Hot UV Brights Stars in Globular Clusters

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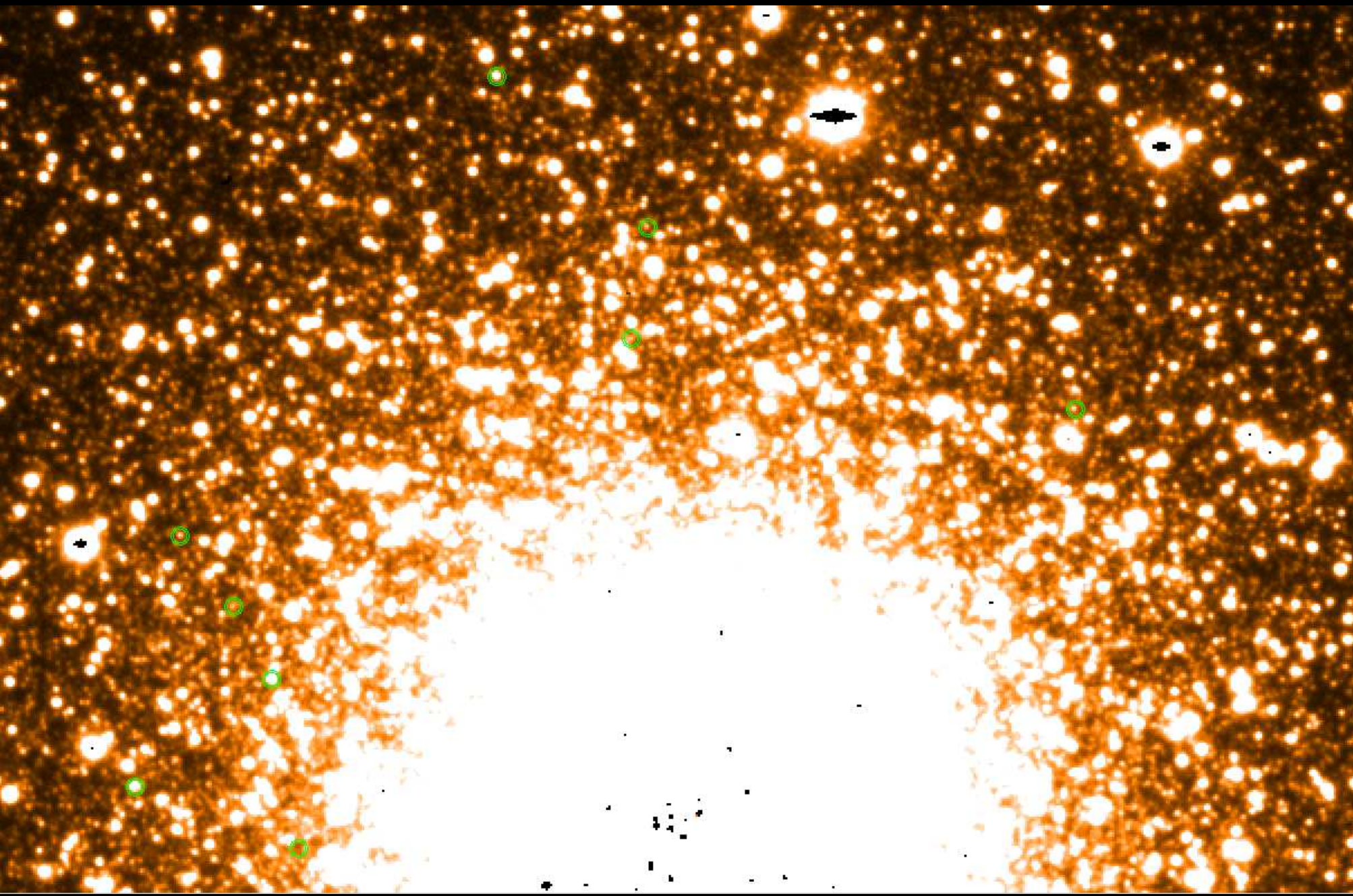
Globular Clusters

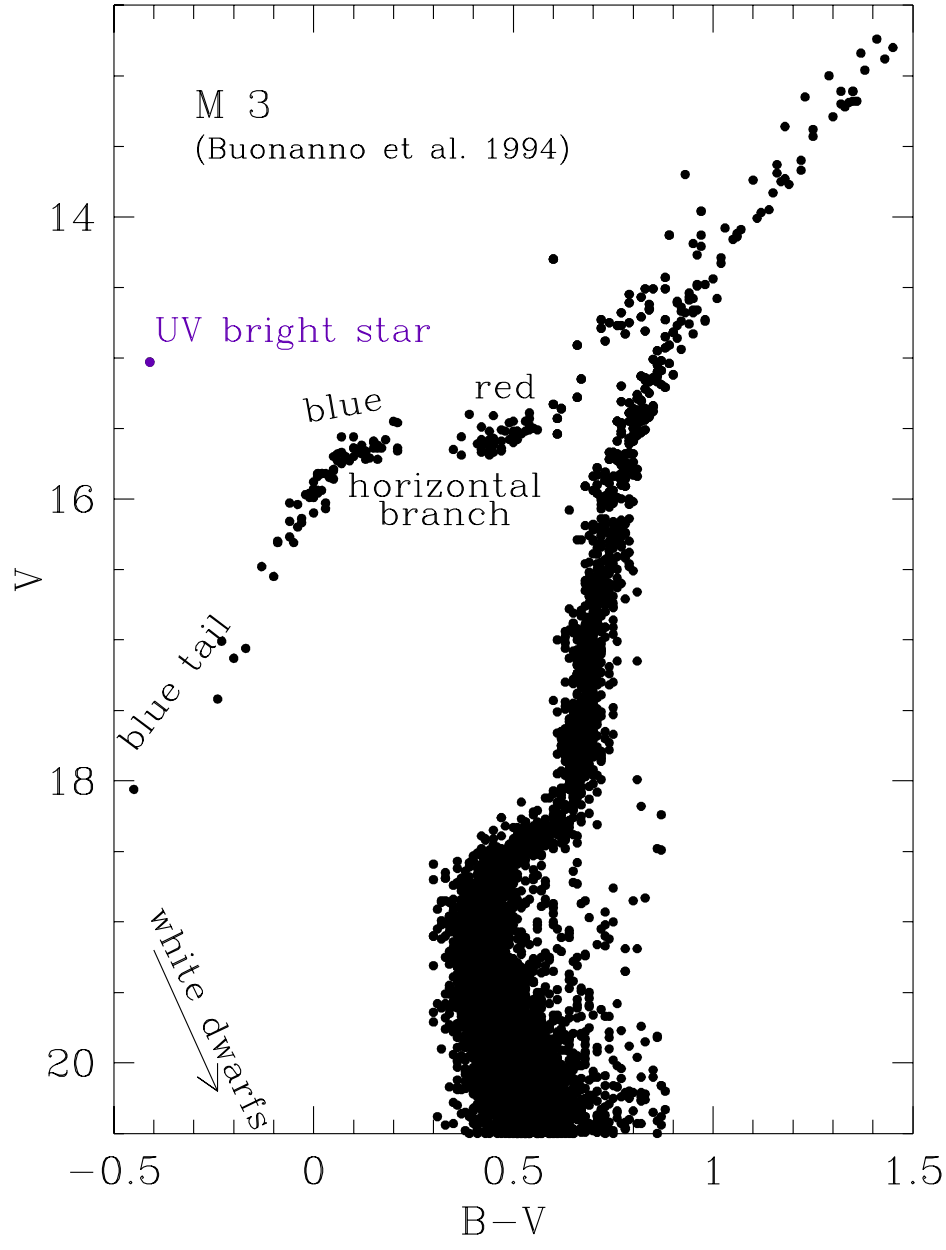
- some 10 000 to more than 1 000 000 stars with
  - same age
  - same distance and reddening
  - same initial chemical composition (mostly)
- best approximation of physicist's laboratory
- large distances $\Rightarrow$ faint stars
- high densities $\Rightarrow$ crowding (next page shows FORS2 image of NGC 6388, seeeing 0.6", stars marked are the ones from Moehler et al. (2006, A&A 455, 943)



