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Stellar angular diameters from infrared photometry. Application to Arcturus and other stars; with effective temperatures

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1 Introduction

Atomic oscillator strengths are now being measured at Oxford to an accuracy of at least 5 per cent (Blackwell *et al.* 1975b, 1976a, b). In order to use these accurate oscillator strengths effectively for stellar spectroscopy effective temperatures of improved accuracy for cooler stars are needed, for these are known to little better than 200 K at 4500 K, even for well-studied bright stars. Ideally, an accuracy of 13 K at 4500 K, is needed to match an oscillator strength accuracy of 5 per cent for low-excitation lines (Blackwell & Willis 1977). This order of accuracy is beyond any present techniques, but in this note we suggest that an improvement can be made in the measurement of effective temperature through the use of an angular diameter derived from infrared photometry. Given the angular diameter θ, the effective temperature is derived from the integrated flux from the star at the earth, $\mathcal{F}_E$, through the defining relation $\sigma T_e^4 = 4\mathcal{F}_E/\theta^2$. We now consider the measurement of θ.

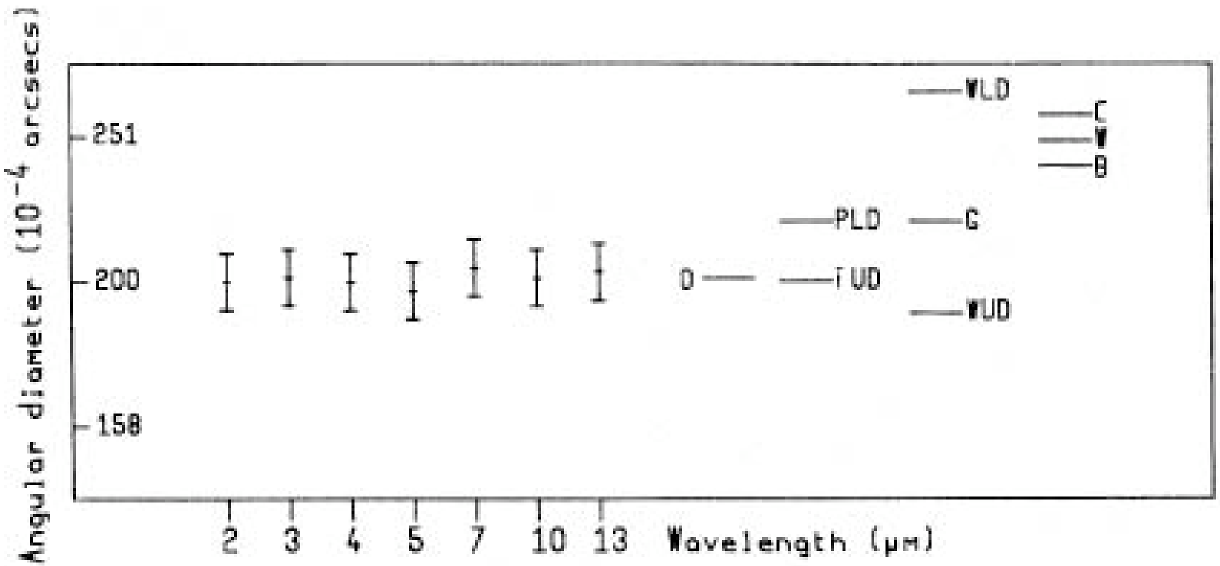


Figure 1. Deduction of angular diameter of Arcturus at a set of infrared wavelengths from measured fluxes. Other measurements of angular diameter are marked on the diagram: PUD, PDL, Pease (1931), uncorrected and corrected for limb darkening; W. Wesselink *et al.* (1972); WUD, WLD, Worden (1976); G, Gezari, Labeyrie & Stachnik (1972); C, Currie *et al.* (1974); Beavers (1965). The angular diameter scale is logarithmic.

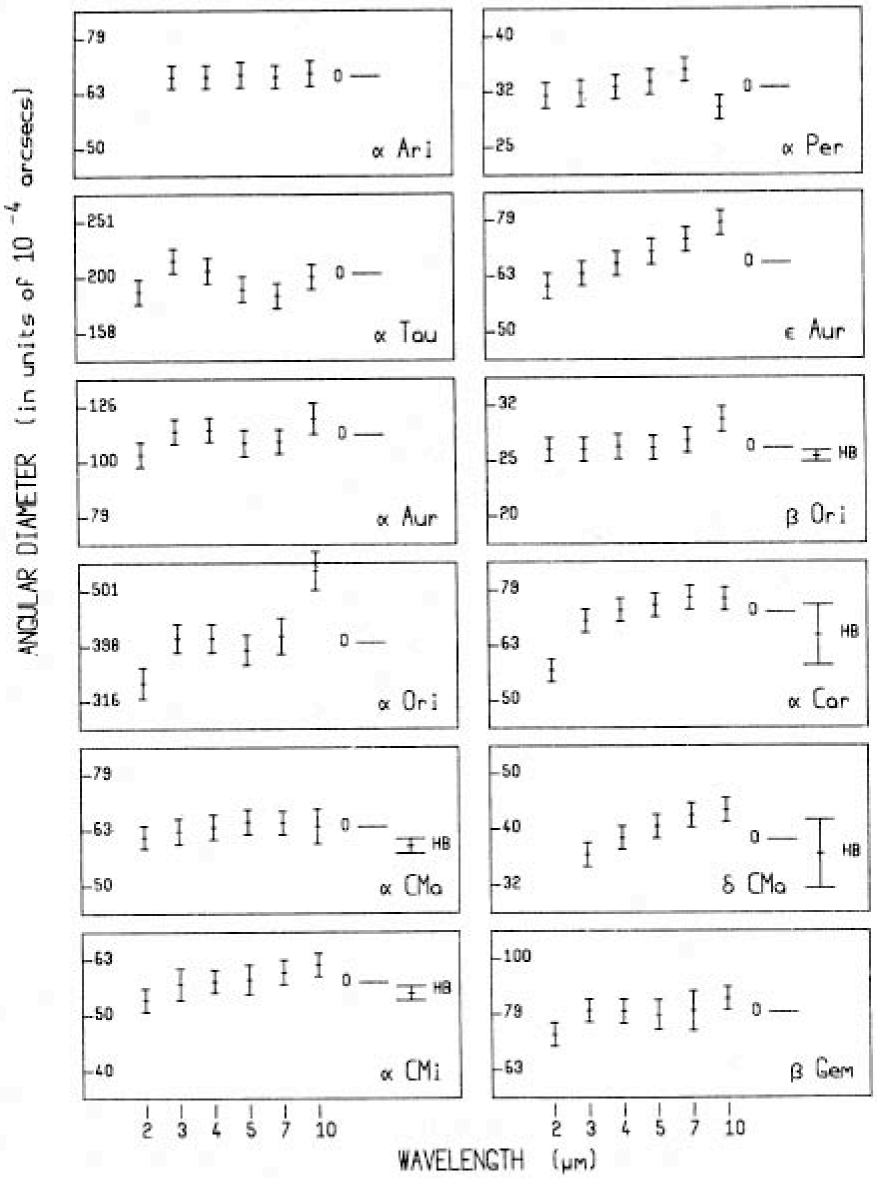


Figure 2 (a)

Figure 2 (a and b). Deduction of angular diameters of a group of stars at various infrared wavelengths. The mean diameters for wavelengths 3, 4 and 5 μm are denoted by O (Oxford), and where available the intensity interferometer values are also given, denoted HB (Hanbury-Brown), with their stated errors. The angular diameter scales are logarithmic.

$$\mathscr{F}_E = \int_0^\infty F_{E,\lambda}\, d\lambda = \frac{\theta^2}{4}\, \sigma T_e^4$$

$$F_{E,\lambda_0} = \frac{\theta^2}{4} \times F_{S,\lambda_0} = \frac{\theta^2}{4} \times \phi(T_e, g, \lambda_0).$$

