Stars in the GOODS-N and GOODS-S fields

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ABSTRACT

Subject headings:

1. Introduction

Studying the old stellar content of our galaxy down to the faintest possible magnitude offers an opportunity to probe the shape of the disk of our galaxy as traced by the old stellar population. In Pirzkal et al. (2005), we showed that, based on deep observation of the Hubble Ultra Deep Field, that the number of M4 and later stellar dwarfs that we detected implied a Galactic disk scale height of 400 ± 100pc for M and L stars. This result, which confirmed the result from Ryan et al. (2004), was however based on a single line of sight observation of a relatively small field of view.
Recent ACS spectroscopic observations within both of the GOODS-N and GOODS-S fields **?**, now allow us to test this result using two different lines of sight and using a significantly large area on the sky (Section 2).

2. Observations

PEARS data
GOODS N and S

3. Object selection

3.1. Morphological pre-selection

Both Kilic et al. (2005) and Pirzkal et al. (2005) derived and tested means to identify stars in deep, sensitive surveys. Both showed that it was possible to distinguish stars from faint and unresolved extra galactic objects down to faint magnitudes, and in Pirzkal et al. (2005) we showed that M and later stellar dwarfs were readily identified using ACS slitless spectroscopic observations. While we are eventually aiming to spectroscopically identifying stellar dwarfs in the GOODS fields, spectroscopically fitting all of the sources in the fields to template spectra is not the most efficient way to proceed since the number of sources involved is several tens of thousands. We instead chose to use the Kilic et al. (2005) selection criteria, based on a combination of the Sextractor stellarity parameter (CLASS_STAR) and half-light radius (R50). The authors showed that objects with a stellarity larger than 0.85 and a half-light radius consistent with an unresolved source (i.e. 2 pixels for ACS) were nearly all stars. In this paper, since we rely on spectroscopic identification of these sources, we relaxes the selection parameter somewhat and selected a group of stellar candidates with $R50 < 4$pixel and Stellarity > 0.85. Figure 1 shows the subset of objects thus selected in the GOODS-N and GOODS-S fields.

3.2. Spectroscopic fitting

Spectral fitting was performed using Pickles stellar templates (ref). These templates were first use to generate high signal-to-noise simulated ACS grism spectra that were then re-extracted to produce realistic templates with the appropriate resolution. Spectral fitting was done in DN/s space by minimizing the cumulative reduced chi^2_n. Rather then simply selecting the spectral type of the template with the lowest χ^2_n, we instead chose to take the approach of rejecting spectral type with fits resulting in a $\chi_n^2 > 2$. This naturally caused several spectral types to be potential matches, especially when in the relatively low signal-to-noise regime.

We first tested our ability to spectroscopically identify stars using a series of $\approx 50,000$ simulated spectra of stars. These simulations were created using the latest version of the aXe 1.6 software (ref) and by assigning each simulated object a spectrum drawn from the Pickles stellar library (ref). The brightness of objects was allowed to vary such that $22 < z_{850} < 28$. These simulated images were then extracted using the same extraction method used to extract the PEARS data, and the resulting 1D spectra were fitted to template spectra. We show in Figure 2 the fraction of objects with a stellar type later than M4 for which we reliably determined the spectral type to within 0.1 stellar type (i.e. M4-M5 etc..). These simulations show that we are able to fit M4 and later dwarfs down to $z_{850} \approx 26.5$. An example of a PEARS spectrum and its fits is shown in Figure 3.

4. Number of M dwarfs and the disk scale height

Figure 4 shows the cumulative number of stars with stellar type M4 or later as a function of magnitude. GOODS-N and GOODS-S are shown in red and green respectively. The solid line shows all fitted objects. The short dash line shows objects with less than 1 full stellar type uncertainty. The long dash line shows objects with less than 0.1 stellar type uncertainty. The solid black line shows the result from Pirzkal et al. (2005).

Figure 5 is similar to Figure 4 but account for the larger field of view.

Both Figures 4 and 5 appear, at least initially, to be consistent with the numbers from GRAPES and Figure 6 shows the PEARS numbers and the simulations done and down in Pirzkal et al. (2005). New simulations are currently in the work. This is very preliminary