UV Bright Stars

Traditionally (Zinn et al. 1972, see also Barnard 1900 and Greenstein 1939 for early observations)

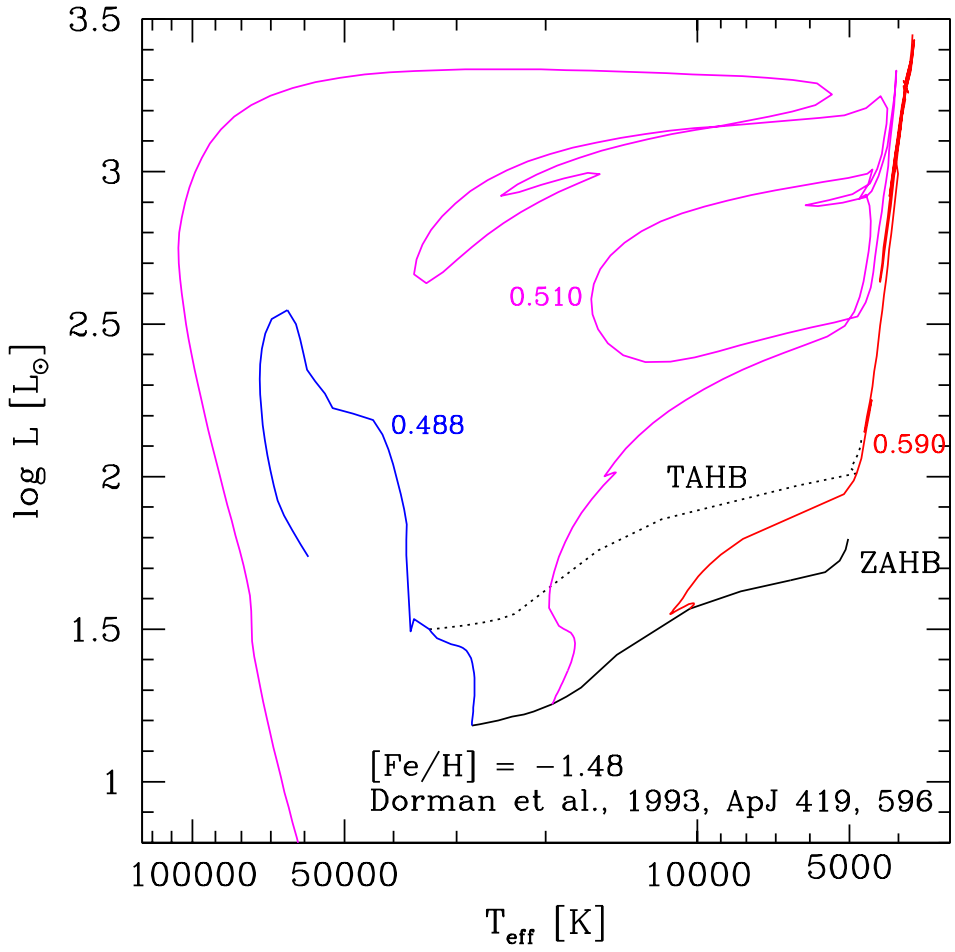
- ⋆ Stars brighter than the horizontal branch and bluer than the red giant branch
- ⋆ hot UV bright stars at least partly responsible for the UV excess in elliptical galaxies



UV Bright Stars

stars evolving away from the

- ⋆ (extreme) horizontal branch (post-(E)HB stars)
- ⋆ asymptotic giant branch (post-AGB stars)



Hot UV Bright Stars *(Zinn 1974)*

Correlation between horizontal branch morphology and type of UV bright stars: At a given metallicity clusters with

- ⋆ redder horizontal branches show more post-AGB stars (e.g. M 15 with a planetary nebula, M 3, but also M 13)
- ⋆ bluer horizontal branches show more post-(E)HB stars (e.g. NGC 6752)

