Photometric and Kinematic Characterization of Tidal Dwarf Galaxy candidates

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Abstract Tidal Dwarf Galaxies (TDG), or self-graviting objects created from the tidal forces in interacting galaxies, have been found in several merging systems. This work will focus on identifying TDG candidates among a sample of Luminous and Ultraluminous Infrared Galaxies (U)LIRGs, where these interactions are occurring, in order to study their formation and evolution. High angular resolution imaging from Hubble Space Telescope (HST) in B, I and H band will be used to detect these sources. Photometric measurements of these regions compared to Stellar Synthesis Population models will allow us to roughly estimate the age and the mass. Complementary optical Integral Field Spectroscopy we will be able to explore the physical, kinematic and dynamical properties in TDGs. We present preliminary photometric results for IRAS 0857+3915, as an example of the study that will be held for the entire sample of (U)LIRGs.

1 Introduction

A large fraction of Luminous Infrared Galaxies, LIRGs (L_{IR} = L(8-1000m) = 10^{11} - 10^{12} $L_\odot$), and most Ultraluminous Infrared Galaxies, ULIRGs ($L_{IR} > 10^{12}$ $L_\odot$; see [5]), show signs of mergers and interactions (e.g. [7]). According to models (eg. [2]), knots of star formation outside the nuclei, with masses $\sim 10^8$ - 10^9 $M_\odot$, can be formed from the debris of the interaction : the Tidal Dwarf Galaxies, TDGs. Besides, many knots associated with star formation have already been observed at the outskirts in other merging systems (eg. [1]). (U)LIRGs are the ideal laboratory to study TDG candidates, since they represent one of the most extreme cases of galaxy merging.

Our main goal will be a systematic search for TDG candidates and their physical, kinematic and dynamical study among 34 low z (U)LIRGs. We report on the

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preliminary photometric results for the ULIRG IRAS 0857+3915 (L_{IR} = 12.15 L⊙), which will exemplify the photometry we are carrying out for the complete sample.

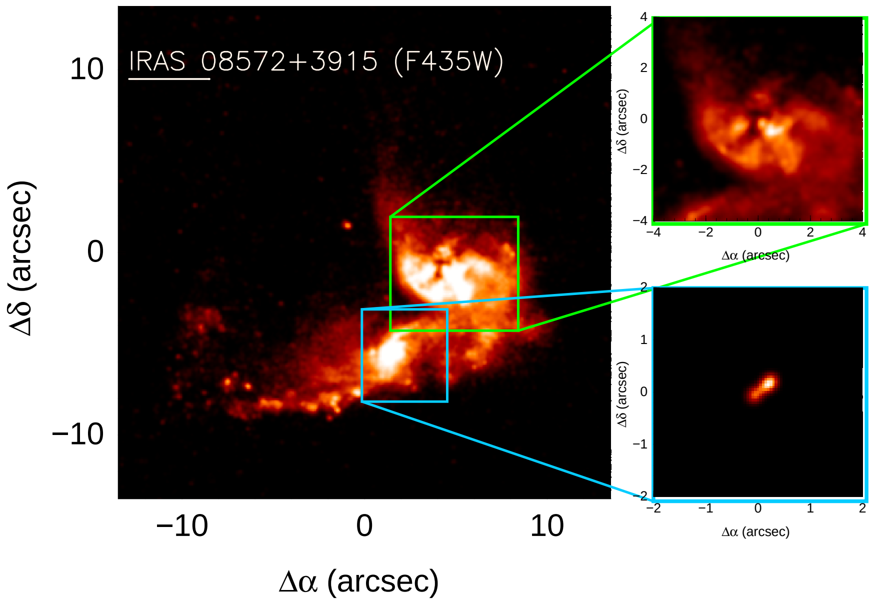

Fig. 1 IRAS 0857+3915 consists of 2 spiral galaxies that have not merged yet. As it can be seen, a tail extends up to 30 kpc from the East nucleus, bending to North-West direction. There is another tail going up straight North from the West nucleus. Throughout the tails many blue knots that could be associated with star formation regions can be observed.

2 Sample

Our sample includes 20 LIRGs and 14 ULIRGs that have been selected from the HST database available with at least blue F435W (∼ B) and red F814W (∼ I) filters with the camera ACS. These systems present different morphologies, that covers all merging phases, and cover distances up to 400 Mpc. We also selected H band images (filter F160W) with the same camera when possible, useful to study the inner regions of the sources.

3 IRAS 08752+3915 Photometry: identifying TDG candidates

3.1 Photometric measurements

We selected our possible TDG candidates for our photometry as the bright condensations above 3 sigma of the local background level, lying outside de nuclear region (i.e., $>$ 2kpc) in our images (see figure 1).