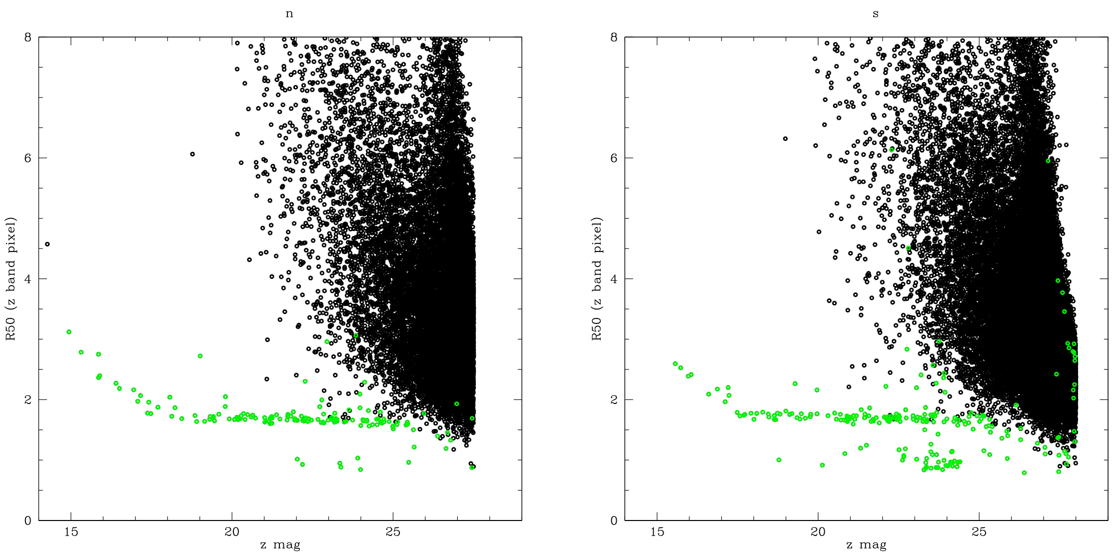

Fig. 1.— Pre-selection of stellar candidates (green) in the GOODS-N (140 objects, left panel) and GOODS-S (192 objects, right panel) fields. Pre-selected objects have a Stellarity > 0.75 and $R_{50} < 4 pixels$

and things were scaled to match at i_{775}=22. However, the slope appears to be different.

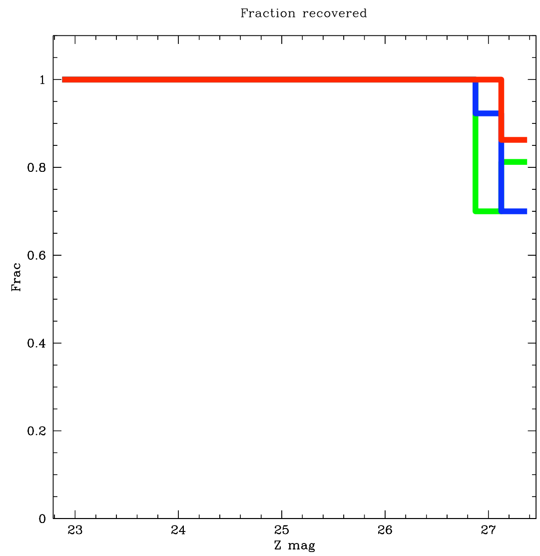

Fig. 2.— Fraction of simulated spectra recovered as a function of magnitude for M4 (red), M5 (blue), and M6 (green) stellar type.

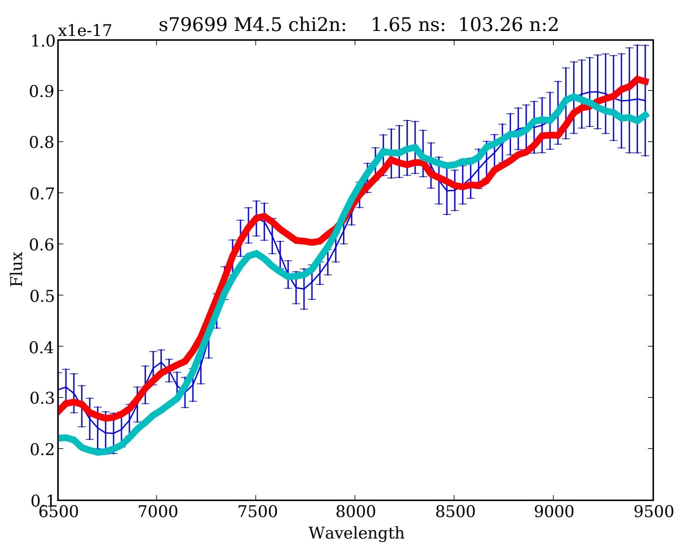

Fig. 3.— Example of a late type stellar type PEARS object and the fits to the data. The two acceptable fits are an M4 and M5 dwarf.