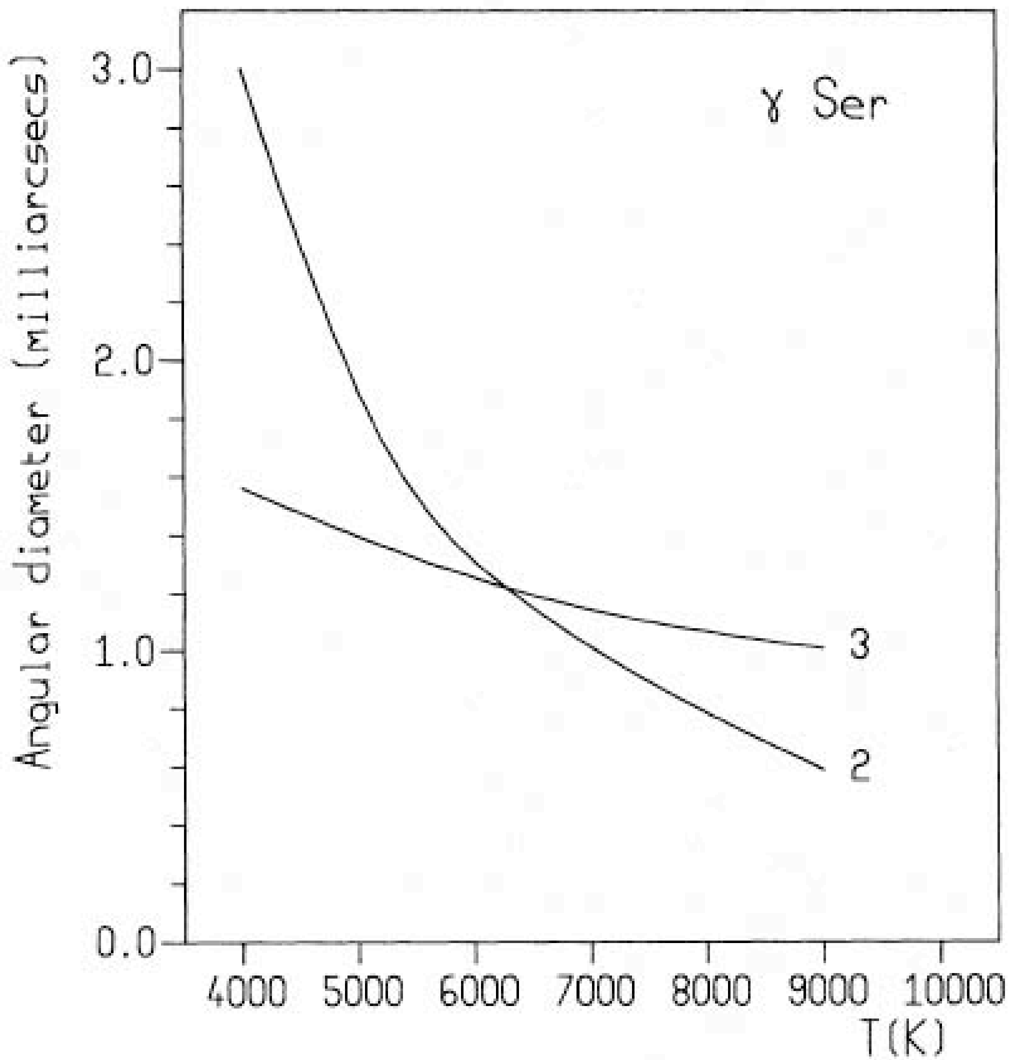
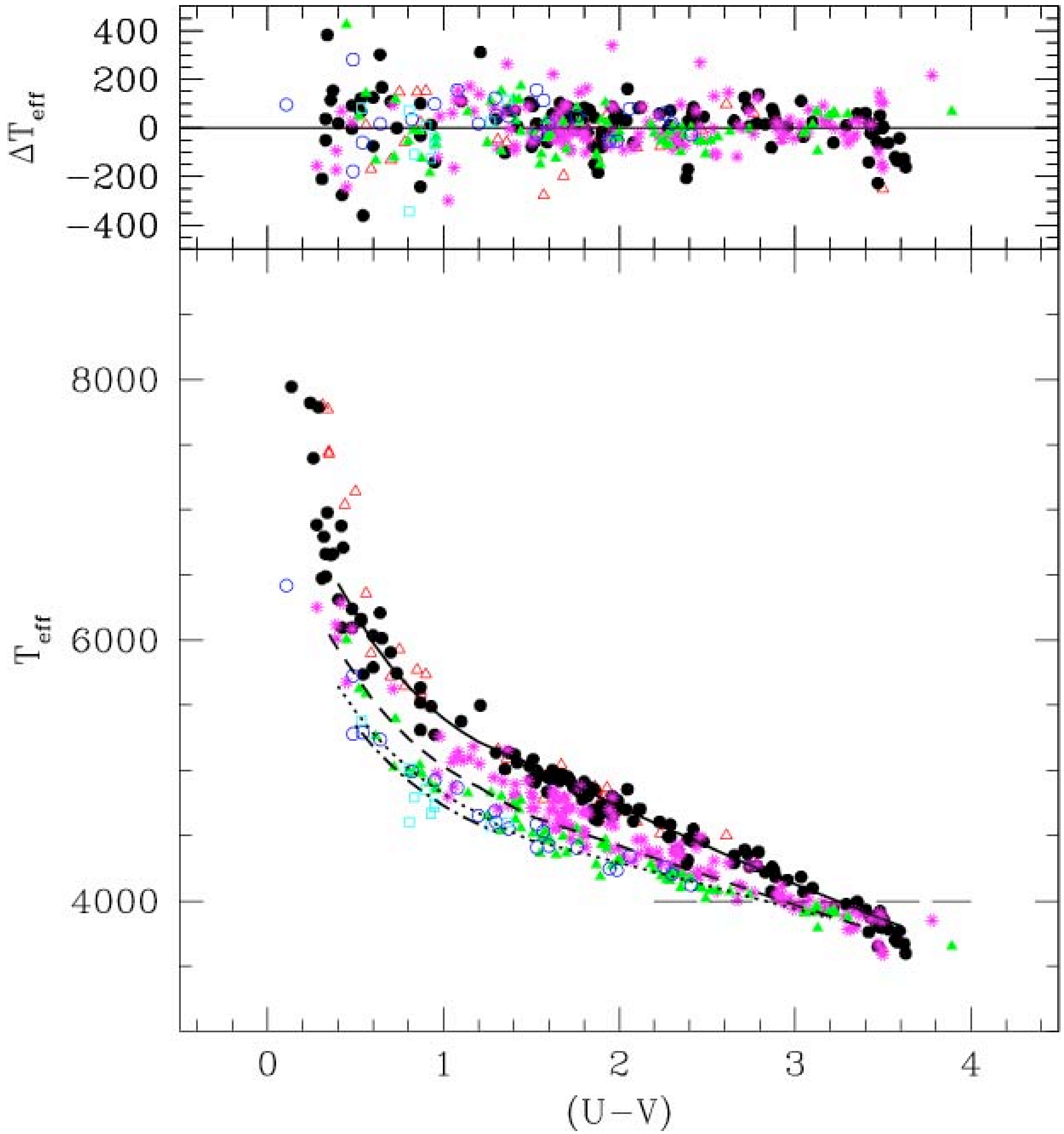


Figure 1. Formal solution of equations (2) and (3) in text for γ Ser at $\lambda_0 = 3.4$ μm. Curve 2 gives the relation between θ and T_e for equation (2) and curve 3 gives this relation for equation (3).



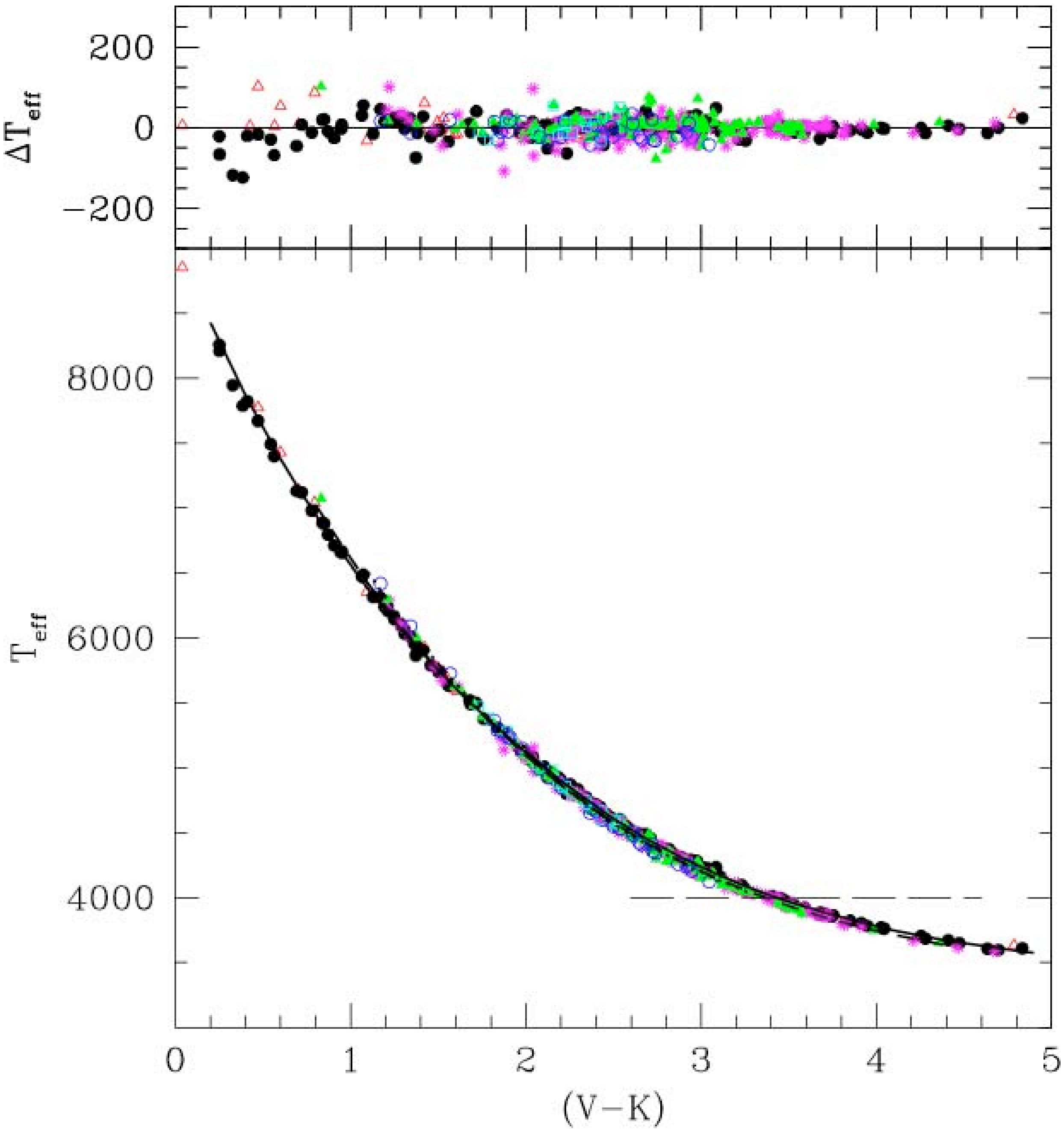
Alonso et al. 1999 (giants)

