Properties of Nearby Galaxies

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We investigate properties of galaxies in the nearby universe in order to find clues on the formation and evolution of galaxies. This is in fact one of the most debated topic in modern astronomy. The two competing scenarios that describe the galaxy formation and evolution are the hierarchical clustering and the monolithic collapse. In the hierarchical clustering framework, small galaxies form first and merge continuously to form bigger structures. In the monolithic collapse scenario galaxies formed in a single event, when the protogalactic cloud of gas collapsed in the potential well of the dark matter halo and formed stars and then evolved passively without any major interference from the outside. There is a lively debate in the astronomical community about which of the two scenarios best reproduces the observed galaxies. In fact, while the hierarchical clustering can explain most of the observed properties (i.e. the microwave background and galaxies spatial distribution), the existence of evolved galaxies at z=3 indicates that at least some object evolved passively since that epoch contrarily to the prediction of clustering.
In our research program we investigated aspects of nearby galaxies that gives crucial clues about the above mechanism of galaxy evolution. In particular, we focused on i) the study of the dark matter spatial distribution in galaxies. In the hierarchical clustering picture, the dark matter spatial distribution is strongly constrained. However, there are indications that real galaxies are characterized by a constant density core which is not foreseen in N-body simulations. ii) decoupled components in galaxies may be the relict of acquisition events in the formation history of a galaxy. We studied all possible type of decoupling in order to either constrain the mechanism of merging and to make a statistical study. iii) The presence of super massive black hole in the nucleus of galaxies is also related to the galaxy evolution. We therefore studied the black hole demography, the connection between the black hole mass and dark matter halo mass and the bulge stellar population in disk galaxies.

Project 1: Super massive black holes.
It is commonly accepted that almost every galaxy harbors a supermassive black hole (SMBH) in its nucleus. Observations and theory support the idea that the formation and accretion of SMBHs are closely linked to the formation and evolution of the host galaxy. However, current demography of SMBHs suffers of important biases, which are related to the limited sampling over the different basic properties of their host galaxies. In particular spiral galaxies with an accurate measurement of the mass of the central SMBH are heavily underrepresented. To this aim we analyzed the nuclear spectra of a sample of disk galaxies in order to detect the curcumnuclear keplerian disk signature of the presence of a SMBH. We then selected the best candidates and obtained HST-STIS spectra for three galaxies. In the most interesting object the SMBH mass derived is significatively smaller than what expected from the scaling relations (M_BH-sigma, M_BH – spheroid luminosity). This project merges with project #2 when we study the relation between the M_BH and the dark halo mass.

Project 2: Dark matter distribution in galaxies.
Deriving the properties of the dark matter halo in galaxies is a key step in understanding their formation process. To this aim we measured the stellar and ionized gas kinematics of several disk galaxies ranging from Sa to Sc and from high to low surface brightness, with and without bar. Several proposal have been presented on this subject. We obtainbed a total of about 15 night/year on 4m class telescopes and 3night/year on 8m class telescopes. This large ammount of observing time allowed us to build up a voluminous database of kinematical data. One of the main results obtained in this projects are the detailed mass modeling of a sample of Sa and S0 galaxies deriving the dark matter properties for this class of objects. More recently, we measured, for the first time, the stellar kinematics of low surface brightness galaxies. This result was possible due to the long-time experienc on stellar kinematics measurements in our research group. We found that low surface brightness galaxies have a different V-sigma relation than high surface brightness, indicating that the relation between the dark halo mass and the SMBH may be different in this class of objects.

Finally, we used the Tremaine-Weinberg method to derive the dark matter density radial profile in the central region of barred galaxies finding constant density core profiles.

Project 3: Acquisition phenomena in galaxies.
Hierarchical merging and monolithical collapse are the two main mechanisms that acted in the formation of galaxies. In particular the presence of decoupled components is generaly considered the signature of an acquisition event in the formation history of a galaxy. Decoupling can be either kinematical and photometric. The data obtained in the past five years, allowed us to find and study counterrotating galaxies. NGC 3593 is a typical example. In this object the counterrotating component shows a high star formation rate, indicating that the acquisition took place not far in the past. From the large kinematical database constructed we also extimated the frequency of counterrotation in disk galaxies. When the decoupled component main axis is perpendicular to the host galaxy axis, we have an orthogonal decoupling. This kind of decoupling has been extensively studied by means of minor-axis velocity curves.
We call photometrical decoupling the presence of a component that is photometricaly distinct from the main body of the galaxy. This is the case of the nuclear stellar disks that we found in few elliptical and spiral galaxies. In one case, the external origin of the disk is suggested by its orthogonal decoupling (i.e. it is orthogonal with respect the the galaxy stellar disk). In other cases the external origin is indicated by the disk young stellar population.

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Research Products;
43 refereed articles
32 proceedings
3 book articles
1 monography
2 volumes edited

- Every year the organization of a "Summer Asiago rendez-vous" at the Asiago Astrophysical observatory. The meeting duration is usually of two days.
- Organization of the conference "Galaxy disks and disk galaxies" - Rome, 12-16 June 2000, in collaboration with the Pontifical Gregorian University in Rome, Italy.

List of 5 most representative publications:

1) Morelli L., Halliday C., Corsini E. M., Pizzella A., Thomas D., Saglia R. P., Davies R.L., Bender R., Birkinshaw M., Bertola F. "Nuclear stellar discs in low-luminosity elliptical galaxies: NGC 4458 and 4478" *2004, MNRAS 354, 753*

2) Corsini E. M., Pizzella A., Coccato L., Bertola F. "Minor-axis velocity gradients in spirals and the case of inner polar disks" 2003, A&A 408, 873

3) Pizzella A., Corsini E. M., Morelli L., Sarzi M., Scarlata C., Stiavelli M., Bertola F., "Nuclear Stellar Disks in Spiral Galaxies" 2002, ApJ 573, 131

4) Pizzella A., Corsini E. M., Vega-Beltran J.C., Bertola F., "Ionized gas and stellar kinematics of seventeen nearby spiral galaxies" 2004, A&A 424, 447

5) Corsini E.M., Debattista V. P., Aguerri J.A.L. "Direct Confirmation of Two Pattern Speeds in the Double-barred Galaxy NGC 2950" 2003, ApJ 599, L29