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CNO ANOMALIES IN O2 SPECTRA

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RESUMEN

Como ejemplo de una reciente aplicación de morfología astronómica, se ilustran y discuten anomalías de CNO en espectros ultravioletas de gigantes O2 en las Nubes Magallánicas.

ABSTRACT

As an example of a recent application of astronomical morphology, CNO anomalies in the ultraviolet spectra of O2 giants in the Magellanic Clouds are illustrated and discussed.

Key Words: stars: abundances — stars: early-type — stars: fundamental parameters — ultraviolet: stars

The morphological techniques of the Morgan-Keenan (MK) System of spectral classification, which is one of the foundations of stellar astrophysics, currently continue to contribute to the formulation of astronomical phenomena and to the discovery of new ones. Whenever a new observational domain is opened to research, as for example a new wavelength range, a different metallicity in an external galaxy or region of our own, or simply a higher information content in data of better quality, morphological principles apply. Briefly, they comprise the description of the phenomena differentially relative to reference objects ("standards"), independently of calibration or interpretational procedures, to prevent the uncertainties inherent to those steps, which should be taken subsequently, from degrading or compromising the validity and future usefulness of the description. In other words, it is essential to formulate an adequate image of the new phenomena before they can usefully be subjected to interpretation or modeling. At the same time, this empirical methodology suggests or eliminates hypotheses and discriminates the peculiar from the normal, thus expediting progress toward the ultimate objective of physical understanding.

Because of space limitations, just one recent example is presented here. A study of the inverse anomalies of N *vs.* C, O in absorption-line OB spectra, denoted as OBN and OBC, was presented by Walborn (1976), and updated by Walborn (2003). It is now generally accepted that the morphologically normal majority of OB supergiants exhibit an admixture of material processed on the CNO cycle in their atmospheres and winds, while the relatively rare OBC objects have physically normal CNO abundances (that is, corresponding to the main sequence), and the OBN have more extreme admixtures caused by binary interactions or high initial rotational velocities, with homogeneous evolution in the most extreme cases (Maeder & Meynet 2000). The optical anomalies are generally reflected in the ultraviolet wind profiles (Walborn et al. 1985, 1995).

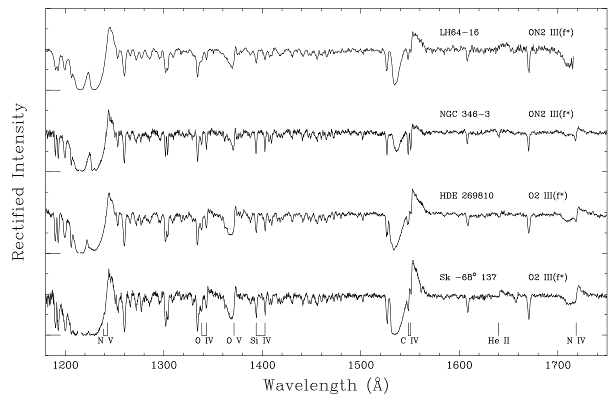

Fig. 1. *HST* UV spectrograms of very early-type stars in the Magellanic Clouds with nitrogen enhanced (ON2) and normal (O2). Courtesy of Ian Howarth and Phil Massey.

The recent discovery of a CNO dichotomy among O2 giants in the Magellanic Clouds, initially from a study of the 3400 Å region in their spectra (Walborn et al. 2002a, 2004), was a surprise. These very massive objects have small absolute ages and lie near the main sequence; thus, the nitrogen-enhanced objects indicate more rapid mixing than produced by current models, and/or very high initial rotational velocities perhaps inducing homogeneous evolution back toward the main sequence. Figure 1 shows the differences in the relative intensities of the N V and C IV profiles between ON2 and O2 spectra in *Hub-*

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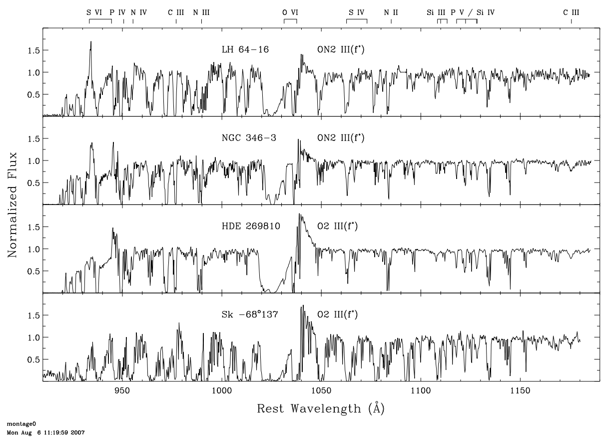

Fig. 2. *FUSE* FUV spectrograms of the same stars as in Figure 1. That of Sk −68°137 suffers substantial absorption by interstellar molecular hydrogen. Courtesy of Alex Fullerton.

ble Space Telescope data, while Figure 2 shows that the anomalies also extend to the superionized O VI species in recently processed data from the *Far Ultraviolet Spectroscopic Explorer* (see Walborn et al. 2002b for reference spectral sequences in this wavelength range). These objects represent a challenge to the models, and eventually a powerful diagnostic of early massive stellar evolution. Other related results from the 3400 Å study are presented by Morrell et al. (2005).

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