

Tracers of Star Formation in the Near Infrared

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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, and have been a tool to identify them in a number of objects. 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 wavelengths stellar photospheres usually remain the dominant sources of light, and galaxy spectra are shaped by red supergiants (RSG) 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 and suggesting powerful tools to find and measure star formation, 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 starbursts to test these models.

Objective

We aim in this project to create the first empirical database of NIR spectra of well-known, carefully 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. These features can be unambiguously used as indicators of ~ 1 Gyr stellar population in the integrated spectra of stellar systems.

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. Examples of the results are shown in Figure 1.

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 $2'' \times 4''.1$. Our extractions have $0.8'' \times 1.6''$.

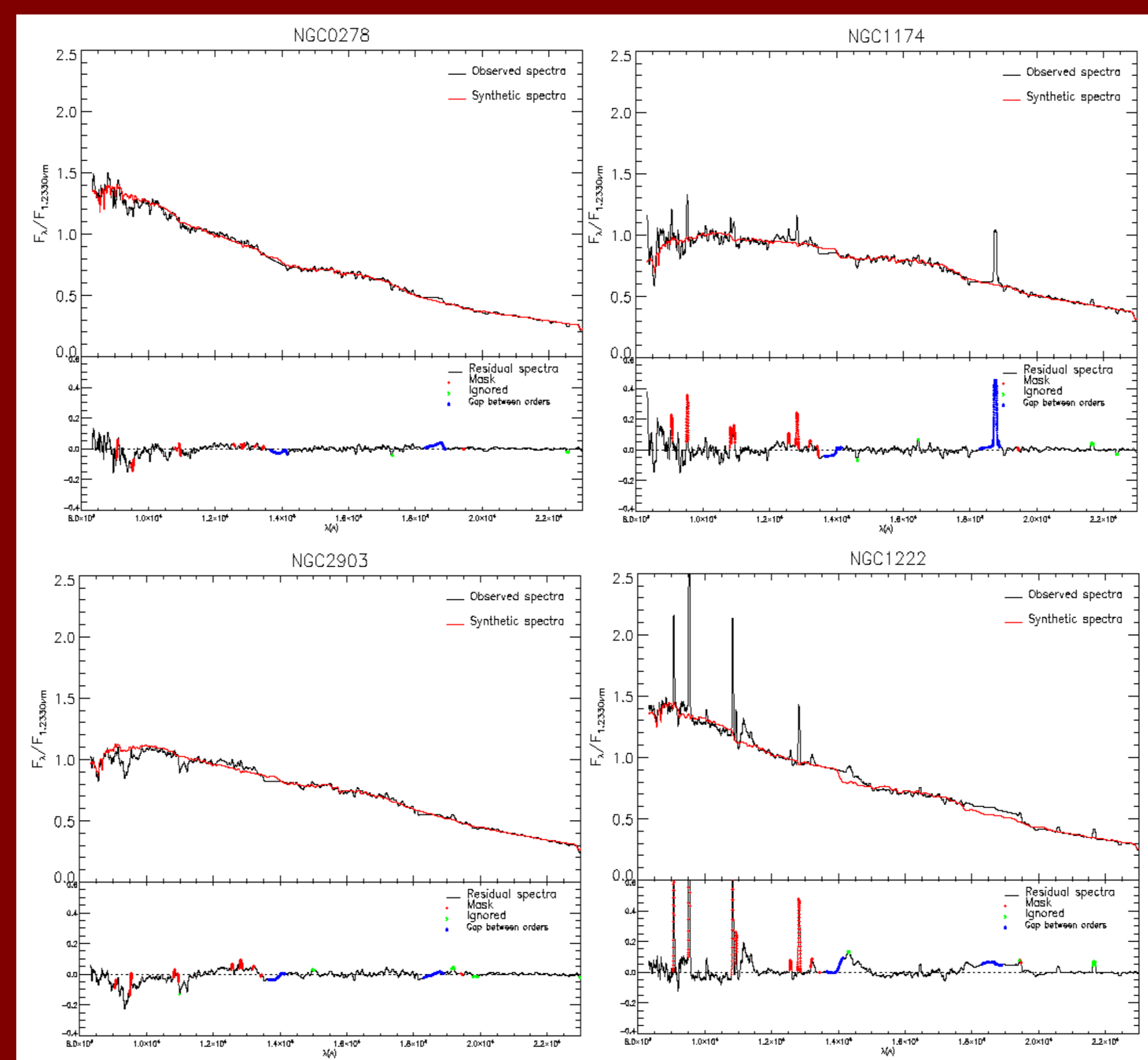


Figure 1 - Example of the spectral fits. Each panel shows the flux of the observed spectrum, normalized at 1.233 μm , and the synthetic spectra at the top, and the difference between them at the bottom.

