Stellar Populations - Planning for the Next Decade
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Tracers of Star Formation in the Near Infrared

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Abstract. Starburst features in the optical are nowadays well known, but the use of this knowledge is not always possible (e.g. objects heavily obscured). In this case the near-IR is of unprecedented value. Recent models show that TP-AGB stars should dominate the NIR spectra of populations 0.3 to 2 Gyr old. While the optical spectra is insensitive to the presence of these stars, the near-IR changes dramatically. Not only does the absolute flux in the near-IR is affected, but also peculiar absorption features appear. These features can be used as indicators of 1 Gyr stellar population. In this work we used the IRTF Spex to create the first empirical database of NIR spectra of carefully selected starbursts, to test for the first time and in a consistent way the new stellar population models that account for the TP-AGB. The methodology used is to do stellar population synthesis in the optical and in the NIR, and compare the predictions of both spectral regions. We also compare the strength of important features of the TP-AGB stars, like the CN (1.1 microns) and CO (2.3 microns) bands with optical diagnostics.

Keywords. stars: AGB and post-AGB, galaxies: starburst, infrared: galaxies.

1. Introduction

The study of star-formation systems is of extreme importance to our understanding of galaxy and the universe formation and evolution. Starburst features in the optical are nowadays considerably well known and well studied. But in many cases, due either to severe dust obscuration, or, for example the strength of an AGN in the optical, the use of this knowledge is not possible. In these cases near-IR (NIR) might be of an unprecedented value. At NIR, stellar photospheres usually remain the dominant sources of light, and galaxy spectra are shaped by red supergiants shortly after starbursts, and then by giants of the first and of the asymptotic giant branches (AGB). On one hand, stellar populations synthesis models are developing in order to be able to predict the spectra of integrated populations in the NIR . On the other hand there is no homogeneous, complete comparison sample available in the literature to test these predictions. It is absolutely necessary to have a sample of classical, well studied starburts to test these models.

2. Objective

We aim in this project to create the first empirical database of NIR spectra of selected optical starbursts. To do this we proposed and got the time to use the IRTF (NASA Infrared Telescope), obtaining spectra of 29 galaxies with the Spex instrument. Spex covers from 0.8 to 2.4 μm, so many of the important features can be observed, like the CO (2.3 μm) and H2O bands in O-stars, and the CN (1.1 and 1.4 μm) and the C2 (1.2 and 1.77 μm) in C-stars.

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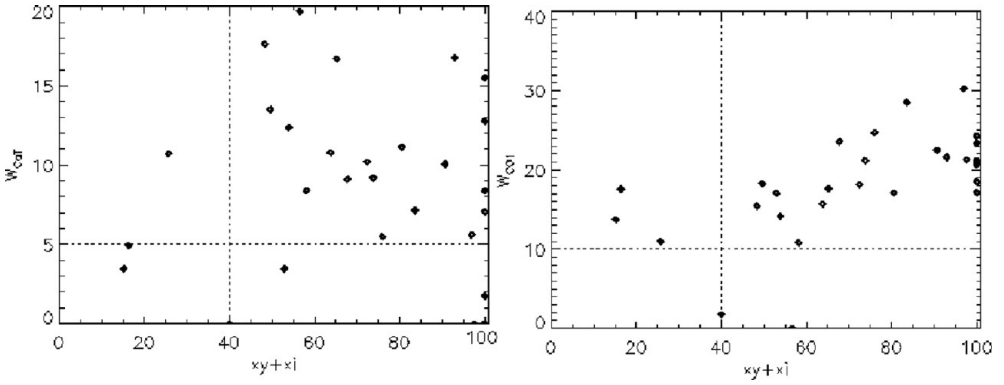

Figure 1. Equivalent width of CaT and CO 2.3 μm as a function of the fraction of young and intermediate age population obtained from the stellar population synthesis.

3. Analysis

The idea is to understand how powerful is the NIR to detect and quantify the star formation of a galaxy. Our approach was to use stellar population synthesis to investigate the age and metallicities of the galaxies. We used the code STARLIGHT (Cid Fernandes *et al.* 2005), and as a base we adopted the models of Maraston (2005), which include the effects of TP-AGB stars. Interestingly, some galaxies classified as starbursts, with strong emission lines in the optical, show very weak or no emission lines in the NIR. This is probably because the strong star formation is not in the nucleus, but in a circumnuclear region. The optical spectra available in the literature is from Ho *et al.* (1997) which has an aperture of 2×4. Our extractions have 0.8×1.6. We also did the spectral synthesis in the optical. The synthesis finds younger ages for the optical spectra. However, as mentioned before, we are probably not sampling the same populations. Some stellar features measured show weak correlations with age. Figure 1 shows the equivalent width of the CaT and CO 2.30 μm versus the fraction of young and intermediate age population obtained from the synthesis. From all the signatures in the NIR, the CN band seems to be the most promising in terms of detecting an intermediate age population (IAP). Most of the objects with clear CN detection have contributions of IAP higher than 30%, with a mean value of 50 $\pm$ 19%. Objects where no CN was detected have a mean value contribution of 38 $\pm$ 14%.

4. Conclusions

We conclude from this work that the NIR is an excellent window to study stellar populations, containing many tracers of intermediate age stellar population. One step further is to use this tracers no only to detect this stellar population, but also to quantify it. That is still a work in progress.

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