Symbols define metallicity regimes:

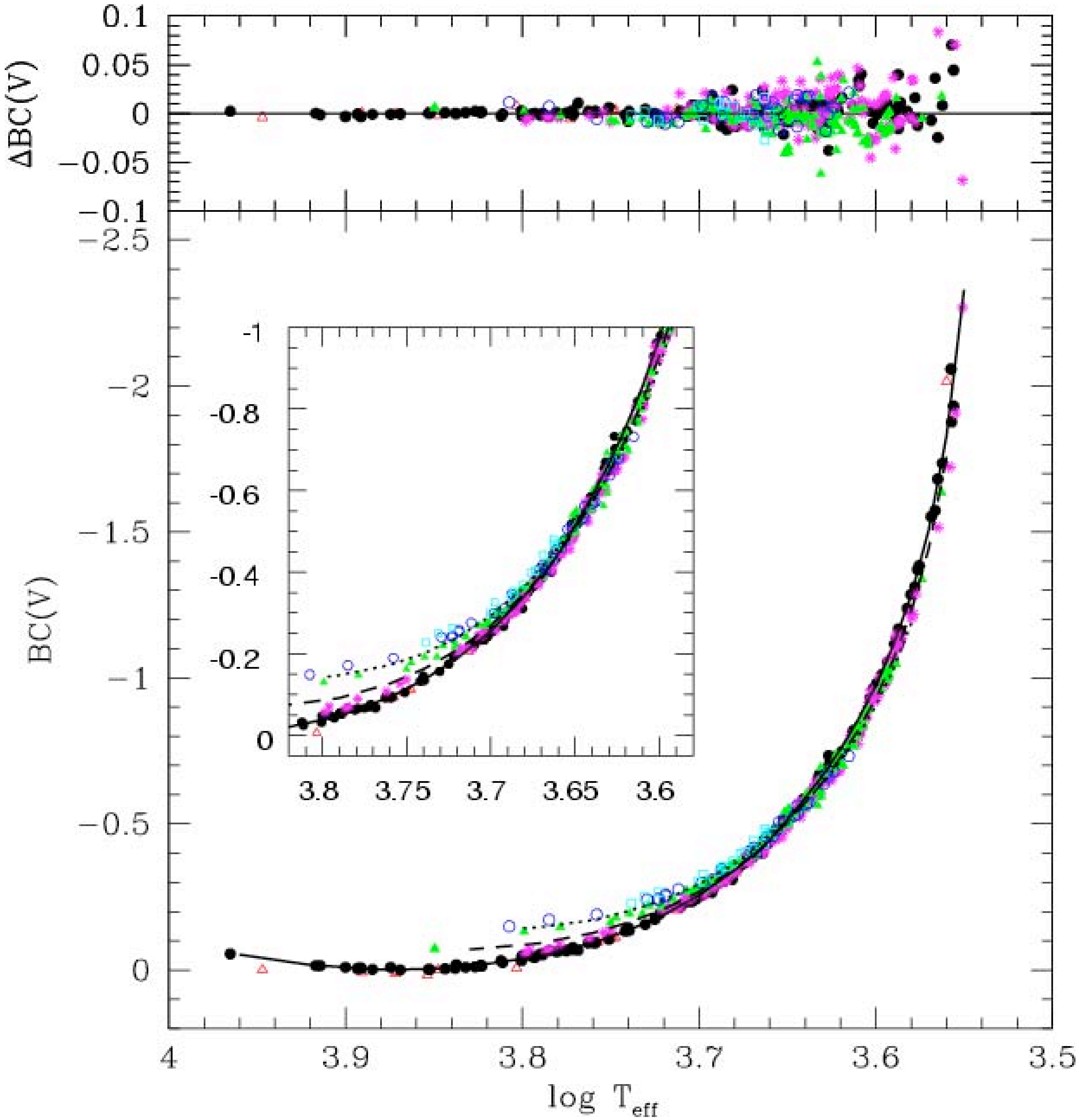
[Fe/H] > 0
0 to -0.25
-0.25 to -1
-1 to -2
-2 to -2.5
< -2.5

Which is which

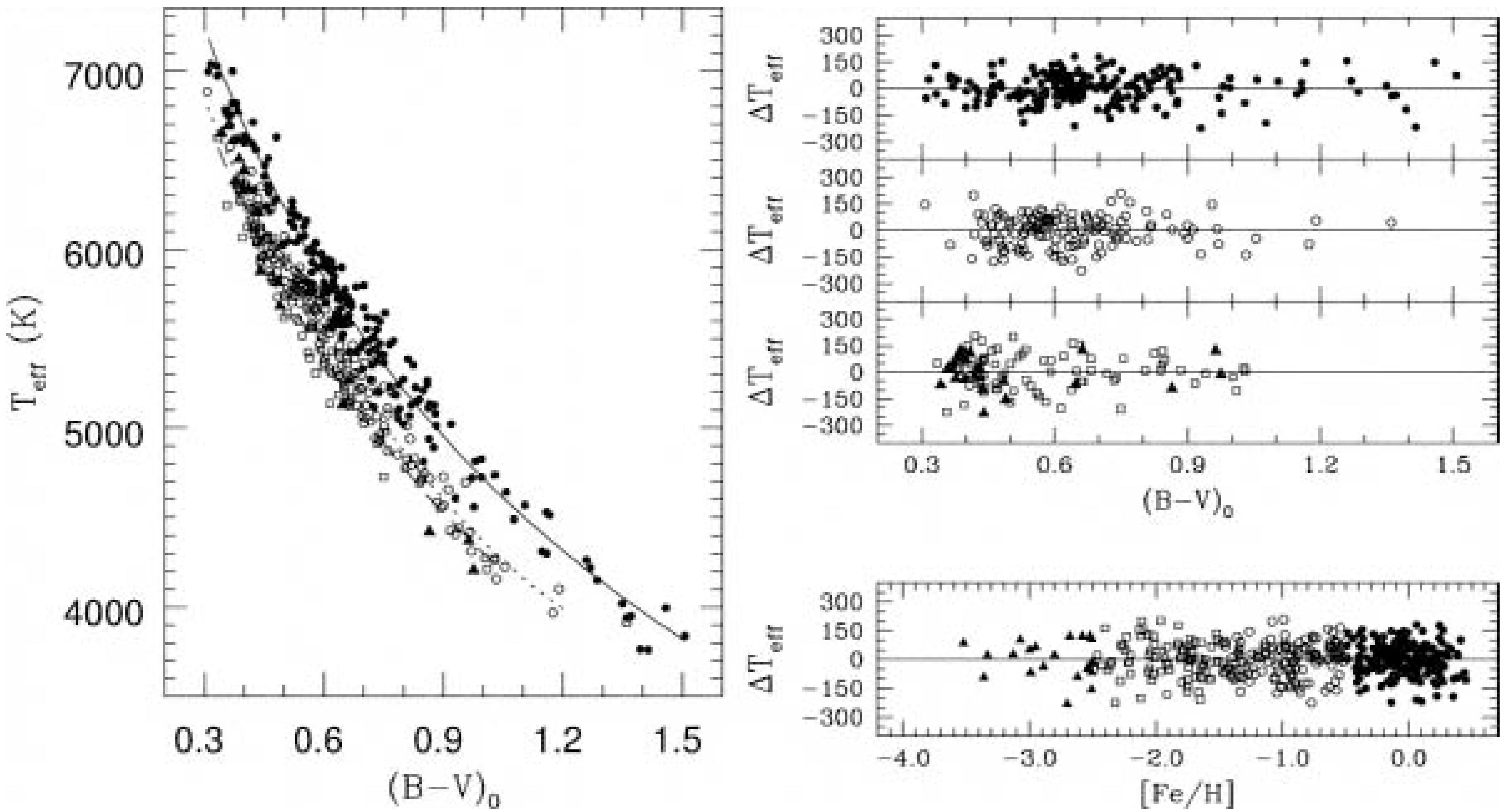
Degeneracies at hot and cool ends?