We also did the spectral synthesis in the optical, using the spectra available from Ho et al. (1997). Figure 2 shows the comparison between the average age found for the galaxy in the NIR and in the optical. It is clear from this figure that the synthesis finds younger ages for the optical spectra. However, as mentioned before, we are probably not sampling the same populations.

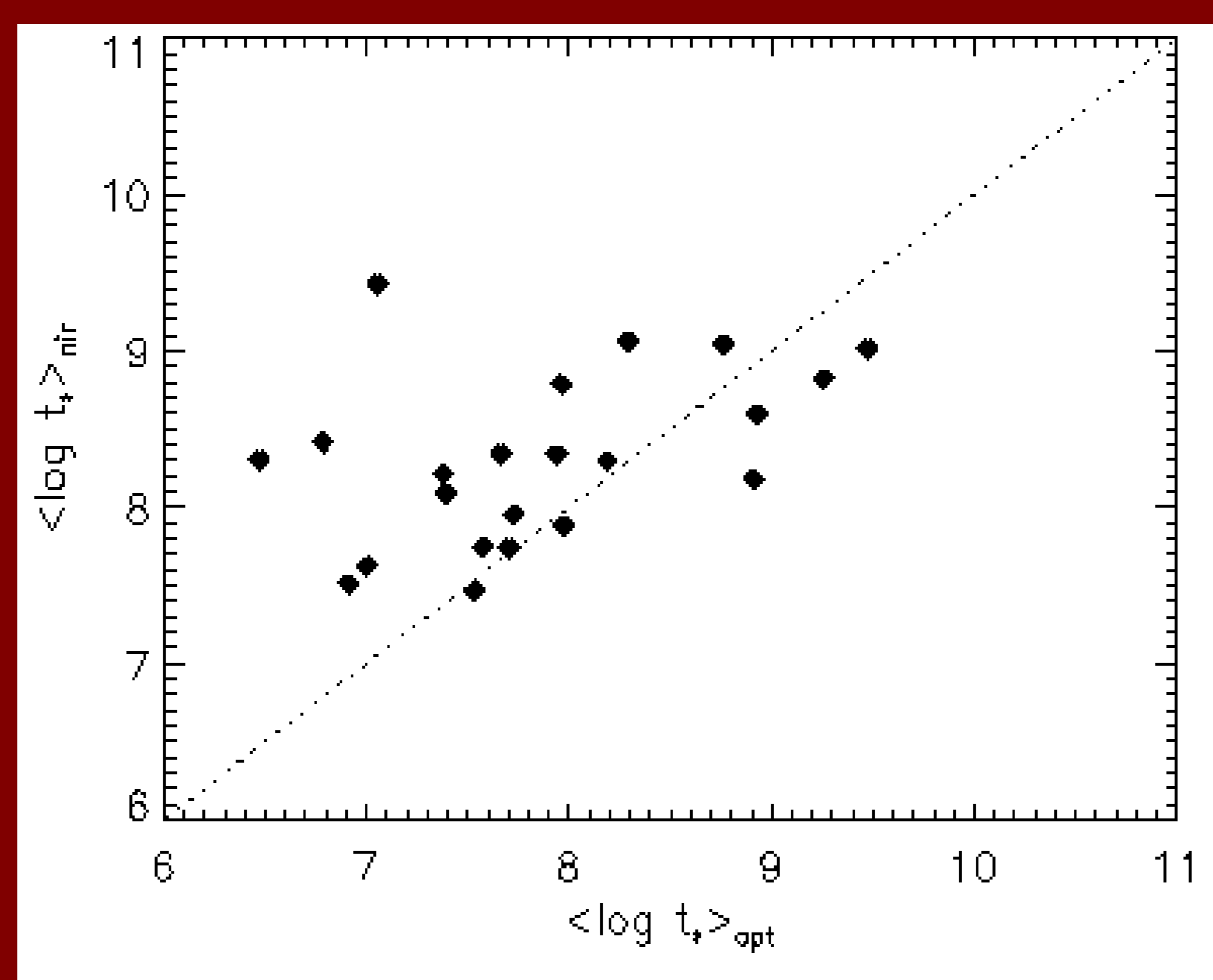


Figure 2 - Comparison between the average of $\log t_\nu$ weighted by luminosity obtained with the spectral synthesis for the optical spectra (from Ho et al.) and the NIR spectra.