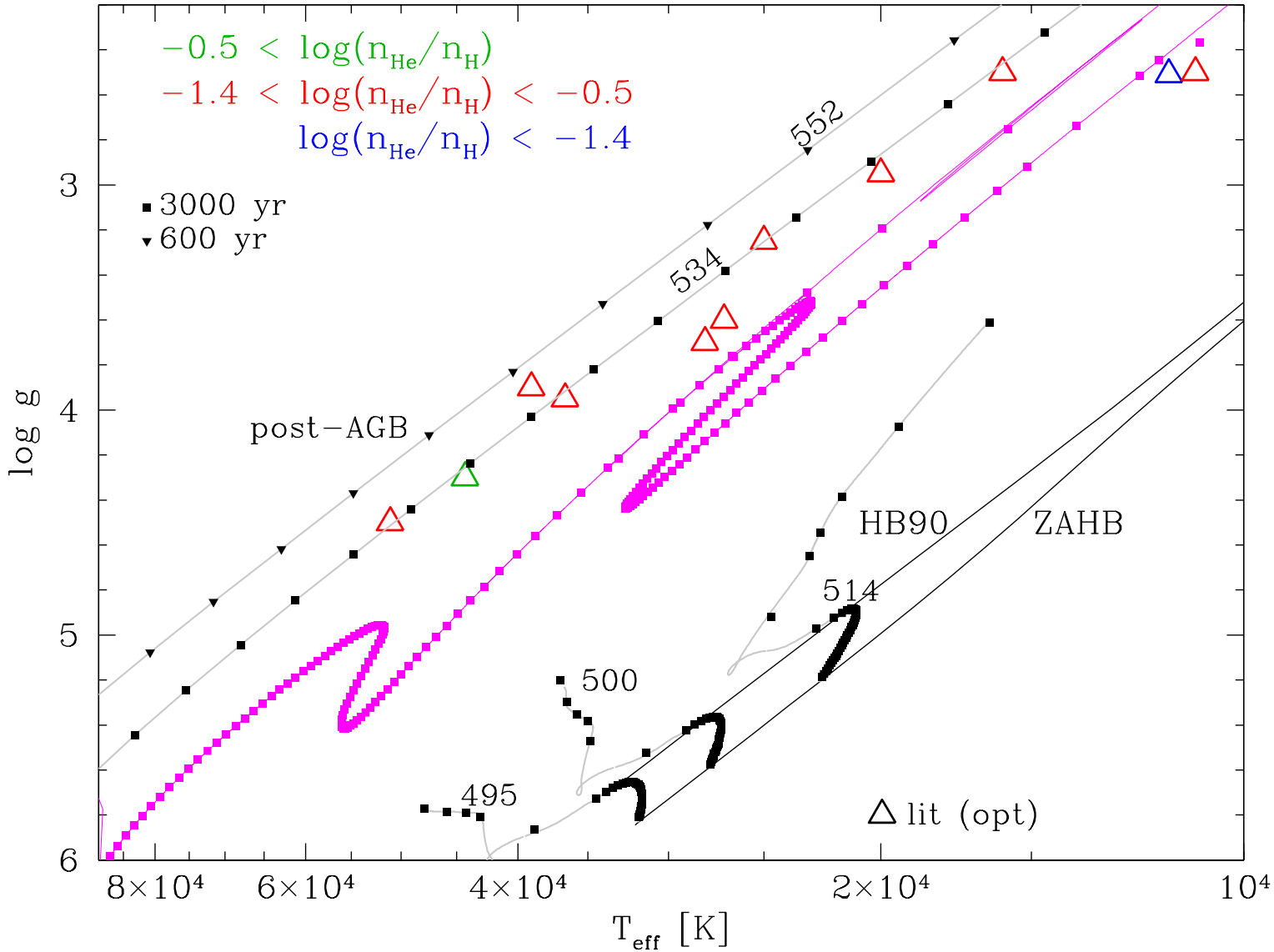
Hot UV Bright Stars

ground-based searches (Chayer et al. 2015; Dixon et al. 1994, 1995, 2004; Glaspey et al. 1985; Heber & Kudritzki 1986; Heber et al. 1993; Jasniewicz et al. 2004; Mooney et al. 2004; Rauch et al. 2002; Thompson et al. 2007)

- mostly cool UV bright stars ($T_{eff} < 9000$ K)
- hot UV bright stars: only (luminous) post-AGB stars
  - minimum mass required
  - fast evolution

Hot UV Bright Stars

(ground-based searches)