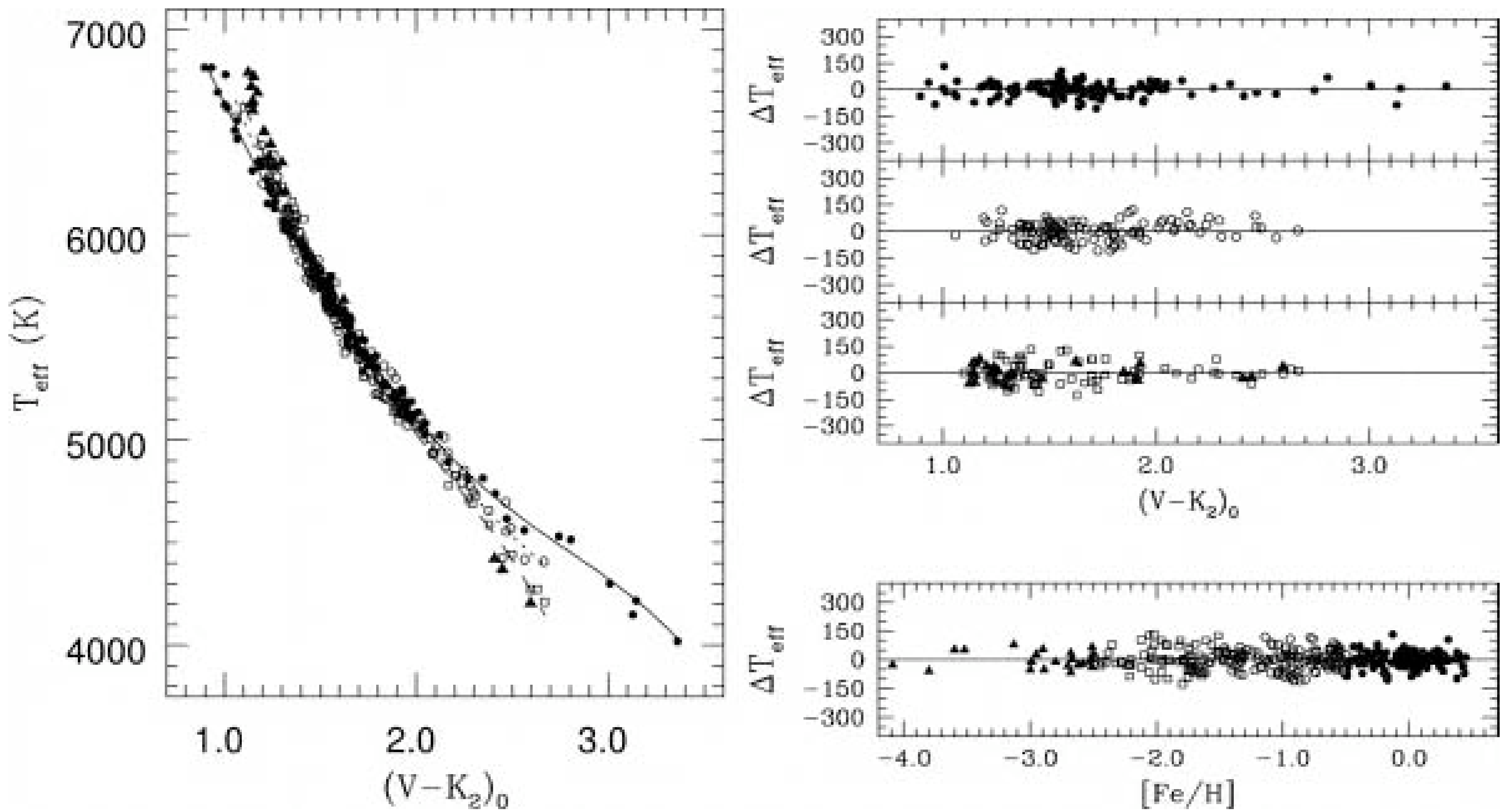
Alonso et al. 1999
(giants)



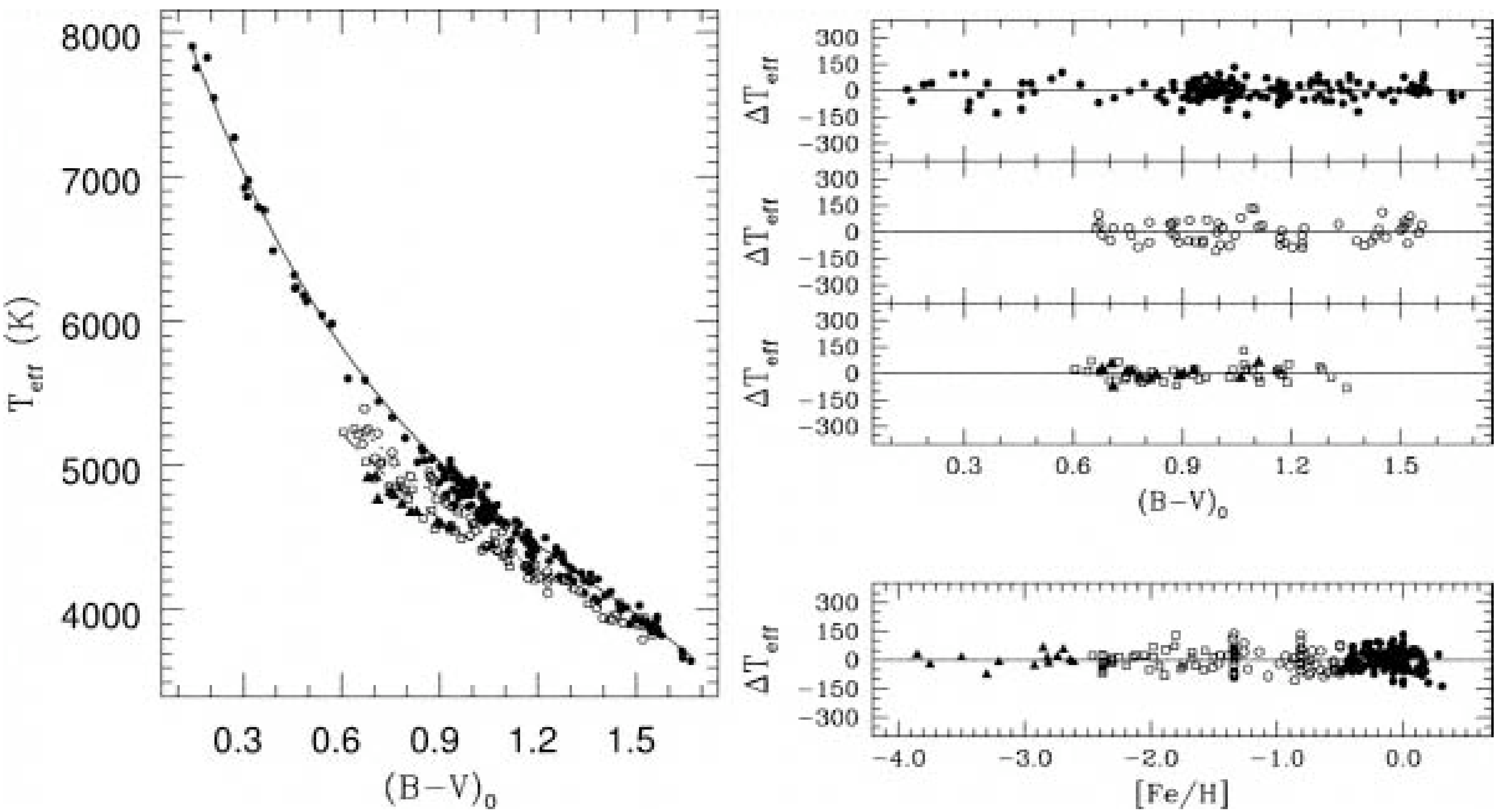
Alonso et al. 1999
(giants)



