Nucleosynthesis signatures in four hot subdwarfs

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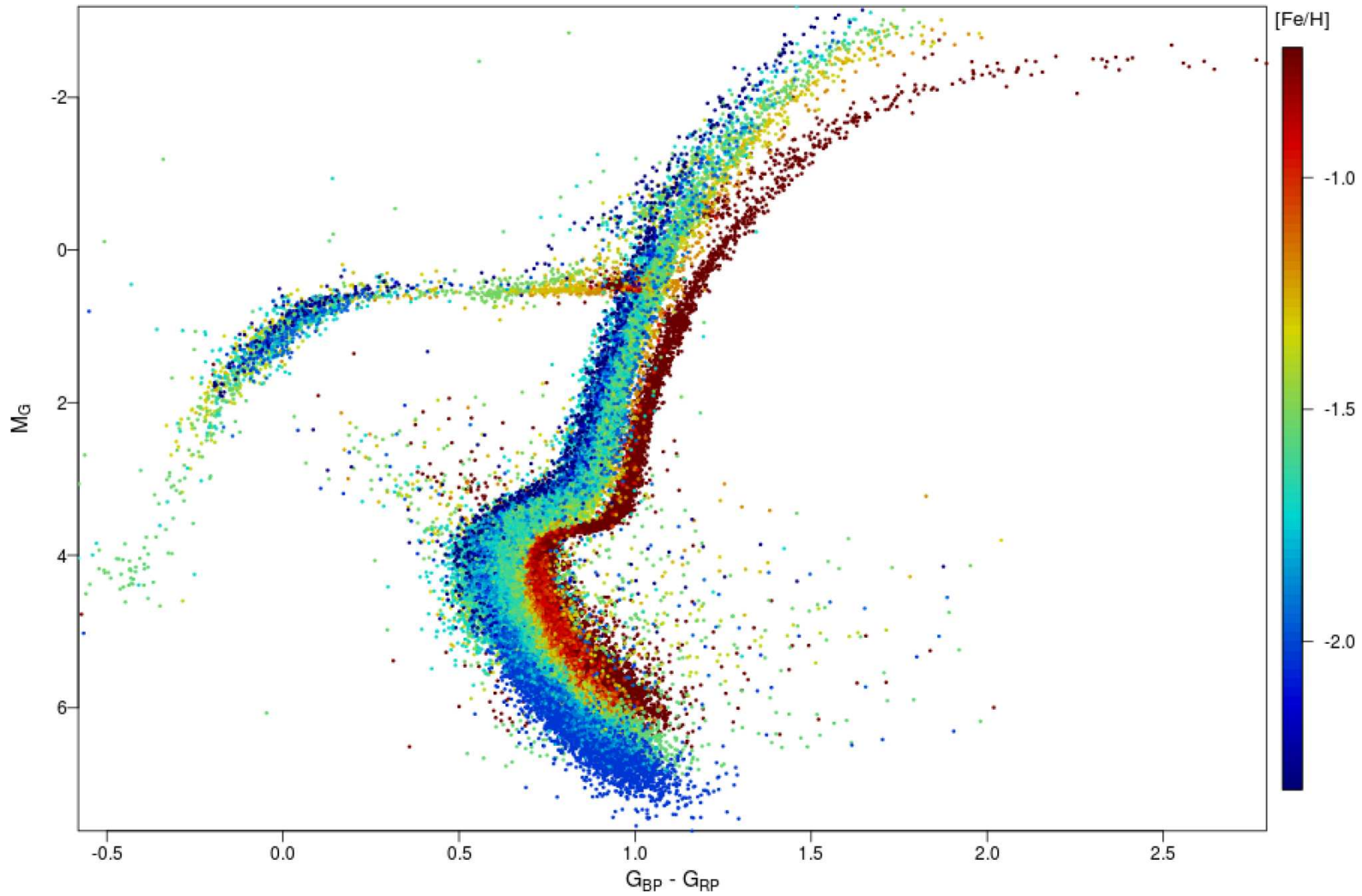
hot subdwarfs