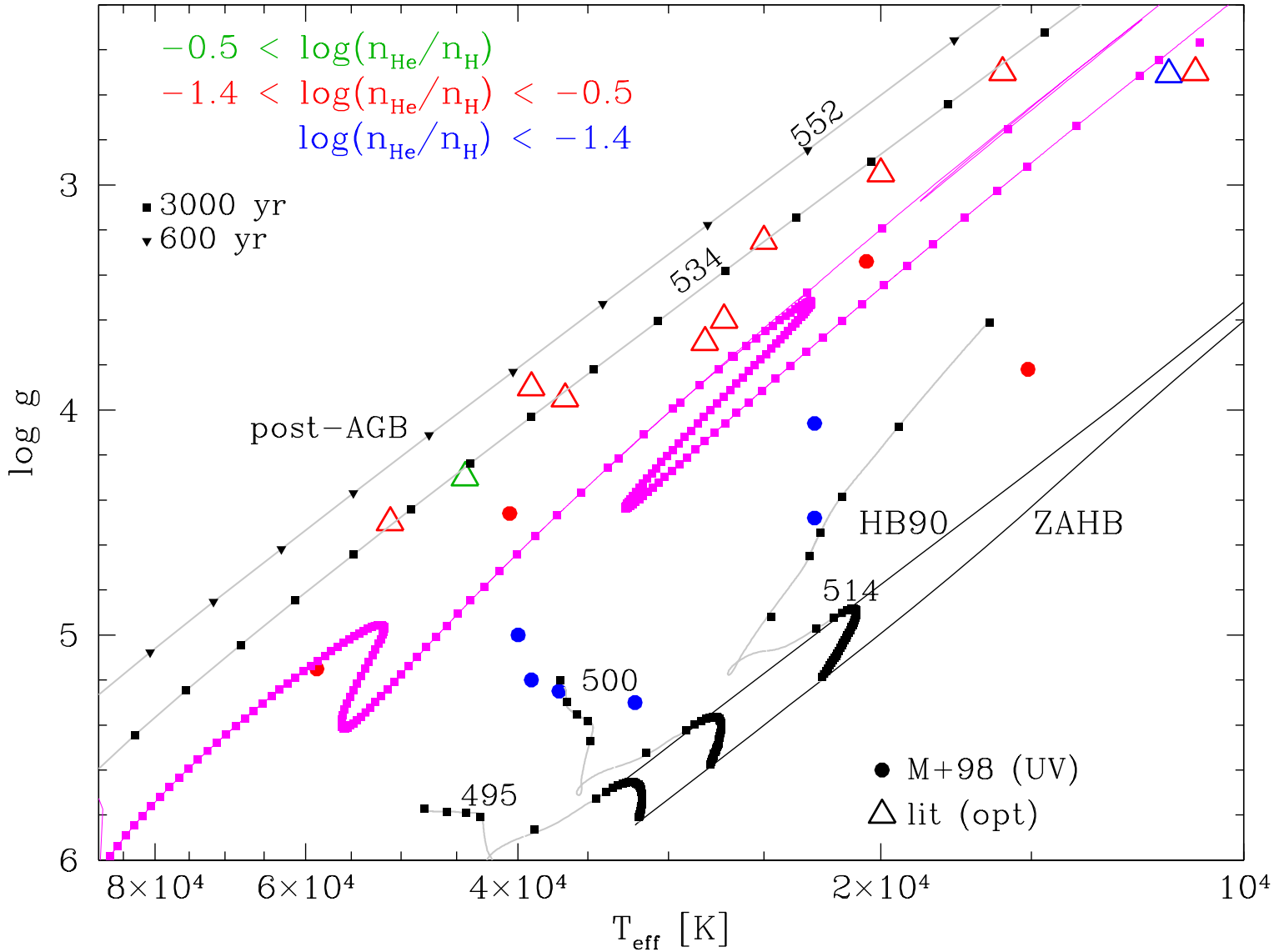
Hot UV Bright Stars

- ⋆ hot UV bright stars emit most of their flux in the UV
- ⋆ EHB stars do not pass through the AGB ⇒ less luminous

⇒ many hot UV bright stars may have been missed in ground-based searches
⇒ UV based searches:

- ⋆ many new hot UV bright stars
- ⋆ spectroscopic analyses (UIT, Moehler et al. 1998)

Hot UV Bright Stars - UIT



Hot UV Bright Stars - UIT

UV-selected stars mainly

- post-(E)HB stars and post-early AGB stars
  - slower evolution
  - low mass progenitors
- rarely classical post-AGB stars (lack of planetary nebulae)
- post-(E)HB stars show evidence for diffusion (e.g. helium deficiency)
- post-(early) AGB stars do not show evidence for the third dredge-up

Hot post-AGB Candidates - UIT/GALEX

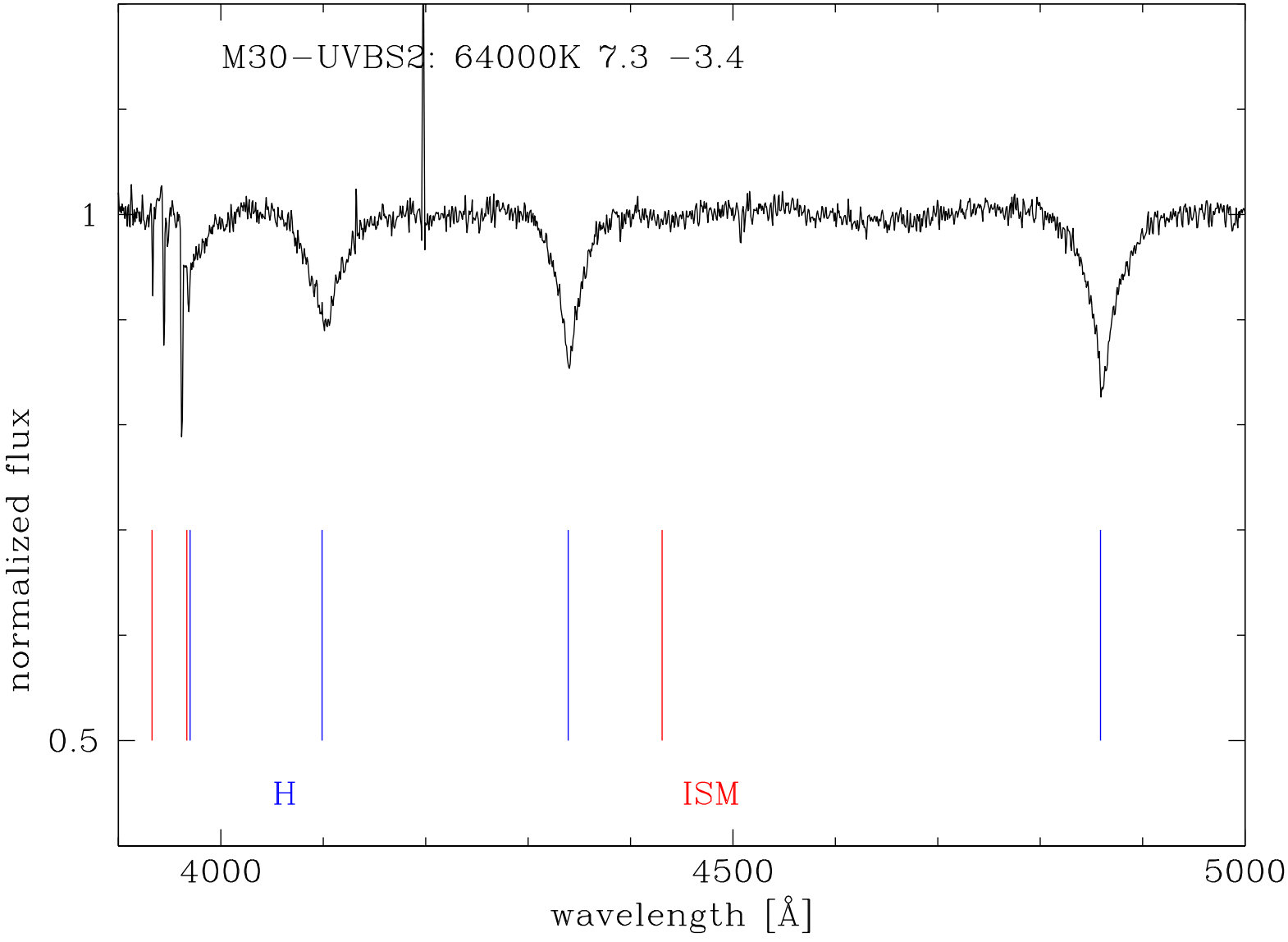
- new studies find fewer than expected post-AGB stars in M 32 (Brown et al. 2008) and the Galactic halo (Weston et al. 2010)
- situation in globular clusters unclear
- select hot post-AGB candidates from UIT and GALEX photometry
- Caveat: ground-based observations are not possible in the cores of the globular clusters