Some stellar features measured show weak correlations with age. Figure 3 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.

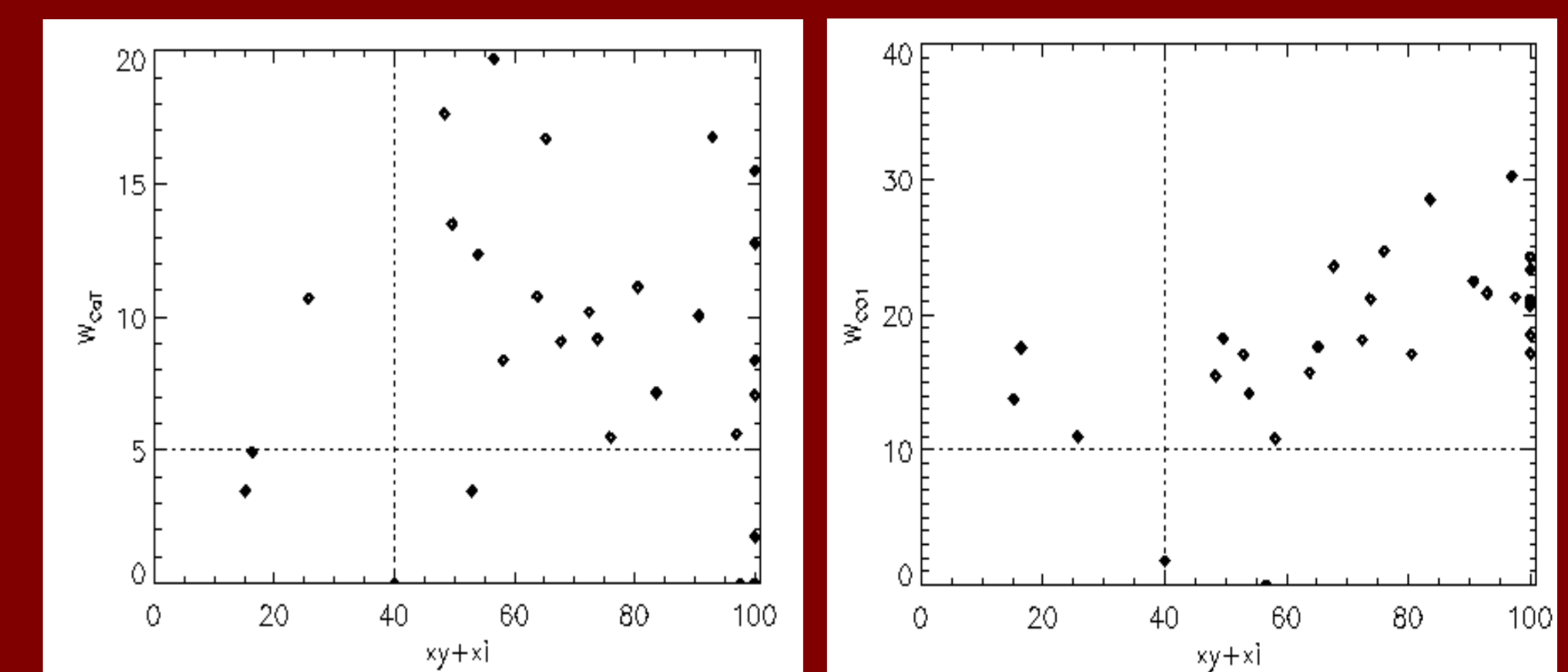


Figure 3 - Example of the spectral fits. Each panel shows the flux of the observed spectrum, normalized at 1.233 μm , and the synthetic spectra at the top, and the difference between them at the bottom.

From all the signatures in the NIR, the CN band seems to be the most promising in terms of detecting an intermediate age population. Figure 4 shows a histogram comparing galaxies where CN was detected with the ones it was not, in terms of the fraction of intermediate age population obtained by the stellar population synthesis. Most of the objects with clear CN detection have contributions of intermediate population higher than 30%, with a mean value of $50 \pm 19\%$. Objects where no CN was detected have a mean value contribution of $38 \pm 14\%$.

