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Stellar Populations in Luminous and Ultraluminous Infrared Galaxies

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Abstract. The goal of this work is to determine the properties of the stellar populations in a sample of LIRGs and ULIRGs. Using the ages as a clock we investigate: a) whether LIRGs-ULIRGs evolve into Radio Galaxies and QSOs; b) whether cool LIRGs-ULIRGs can evolve into warm LIRGs-ULIRGs; c) the merger sequence deduced from the morphological studies is reflected in the properties of the stellar populations. Using evolutionary synthesis models with high spectral resolution stellar libraries we have found that the intermediate age stellar population dominates at optical wavelengths. The stellar population in LIRGs is similar to ULIRGs and ULIRGs-QSOs transition objects.

Keywords. galaxies: stellar populations — galaxies: evolution

1. Introduction

Luminous and Ultraluminous Infrared Galaxies (LIRGs and ULIRGs, respectively) are rare in the local universe, but they were very luminous in the past and they are the most significant contributors to the infrared galaxy population at redshift $\geqslant$1. At the local universe, ULIRGs are primary interacting or merging systems, that are undergoing starbursts and/or fueling an AGN. They are intermediate mass ellipticals in formation. Mergers can drive an evolutionary sequence from cool to warm ULIRGs on the way to the objects becoming QSOs. LIRGs are the majority of the IR-selected galaxies at z$\leqslant$1. At the local universe, the LIRGs density is two order of magnitude higher than ULIRGs. It has been proposed that LIRGs can be the link between normal field galaxies and ULIRGs because many of the properties scale with the far-infrared (FIR) luminosity.

We present here a detailed study of the stellar populations in a sample of LIRGs, and we compare with the results that we have already obtained in a similar work in a sample of ULIRGs (Rodríguez-Zaurín *et al.* 2009a,b). The goal is to investigate whether an evolutionary link exists between LIRGs, ULIRGs, QSOs and normal elliptical galaxies.

2. The Sample and Data

LIRGs have been selected from the IRAS Revised Bright Galaxy sample. They have log $L_{FIR} \geqslant 11.3\ L_{\odot}$. They are nearby, z$\leqslant$0.05. By their emission line spectrum, 60% are HII galaxies, 27% are LINERs, and 9% are Seyfert 2 galaxies.

ULIRGs sample is a complete sub-sample of the 1 Jy catalogue from Kim & Sanders (1998). They are at z$\leqslant$0.13. They are: 28% HII galaxies, 33% LINERs, 30% Seyfert 2 and 8% Seyfert 1 galaxies.

We have obtained long-slit spectra at optical wavelengths at intermediate resolution with the WHT and NOT telescopes in La Palma observatory. The slit was set through the main components (e.g. two nuclei or the nucleus and the brightest stellar cluster). We have also retrieved optical ACS images for most of the LIRGs and some of the ULIRGs that are available at the HST archive.

3. Method and Models

To determine the properties of the stellar populations (age, metallicity, and extinction) we fit the whole optical spectra using the STARLIGHT code (Cid Fernandes *et al.* 2005). The code combines several SSP and provides for each base of a given metallicity a population vector that represents the fractional contribution of each SSP of a given age to the model flux at a given wavelength. The extinction is parametrized by a foreground dust screen, but allows different values of A_V for the young, intermediate ages and old SP. The Calzetti *et al.* (2000) law was adopted. For each set of models at a given metallicity, we have adopted a base that contains 11 SSPs with ages of 4, 10, 25, 40, 100, 280, 500, 900 Myr, 1.27, 5, and 14 Gyr. We have used the high spectral resolution models from González Delgado *et al.* (2005) and Charlot & Bruzual (2009, in prep.). The former uses the GRANADA stellar library (Martins *et al.* 2005) that contains high (0.3 Å sampling) spectral resolution synthetic stellar models covering a wide range of effective temperature (3000-55000 K) and gravity (-0.5$\leqslant$ log g$\leqslant$ 5). The library was implemented in the code SED@ (Cerviño & Luridiana 2006) to predict SSP with the Padova 2000 isochrones and Salpeter IMF. MILES (Sánchez-Blálquez *et al.* 2006) and GRANADA libraries have been implemented in Galaxev (Charlot & Bruzual 2009, in prep.) to predict SSPs with the Padova 1994 isochrones and Chabrier IMF.

4. Results and Conclusions

The main results are: a) The old (age$\geqslant$1 Gyr) SP contributes very little to the total optical continuum. b) Intermediate age SSPs (100-900 Myr) can account for most of the optical light. c) Young age components ($\leqslant$ 10 Myr) are more reddened than the intermediate and old SP d) The extinction is high. The evidence comes from the continuum which is very red, and the NaI line which is very deep indicating that its origin is interstellar. e) There are not significant differences between the SSPs that dominate the optical light of LIRGs and ULIRGs (Rodríguez-Zaurín *et al.* 2009a,b). A more extended explanation and Figures related with these results can be seen in the poster presented in this symposium (it can be download from http://www.bruzual.org/S262_online/).

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