JOURNAL OF THE KOREAN ASTRONOMICAL SOCIETY
29: S133 ~ S134, 1996

THE EFFECTS OF HORIZONTAL-BRANCH STARS ON THE H_β INDEX OF SIMPLE STELLAR POPULATION MODELS

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ABSTRACT

We present the systematic variations of H_β index of simple stellar populations due to horizontal-branch (HB) stars. Most of the previous works have been done without careful considerations of HB stars. Since the Balmer line strengths are very sensitive to the temperature, including the HB stars are quite important. We found that the strength of H_β index is strongly affected by HB stars, and hence the age estimation without careful consideration of the variation of HB morphology with metallicity and age would underestimate the ages of ellipticals.

Key Words : HB stars, star clusters, elliptical galaxies

I. INTRODUCTION

Since Worthey (1994) cast an eye forward to the disentanglement of the age effect from the metallicity effect of simple stellar populations using H_β index, it has been considered as an useful age indicator. As emphasized by Buzzoni (1995) and Ferguson (1995), however, researchers in this field almost ignored the presence of stars beyond the Red Giant Branch (RGB) tip. With stars only till the RGB tip, they claimed that H_β line strengths could be the best indicator of the main sequence turn off (MSTO) region that is well-studied age tracer of the simple stellar populations.

In this work, we present the preliminary results on how H_β line strengths vary when HB stars are included in the population models.

II. POPULATION MODELS

The present models were constructed using our evolutionary population synthesis code (Park & Lee 1997), which has been developed specifically to study the stellar populations in globular clusters and elliptical galaxies. In our construction of model H-R diagrams, we have used the Revised Yale isochrones (Green et al. 1987) rescaled for α-elements enhancement (Salaris et al. 1993), together with Lee and Demarque's (1990) tracks for HB stars.

We made use of the recent empirical calibrations of twenty one absorption feature strengths compiled by Worthey (1994). The calibrations are presented in forms of analytical fits that give the index strength as functions of stellar atmospheric parameters, i.e., the effective temperature, gravity, and [Fe/H] both for warm (up to 13,260 K) and cool (down to 3,570 K) stars. The definition of the indices are given in Worthey (1994) to whom we refer. According to his definition, all indices are constructed by means of a central band-pass and two pseudo-continuum band-passes on either side of the central band. The continuum is placed at the center wavelength of the index passband by drawing a line between the centers of the two pseudocontinua. For every combination of temperature, log g, and [Fe/H], first we derive the flux in the continuum band-pass from the library of stellar spectra (Kurucz 1992), and then we calculate the flux in the central pass-bands with the analytical fits of Worthey (1994).

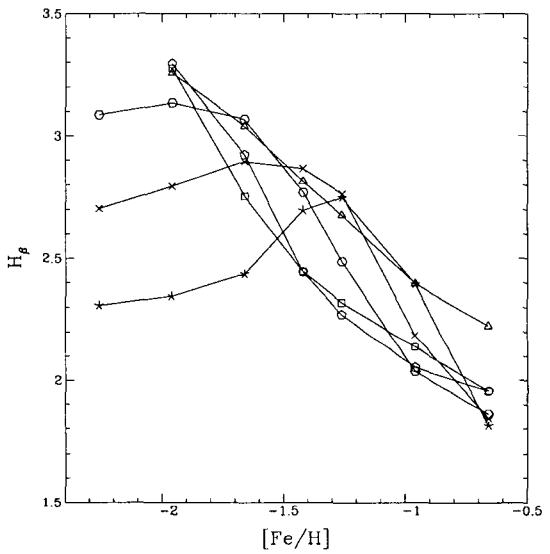

Fig. 1.— H_β line strengths of simple stellar populations. HB stars are included. Same symbols are used as in Fig. 1.

In Fig. 1, we present the result for H_β line strengths without HB stars. As in Worthey (1994), we can see that H_β line strengths increase as metallicity and age decrease since color becomes blue. The effect of HB stars is clear in Fig. 2, where we see different fashions. In particular, we see that overall values of H_β line strengths increase after the inclusion of HB stars. Also, we see that H_β line strengths do not monotonically increase but they show a peak at certain metallicity when

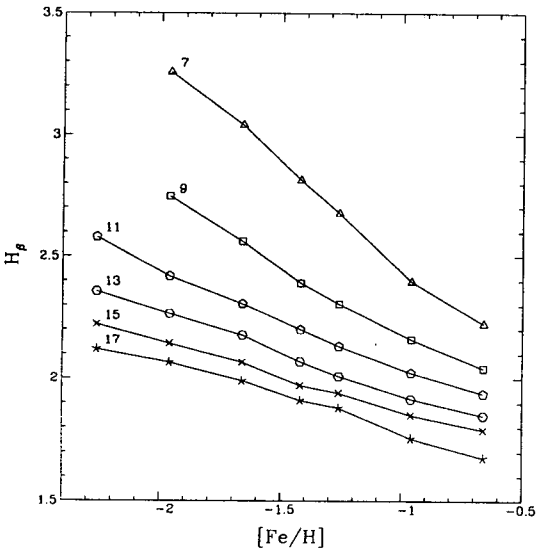

Fig. 2.— H_β line strengths of simple stellar populations under different assumptions on age (Gyr). HB stars are not included.

most of HB stars are at around 10,000 K.

This illustrates that the strength of H_β index is strongly affected by HB stars; and hence the age estimation without careful consideration of the variation of HB morphology with metallicity and age would underestimate the ages of ellipticals.

ACKNOWLEDGEMENTS

Support for this work was provided by the Basic Science Institute Program, Ministry of Education, 1996, Project No. BSRI-96-5413.

REFERENCES

Buzzoni A., 1995, ApJS, 98, 69.

Ferguson H.C., 1995, in IAU Symposium 164, Stellar Populations, ed. P.C. van der Kruit & G. Gilmore (Dordrecht: Kluwer), 249.

Green E.M., Demarque P., & King C.R., 1987, The Revised Yale Isochrones and Luminosity Functions(New Haven: Yale Univ. Obs.).

Kurucz R., 1992, in IAU Symposium 149, The Stellar Populations of Galaxies, ed. B. Barbuy & A. Renzini (Dordrecht: Kluwer), 225.

Lee Y.-W., & Demarque P., 1990, ApJS, 73, 709.

Park J.-H., & Lee Y.-W., 1997, ApJ, 476, in press.

Salaris M., Chieffi A., & Straniero O., 1993, ApJ, 414, 580.

Worthey G., 1994, ApJS, 95, 107.