Hot post-AGB Candidates - UIT/GALEX

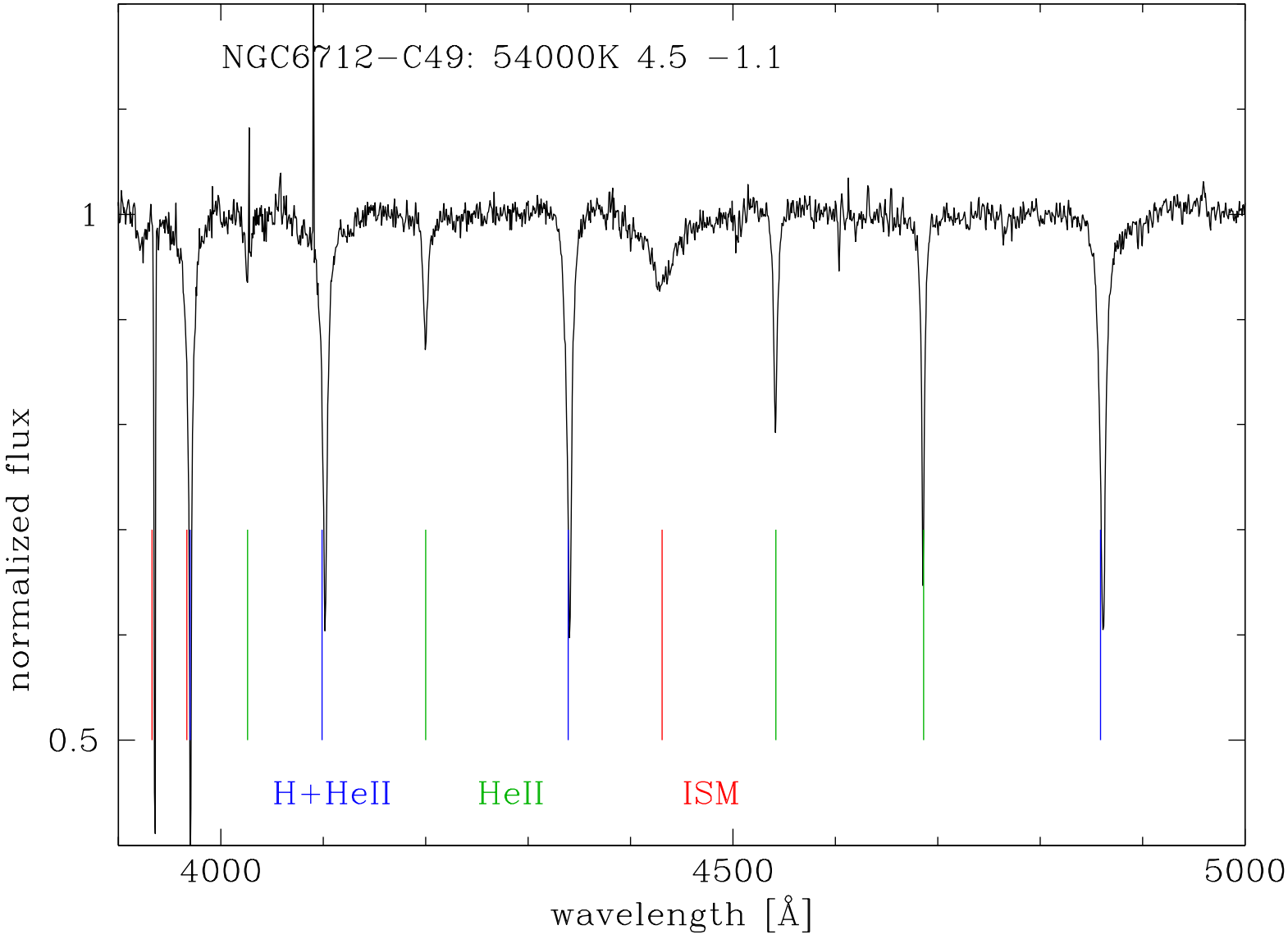
cluster	[Fe/H]	HB type	M_V	observ.	predict. pAGB
ω Cen	-1.5:	RHB–EHB	-10.3	7	1–8
M 22	-1.7	BHB–EHB	-8.5	1	0–2
NGC 6712	-1.0	HHB (R)	-7.5	1	0–1
M 30	-2.4	HHB (B)	-7.5	1	0–1
M 4	-1.2	HHB	-7.2	1	0–1