All photometric calibrations and magnitude determinations of these regions were performed following the prescriptions outlined in [6]. Most of the magnitudes were derived from aperture photometry from circular apertures typically 4-7 pixels (scale of 0.05 ”/pixel)in radius, although in some cases polygonal apertures were needed due to the irregular shape of the regions. We measured the flux for the total region and also estimated the underlying galaxy flux (tail flux) by using the mean of the pixels in a 5-pixel annulus starting 8 pixels away from the center of the condensation, more than 8 times the width of the PSF but close engouh to really estimate its nearby local background. The knot flux is defined as the total region flux subtracting the tail flux. These measurements will allow us to study the relative ages and masses of both knots and the underlying galaxy in each case. Aperture of 1.5” was centered at the nuclei and no correction for internal extinction in the parent galaxy has been applied.

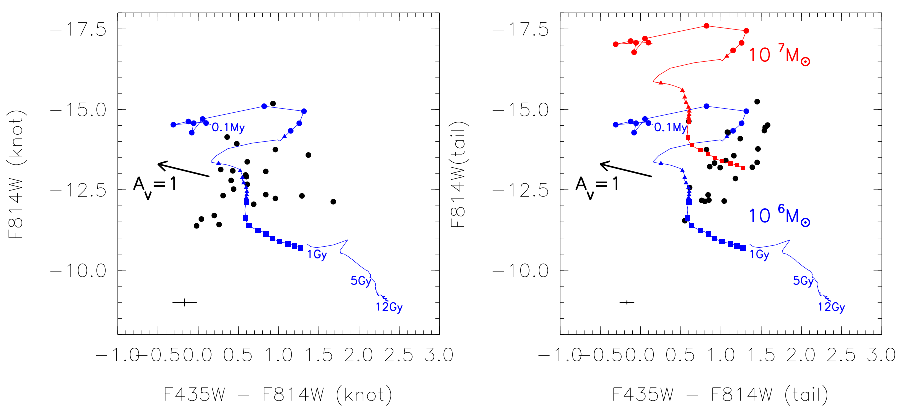

Fig. 2 Comparison between the model chosen and absolute magnitudes of the knots (left) and the tails (right). The blue curve is normalized to $10^6 M\odot$ and the red one to $10^7 M\odot$. Typical error for regions is plotted on the bottom left side corner. Arrows indicating the effects of 0.5 mag deredening in V are also plotted. Ages are indicated such a way that circles stand for steps of 1 Myr, triangles of 10 Myr and squares of 100 Myr

Photometric measurements will be compared to a stellar population synthesis model to roughly derive the age and mass of the regions. Starburst99 (SB99, [3]) are used, since they are suitable for young population. We will compare our data to an instantaneous burst model with solar metalicity and Salpeter IMF (same as previous studies) with lower mass limit of 0.1 M$\odot$ (with 1M $\odot$ would scale the derived mass to 0.4) and upper mass limit of 120 M$\odot$. We chose this to be instantaneous because it is the type of burst expected for young population.

3.2 *Properties of the TDG candidates*

Figure 2 shows the preliminary results of the comparison between the model and the data of the 25 regions found in IRAS 08752+3915. From it some properties for the possible TDG candidates found can be inferred:

1. Average magnitude differences between tail and knots in I band suggests that most of the mass in the tail corresponds to old population, which is what we would expect.
2. Around 70 % of the knots have a B-I color value below 0.7. Hence, their estimated age cannot be more than 300 Myr. Some of them could even be less than 10 Myr, dependening on the extintion and mass degeneration. Assuming this, total region (knot + underlying galaxy) stellar mass is estimated to be around 10^6-10^7 M$\odot$ for most of the regions.

The forhtcoming spectral study will help us further characterize the properties of these TDG candidates and, therefore, better understand their evolution.

Acknowledgements This work has been supported by the Spanish Ministry for Education and Science under grant ESP2007-65475-C02-01.

References

1. Duc, P.-A., & Mirabel, I.F. (1998), A&A, 333, 813-826
2. Duc, P.-A., Bournaud, F., & Masset, F. (2004), A&A , 427, 803-814
3. Leitherer, C., Shaerer, D., Goldader, J. et al. (1999), ApJS, 123, 3
4. Monreal-Ibero, A., Colina, L., Arribas, S., & Garca-Marn, M. (2007), A&A, 472, 421
5. Sanders, D.B., & Mirabel, I.F. (1996), ARA &a, 34, 749
6. Sirianni, M., Jee, M.J., Bentez,N. et al. (2005), PASP, 117, 1049
7. Veilleux, S., Kim, D-C., & Sanders, D.B. (2002), ApJS, 143, 315