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Disentangling Nitrogen and Carbon Abundances in Early-Type Galaxies

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Abstract. The near-UV NH3360 feature has been measured in a sample of 35 early-type galaxies in a wide range of masses and environments. We found that, contrary to what is seen with Mg- and C-sensitive Lick-style indices, NH3360 does not vary significantly with galaxy velocity dispersion. When compared with solar-scaled stellar population models N/Fe appears mildly enhanced. We do not detect any difference in the NH3360 index between galaxies in different environments. We outline the important implications of these conclusions for our understanding of the origin of carbon and nitrogen, and the star formation histories of early-type galaxies.

Keywords. galaxies: abundances, galaxies: elliptical and lenticular, cD, galaxies: evolution

1. Introduction

The combination of Lick-style indices and our knowledge of chemical evolution is a powerful tool to inferring the star formation histories of early-type galaxies. For example, in massive early-type galaxies, Mg/Fe is known to reach super-solar values, an attribute thought to be a consequence of the short star formation timescales in these systems. Other ratios (e.g., C/Fe, N/Fe, Na/Fe) have also been claimed to be enhanced in massive ellipticals (Worthey 1998; Sánchez-Blázquez *et al.* 2003, 2006b; Schiavon 2007) and correlated with their velocity dispersions. The study of N abundances has been performed traditionally using the CN-band at 4175 Å, but to disentangle the contributions of C, N and O is challenging (Burstein 2003). This can be ameliorated by observing the near-UV NH feature (3360 Å), as it offers a more direct and robust estimator of N abundances (Tomkin & Lambert 1984). Another advantage of the NH feature over the CN-band is that the near-UV light is produced mainly by dwarf stars (Davidge & Clark 1994), i.e., the N abundance is not modified by mixing during the first dredge-up.

2. Results and Discussion

We have found that C-based indices are overabundant only for LDEG and show a strong correlation with σ, in a similar way to Mg (as previously claimed by Sánchez-Blázquez *et al.* 2003, 2006a). N-based indices are mostly compatible with being mildly overabundant with respect to solar and do not correlate with σ, contrary to the claims by previous works based on the CN feature (Worthey 1998; Sánchez-Blázquez *et al.* 2006a; Schiavon 2007). This lack of correlation points to a primary origin for N, because in the case of secondary elements it is expected a correlation between its abundance and the overall metallicity (Henry *et al.* 2000), therefore a correlation with the galaxy mass (σ) through the mass-metallicity relation.

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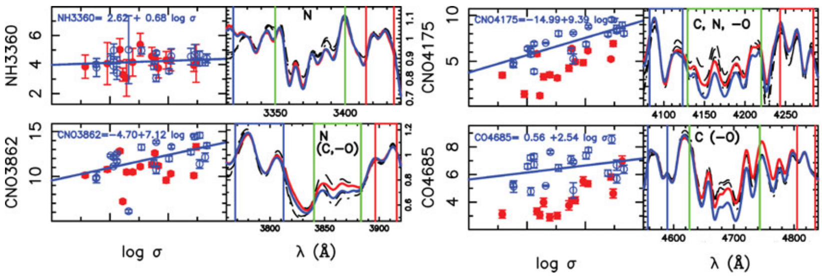

Figure 1. Left column: Line-strength indices versus velocity dispersion (our proxy for mass). Red solid circles correspond to HDEG (high density environment galaxies), while blue open circles represent LDEG (low density environment galaxies). **Right column:** Blue, green, and red boxes represent the bandpasses and the index definition. Black lines represent stellar population models (solar (dashed lines) and supersolar (dotted lines) metallicity, with ages 6 and 15 Gyr), Bruzual & Charlot (2003) for NH3360 and Vazdekis *et al.* (2009, submitted) for the rest. The blue stacked spectra are LDEG, while the HDEG are represented in red. Dominant species and other important species (within brackets) contributing to the indices defined by Serven *et al.* (2005) are shown in the inset of the panels.

The NH feature seems insensitive to metallicity, but this does not imply a lack of sensitivity to N abundance. The large NH3360 values of M31 globular clusters, compared with ellipticals (Ponder *et al.* 1998), indicates that this feature is not saturated.

These results help us to understand the chemical evolution and the formation of these early-type galaxies. In the production of N, both, massive and intermediate-mass stars contribute. Massive galaxies (those that experience a short and rapid star formation, experience the major contribution of N via massive stars, but less massive galaxies would increase their N also from intermediate-mass stars because their star formation is more extended in time. This last contribution woud flatten the N-σ correlation. The production of C comes from massive and intermediate-mass stars in comparable proportions. The steep slope with σ would be due to the contribution of massive stars, in a similar way as the Mg-σ correlation. The offset would come from a different production in intermediate-mass stars. Their latter C release would increase the C budget in field galaxies, while in the Coma cluster the star formation ceases before this can happen.

In summary, the study of CNO abundances via indices that depend only on one of the species, as NH3360, impose strong contraints in chemical evolution and galaxy formation models.

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