation to minimize the total energy when conserving the angular momentum. However, through the evolution of a galaxy,

several processes interfere on the kinematics of the galaxy and provoke deviations from the pure rotation, what we call non-circular motions. In particular, non-axisymmetric structures such as bars are understood to create potentials that influence the way material move toward the center of the galaxy. As a first step to understand the non-circular motions, I present detailed results on the barred galaxy NGC 864 from the kinematical program. I find asymmetries in the velocity field in the bar zone, caused by non-circular motions, probably in response to the potential of the bar.

The study regarding the non-circular motions is expanded to the whole sample of galaxies. In particular, those motions found along the bars and spiral arms. The data indicate that the amplitude of the non-circular motions created by the bar in the $H\alpha$ gas does not correlate with the strength of the bar. The amplitude of those non-circular motions related to the spiral arms does not correlate with either arm class or star formation rate along the spiral arms. This implies that the presence and magnitude of streaming motions in the arms seem to be a local phenomenon. I also study here the global SFRs of the galaxies of the sample, and in particular the star formation within the bar and its relationship with its kinematics.

The dynamics in the central parts of galaxies are influenced by both baryonic matter (gas and stars) and DM. This thesis will try to find out which contribution is more important regarding the dynamics of the central parts of the galaxy. Taking advantage of the high angular and spectral resolution of the kinematic data, I perform a detailed study of the shape of the innermost part of the rotation curve of the sample galaxies. In particular, I quantify the steepness of the rotation curve by measuring its slope. As previously noted in the literature and, in fact, physically intuitive, I find that the compactness of the mass in the central parts of a galaxy (more concretely, the presence of the bulge) is translated into steeper slopes. Otherwise, I find no influence of the degree of secular evolution of a galaxy on the value of the slope, as the presence of the bar and the star formation rate does not correlate with the slope. I find that although the luminous matter dominates the gravitational potential in the central parts of the galaxies, dark matter is also present.

Morphology, Kinematics and Star Formation Across the
Hubble Sequence of Galaxies

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