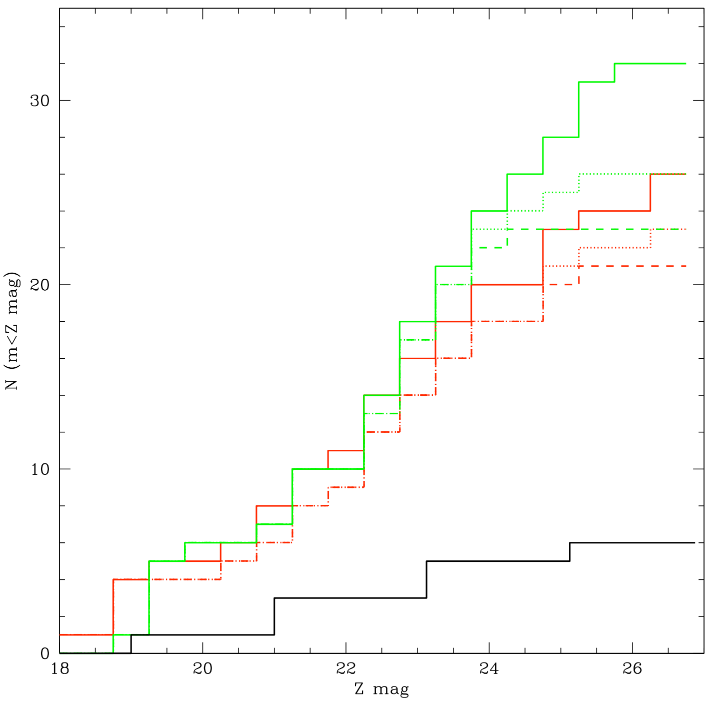

Fig. 4.— cumulative number of stars with stellar type M4 or later as a function of magnitude. GOODS-N and GOODS-S are shown in red and green respectively. The solid line shows all fitted objects. The short dash line shows objects with less than 1 full stellar type uncertainty. The long dash line shows objects with less than 0.1 stellar type uncertainty. The solid black line shows the result from Pirzkal et al. (2005)

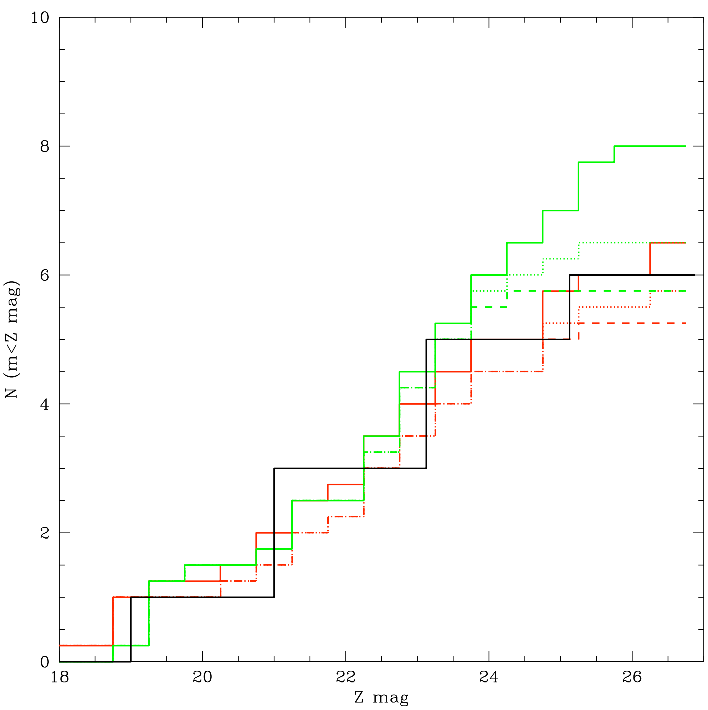

Fig. 5.— Similar to Figure 4 but account for the larger field of view

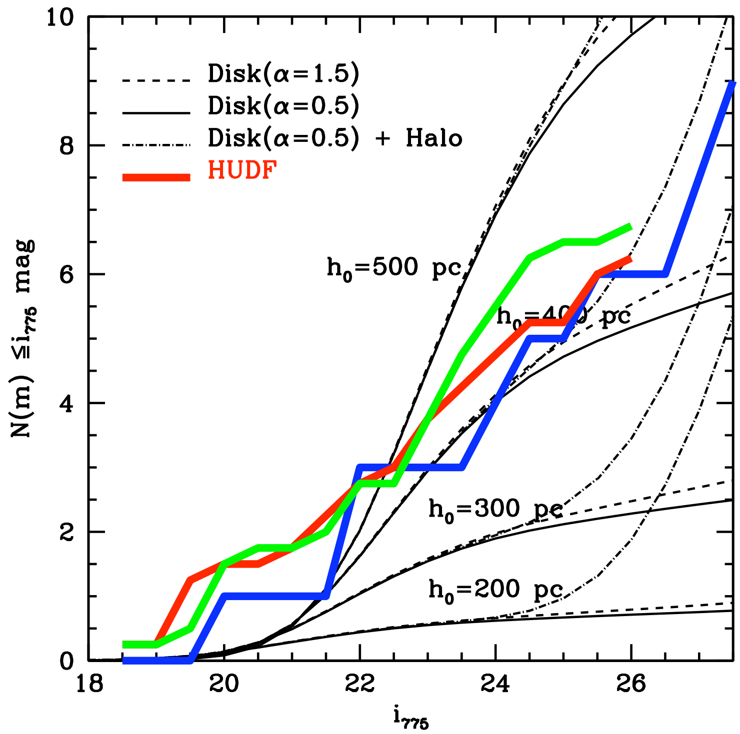

Fig. 6.— Disk scale height models from Pirzkal et al. (2005) and these results.

REFERENCES

Kilic, M., Mendez, R. A., von Hippel, T., & Winget, D. E. 2005, ApJ, 633, 1126

Pirzkal, N., et al. 2005, ApJ, 622, 319

Ryan, R. E., Jr., Hathi, N. P., Cohen, S. H., & Windhorst, R. A. 2005, ApJ, 631, L159

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