HHB= horizontal HB, i.e. no blue tail

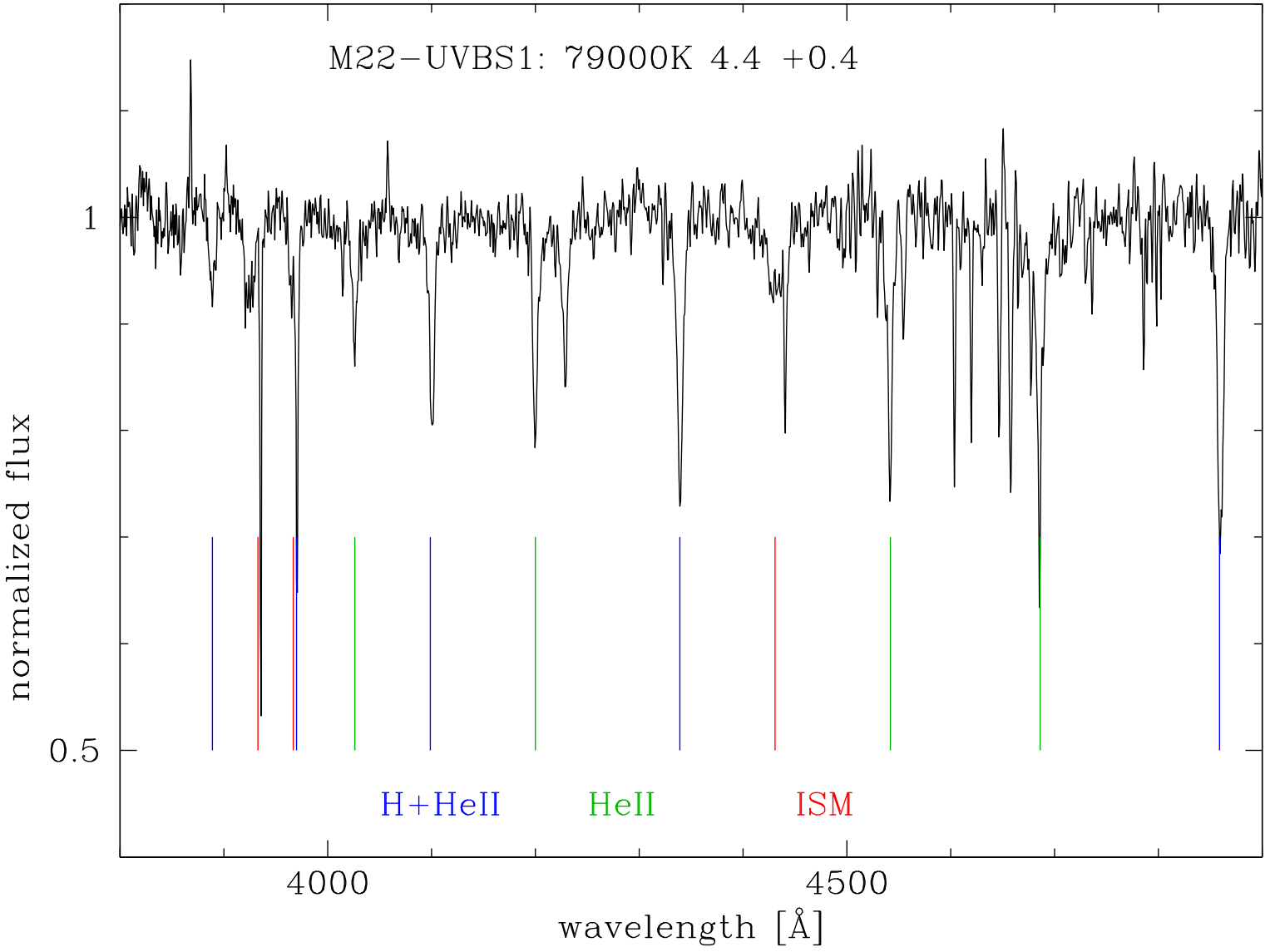
M30-UVBS2: Foreground White Dwarf



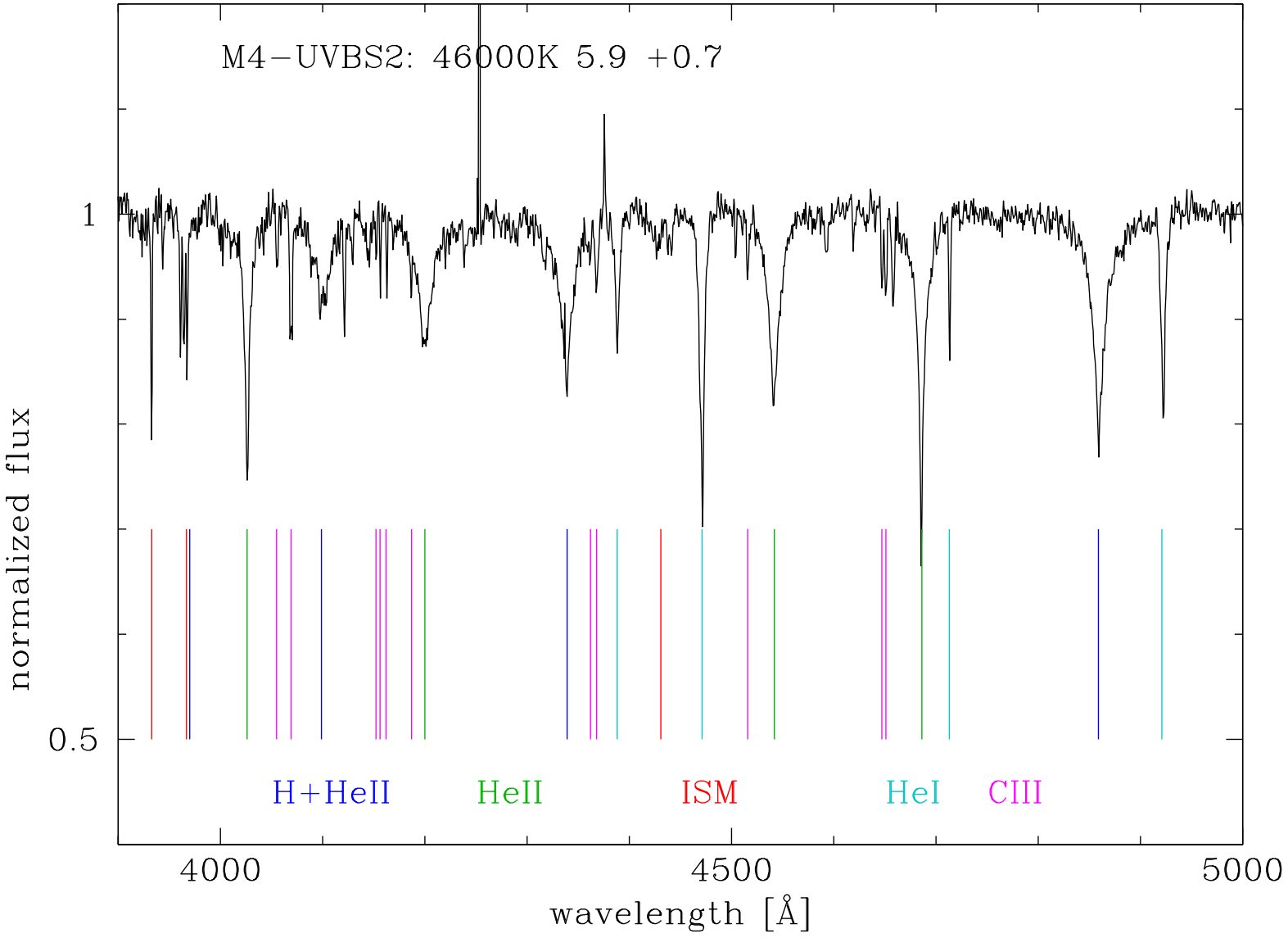