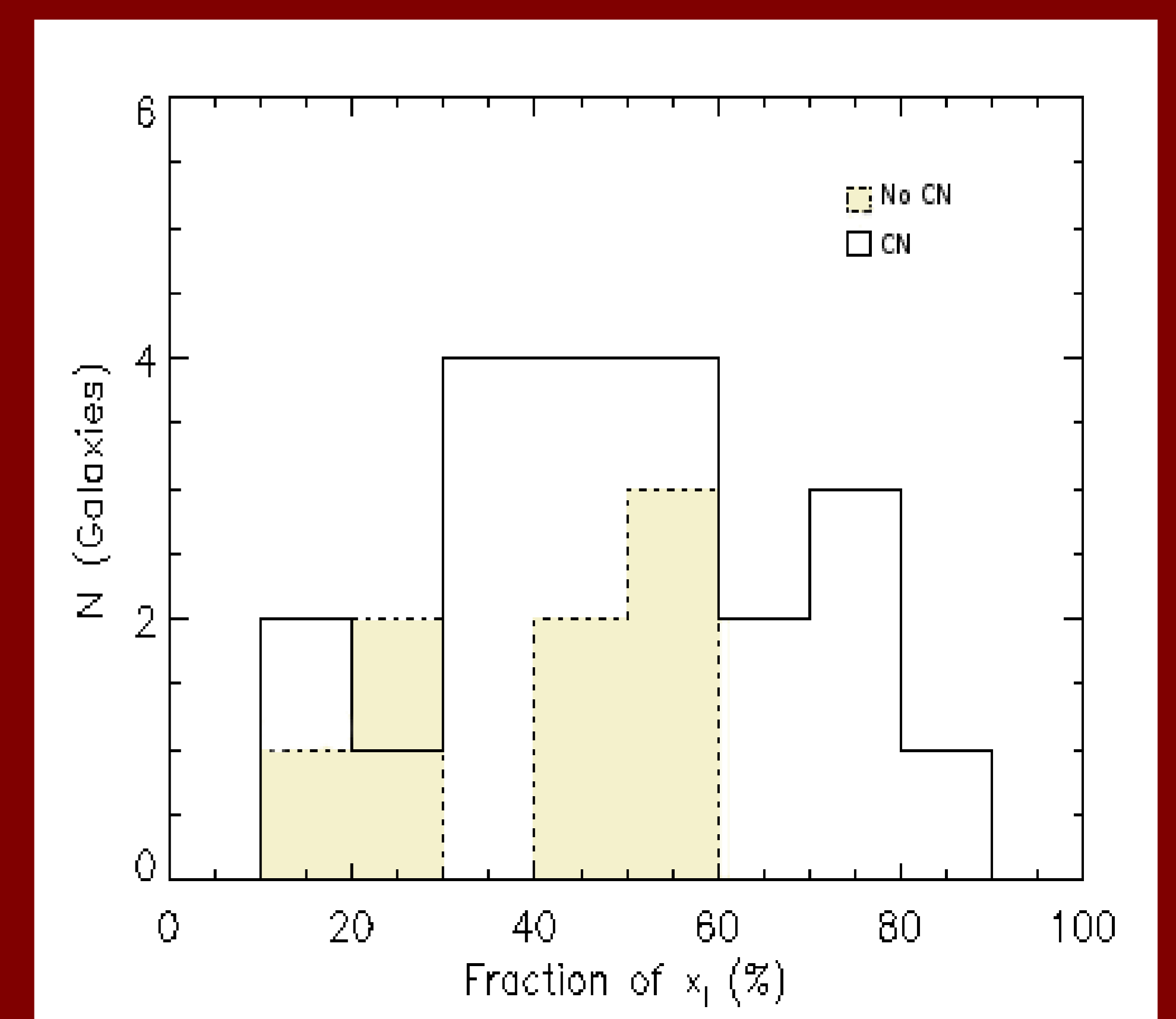


Figure 4 - Histogram comparing the intermediate age component of the galaxies with CN detection (empty histogram) and no detection (yellow histogram).

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 not only to detect this stellar population, but also to quantify it. That is still a work in progress.

Acknowledgments

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