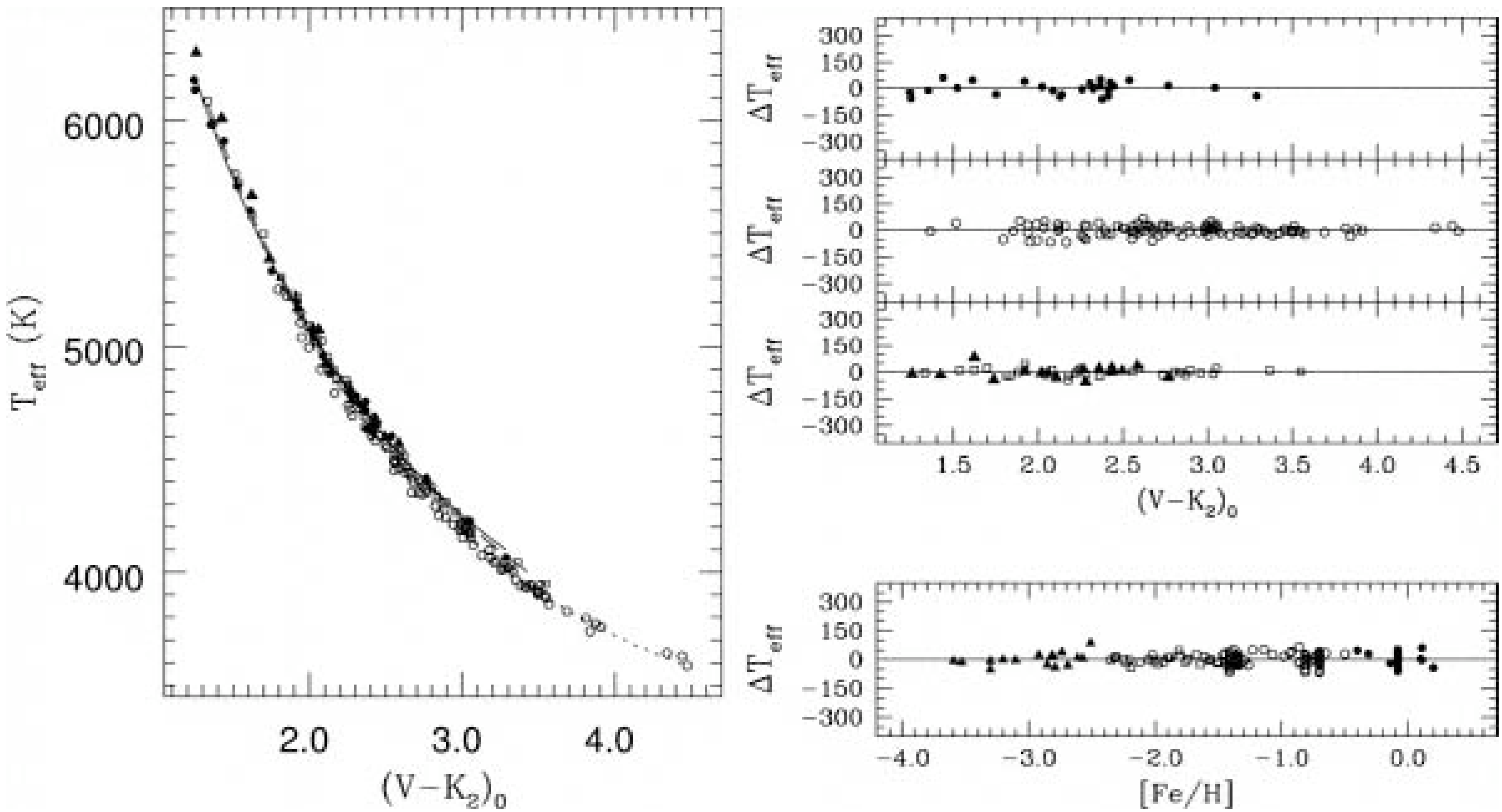
Ramirez & Melendez 2005 (main seq)



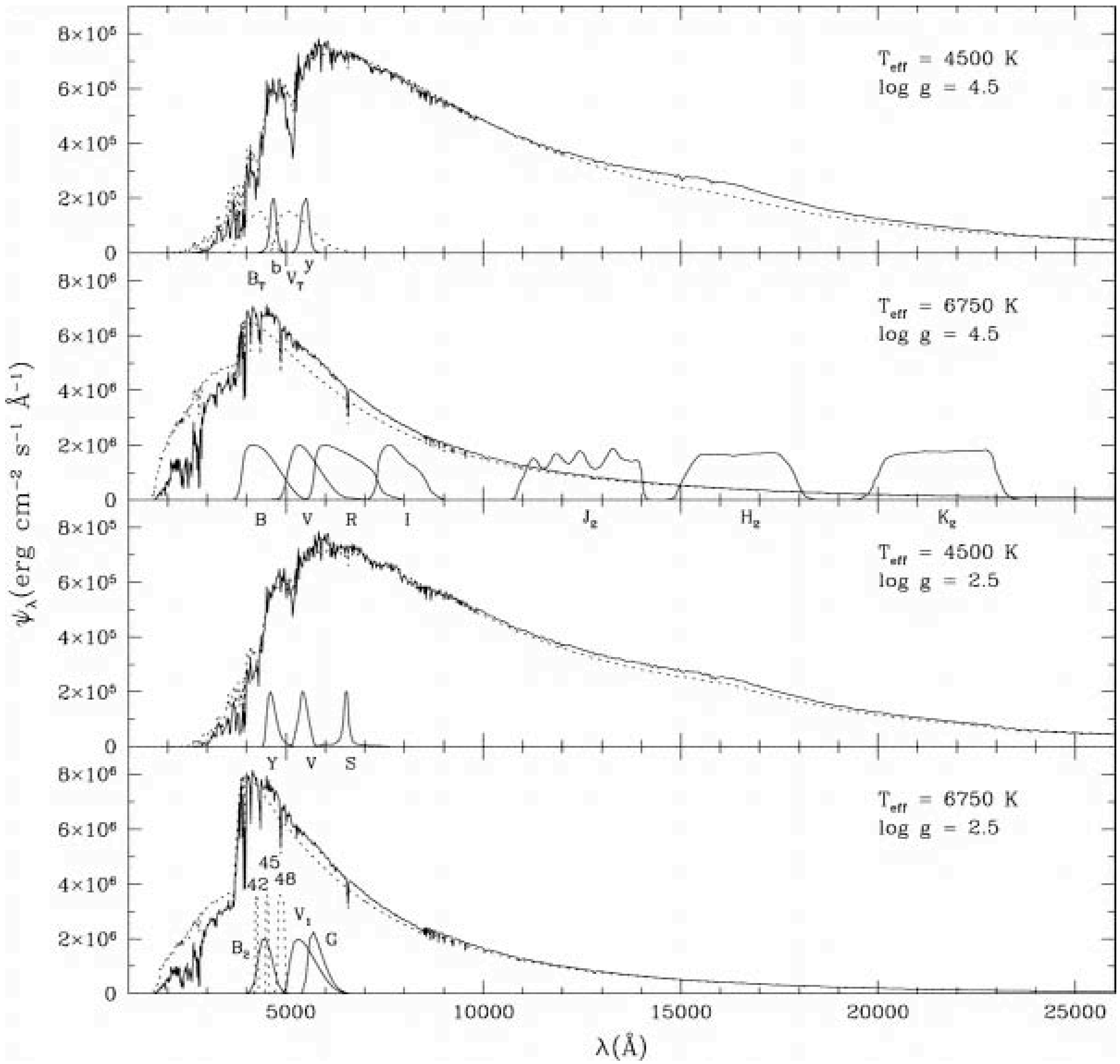
Ramirez & Melendez 2005 (main seq)