NGC 6712-C49: post-AGB



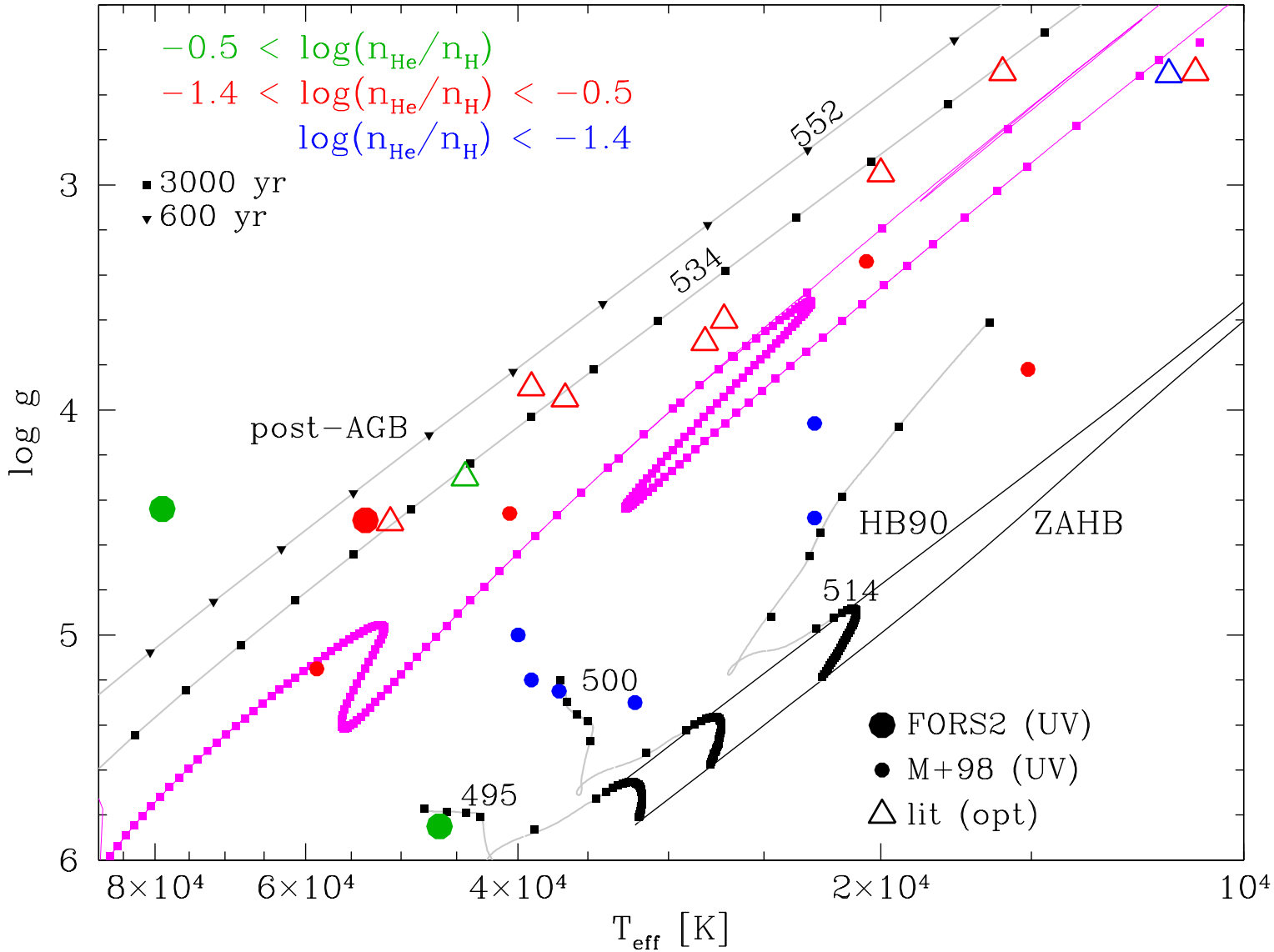
M22-UVBS1: post-AGB (contaminated!)



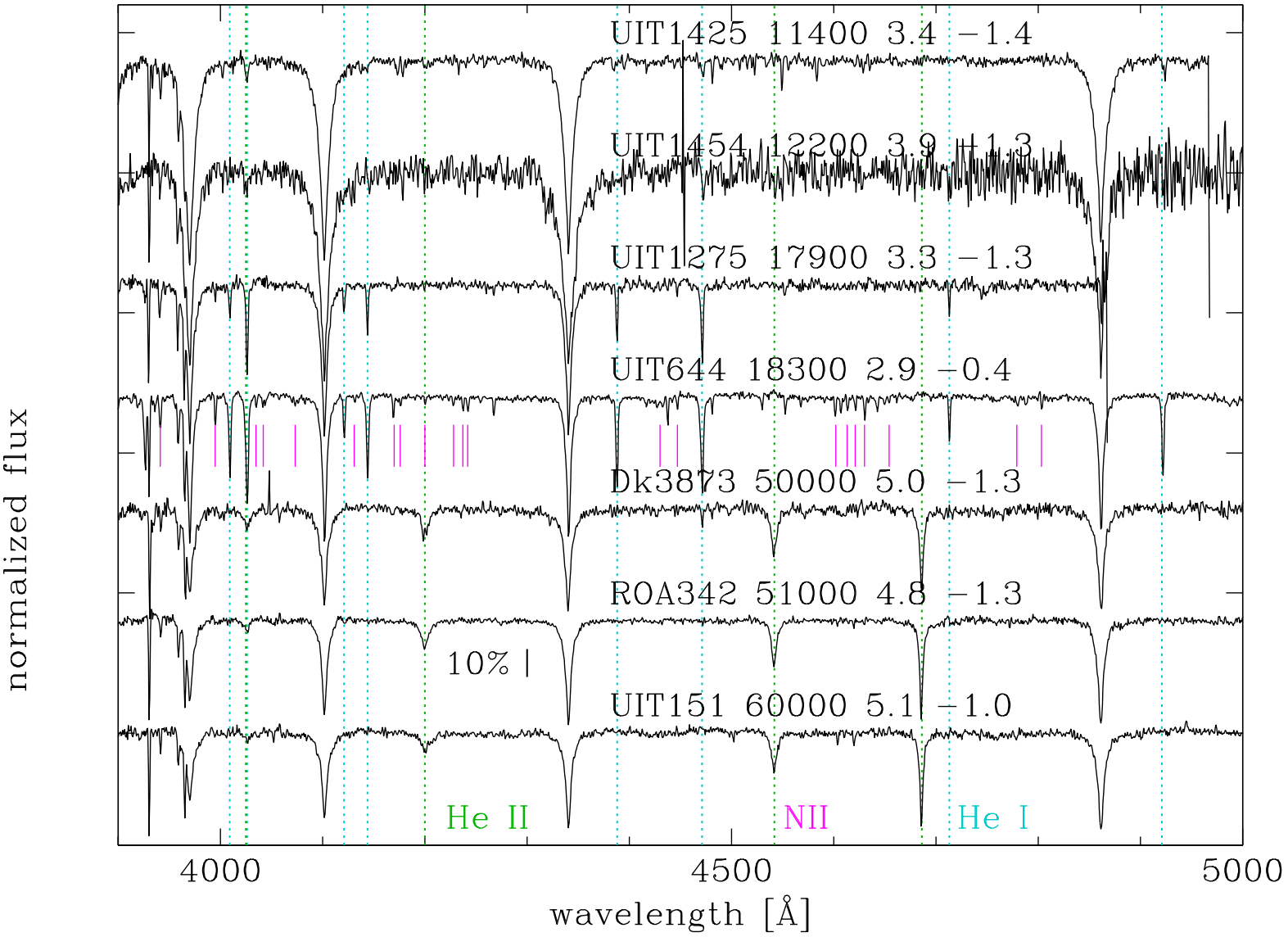
M4-UVBS2: White Dwarf Merger(?)



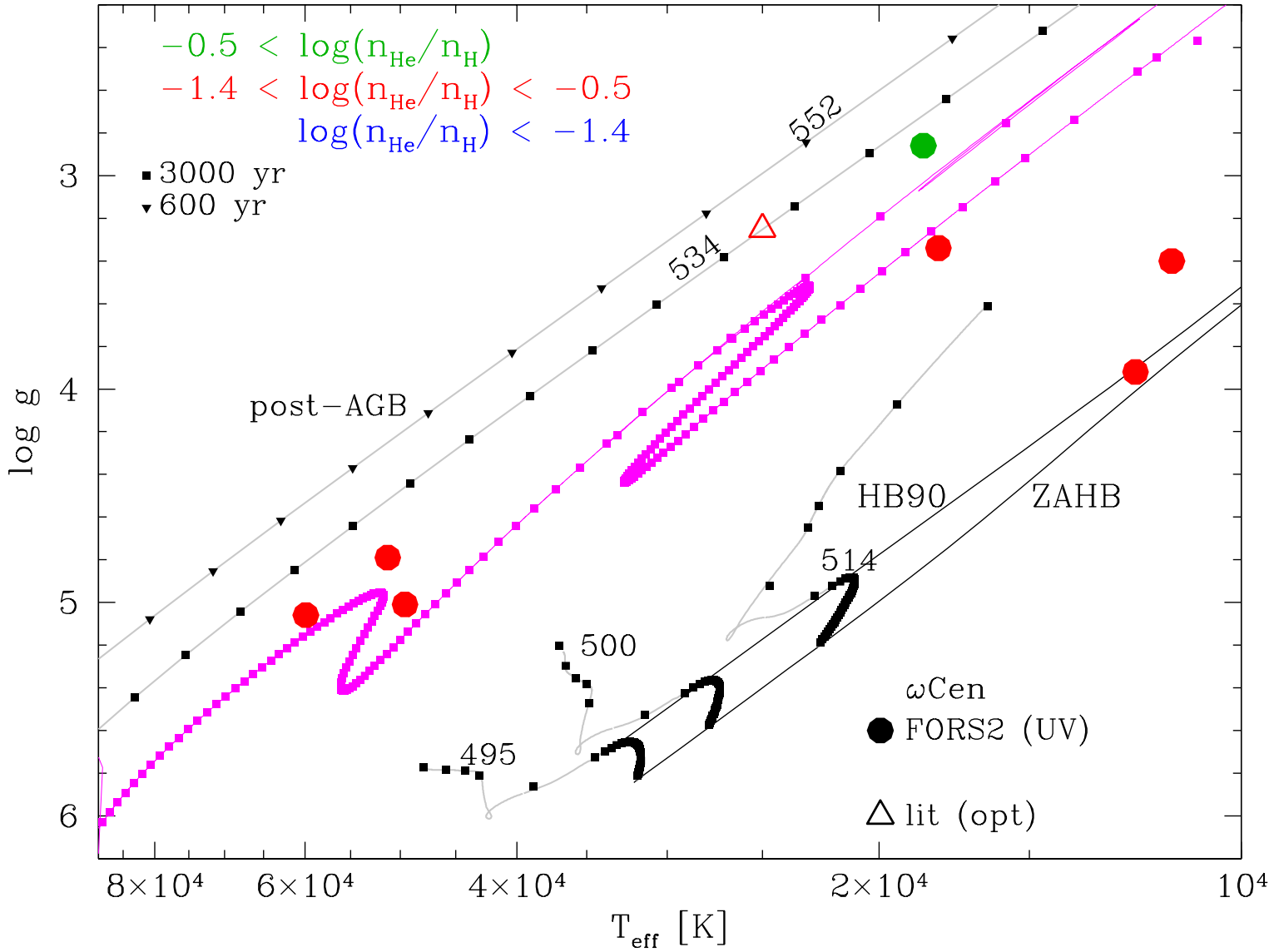
Hot UV Bright Stars (w/o ω Cen)



ω Cen


UIT1425 11400 3.4 −1.4
UIT1454 12200 3.9 −1.3
UIT1275 17900 3.3 −1.3
UIT644 18300 2.9 −0.4
Dk3873 50000 5.0 −1.3
ROA342 51000 4.8 −1.3
10%
UIT151 60000 5.1 −1.0
He II
NII
He I
normalized flux
4000
4500
5000
wavelength [Å]

Hot UV Bright Stars (ω Cen)



Conclusions

- ⋆ UV photometry provides good criteria to select hot UV-bright star candidates
- ⋆ Spectroscopy is necessary to determine the evolutionary status of a star (e.g. foreground white dwarf in M 30, helium-rich “EHB” star in M 4)