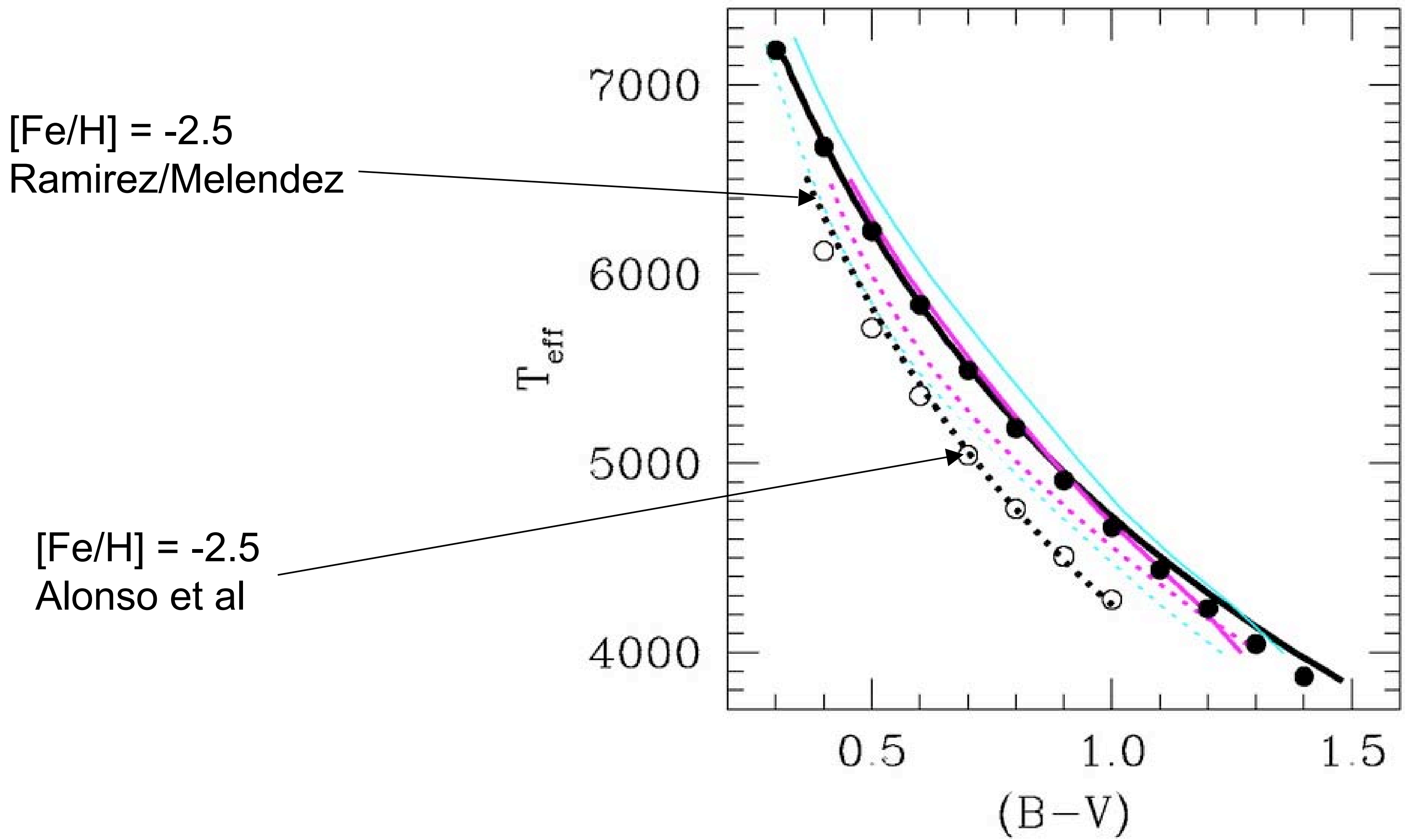
Ramirez & Melendez 2005 (giants)



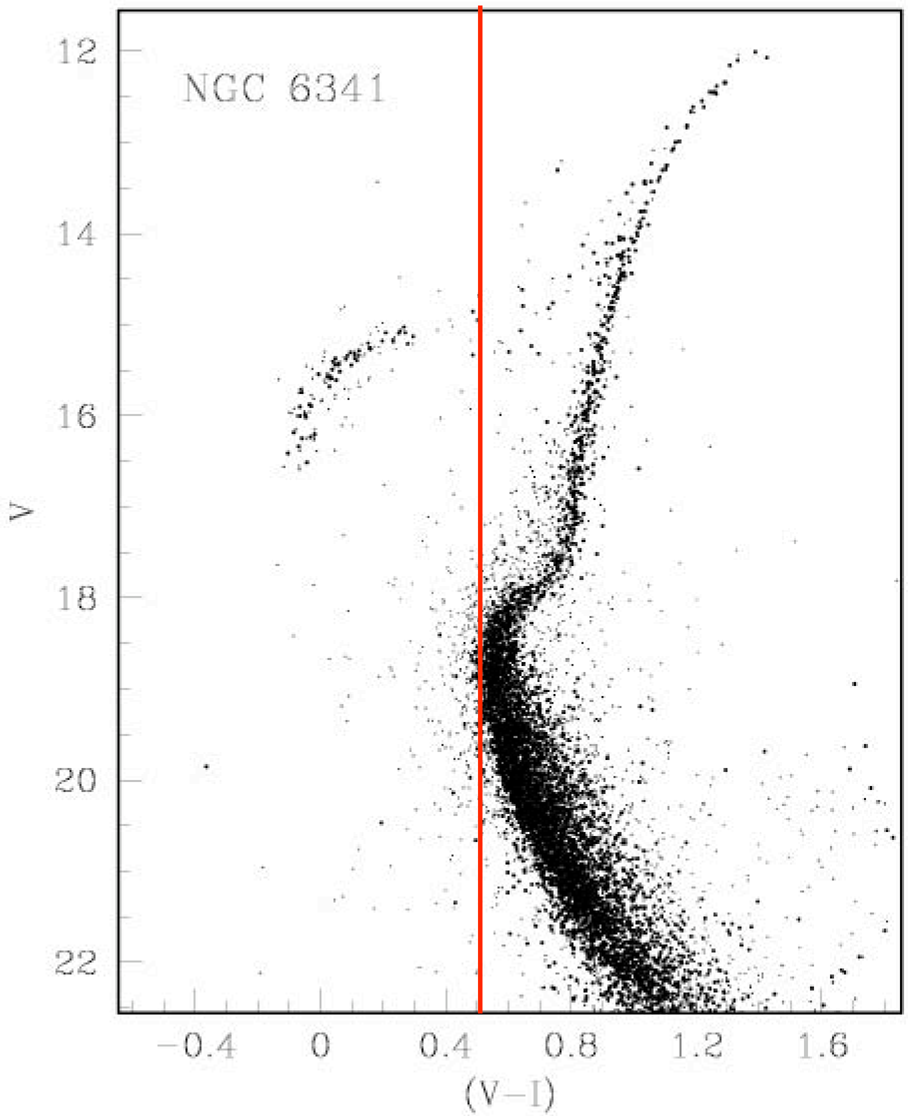
Ramirez & Melendez 2005 (giants)



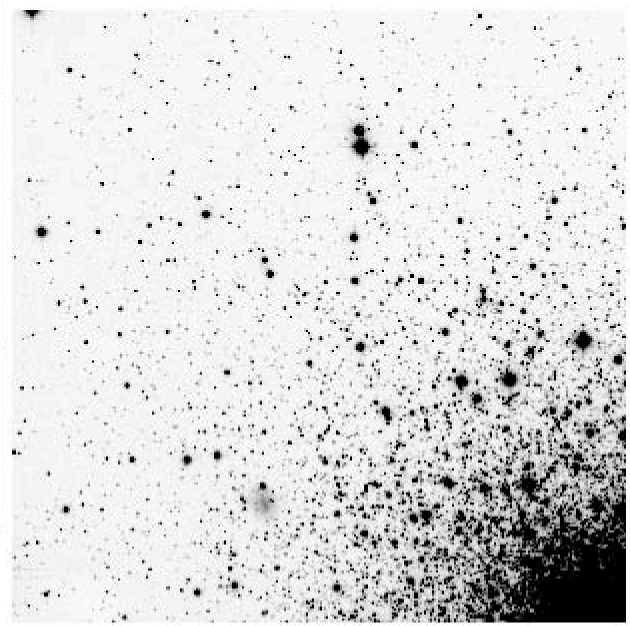
Ramirez & Melendez 2005

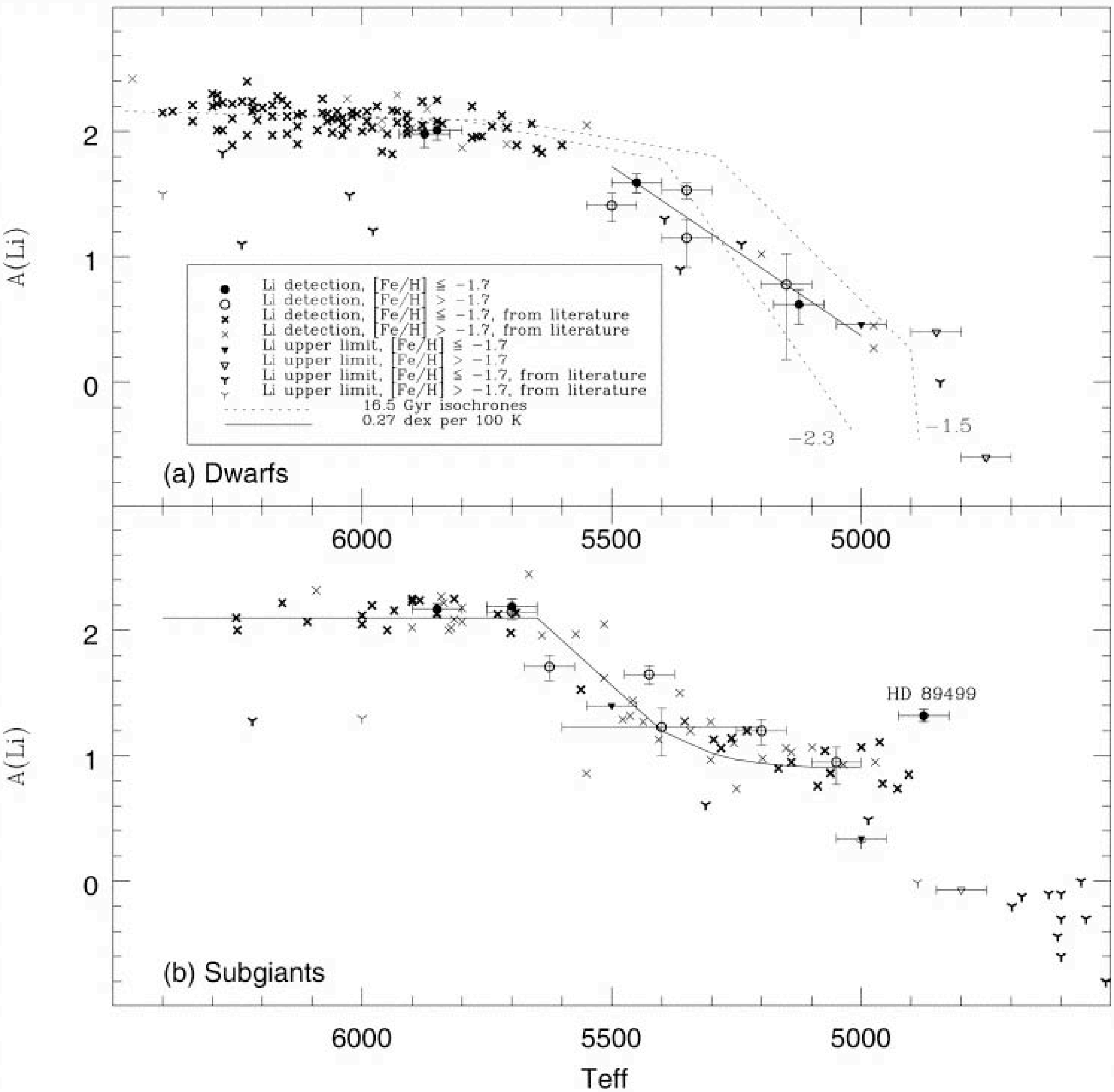


Ramirez & Melendez 2005 (main sequence)

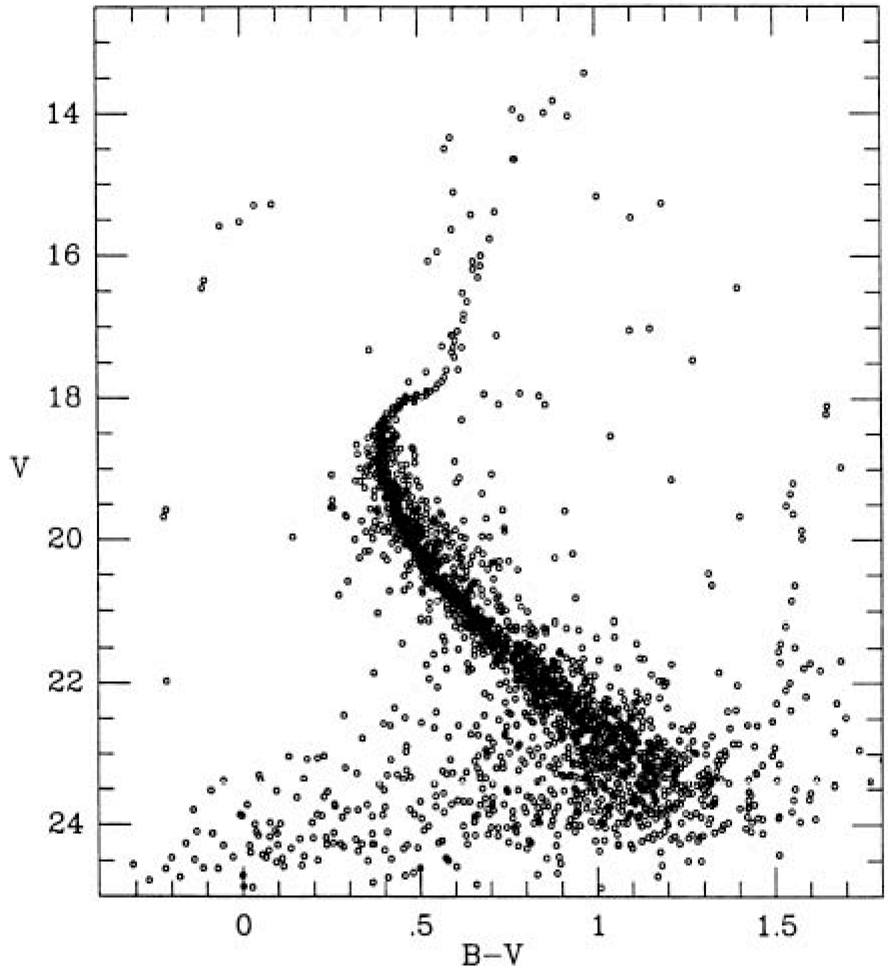


M92: [Fe/H] ~ -2.5

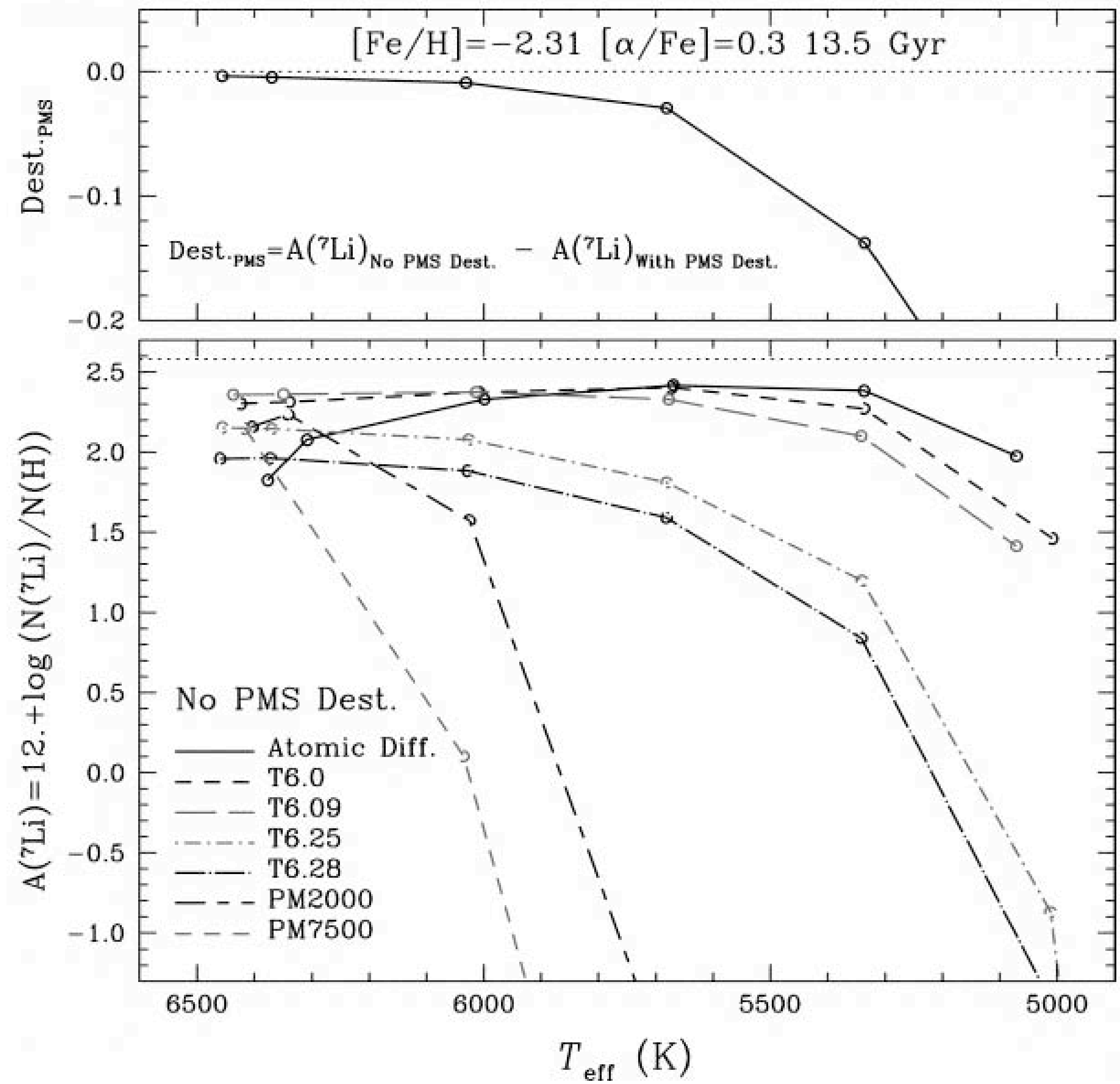




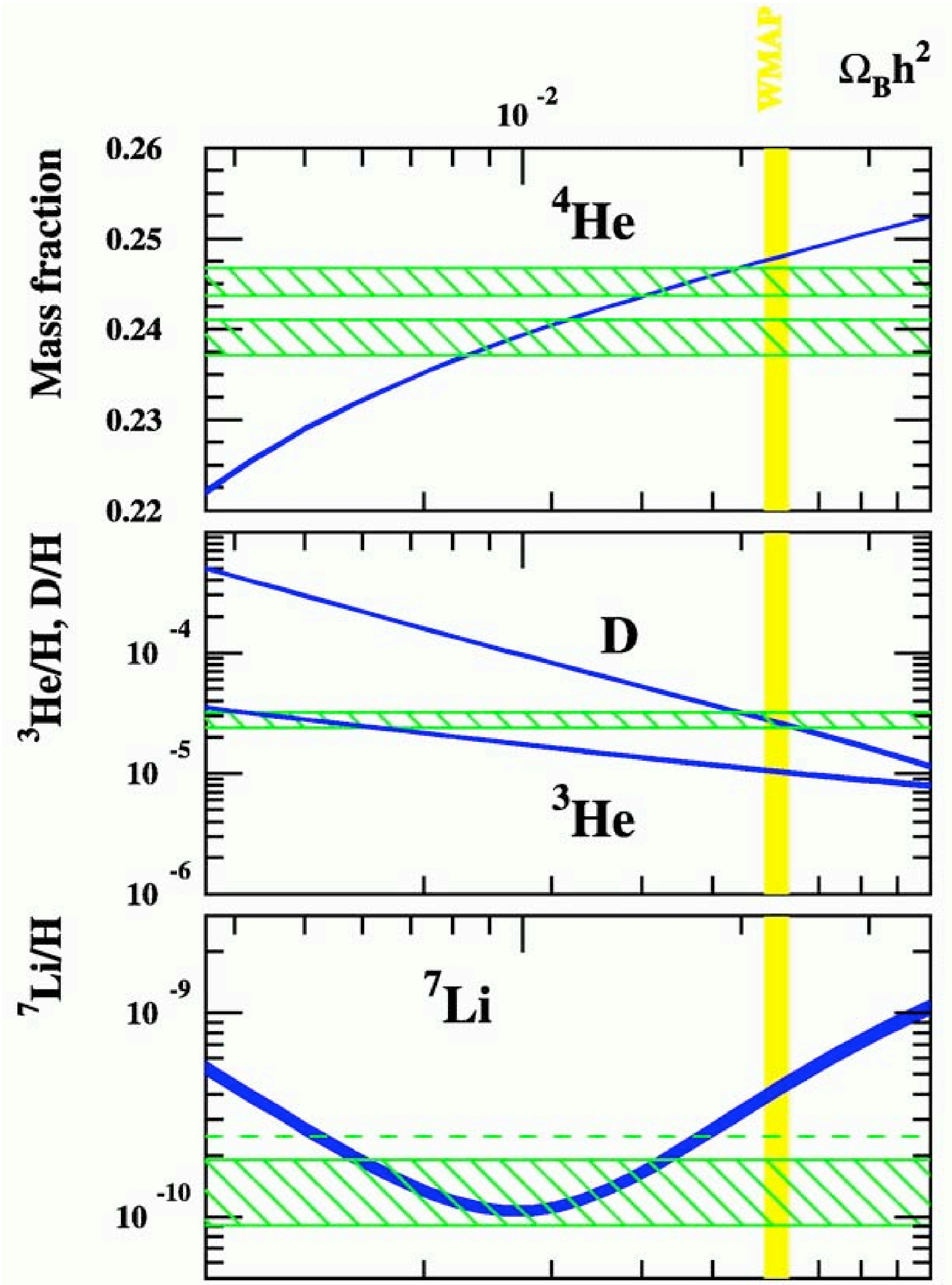
A(Li)
Li detection, [Fe/H] ≤ −1.7
Li detection, [Fe/H] > −1.7
Li detection, [Fe/H] ≤ −1.7, from literature
Li detection, [Fe/H] > −1.7, from literature
Li upper limit, [Fe/H] ≤ −1.7
Li upper limit, [Fe/H] > −1.7
Li upper limit, [Fe/H] ≤ −1.7, from literature
Li upper limit, [Fe/H] > −1.7, from literature
16.5 Gyr isochrones
0.27 dex per 100 K
−2.3
−1.5
(a) Dwarfs
HD 89499
(b) Subgiants
6000
5500
5000
Teff



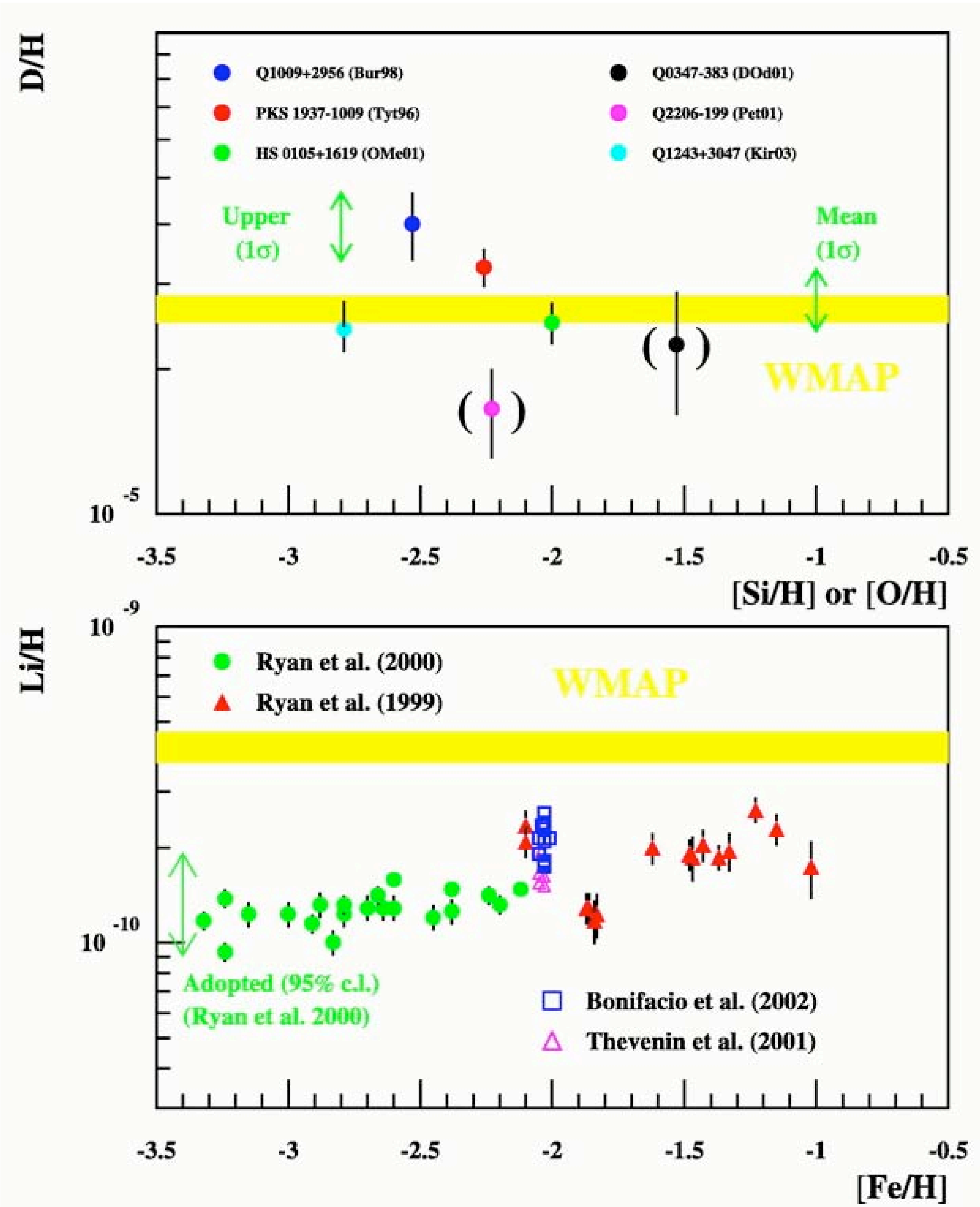
14
16
18
20
22
24
V
0
.5
1
1.5
B−V



[Fe/H]=−2.31 [α/Fe]=0.3 13.5 Gyr
Dest.PMS
Dest.PMS=A(7Li)No PMS Dest. − A(7Li)With PMS Dest.
0.0
−0.1
−0.2
A(7Li)=12.+log(N(7Li)/N(H))
2.5
2.0
1.5
1.0
0.5
0.0
−0.5
−1.0
No PMS Dest.
Atomic Diff.
T6.0
T6.09
T6.25
T6.28
PM2000
PM7500
6500
6000
5500
5000
Teff (K)



Coc et al. 2004



Coc et al. 2004