HR diagram of globular clusters



Gaia DR2 (Babusiaux et al. 2018)

hot subdwarfs

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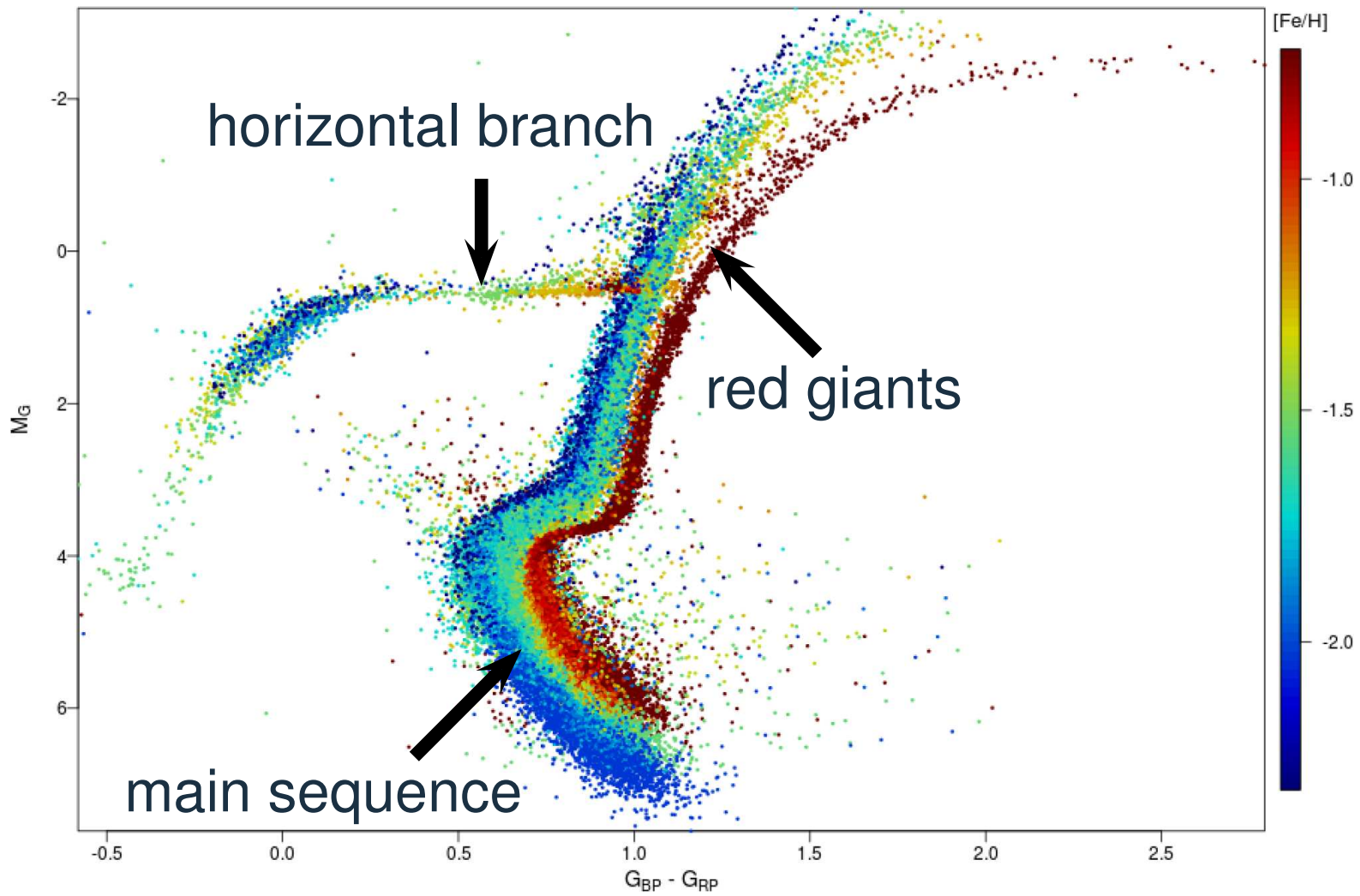

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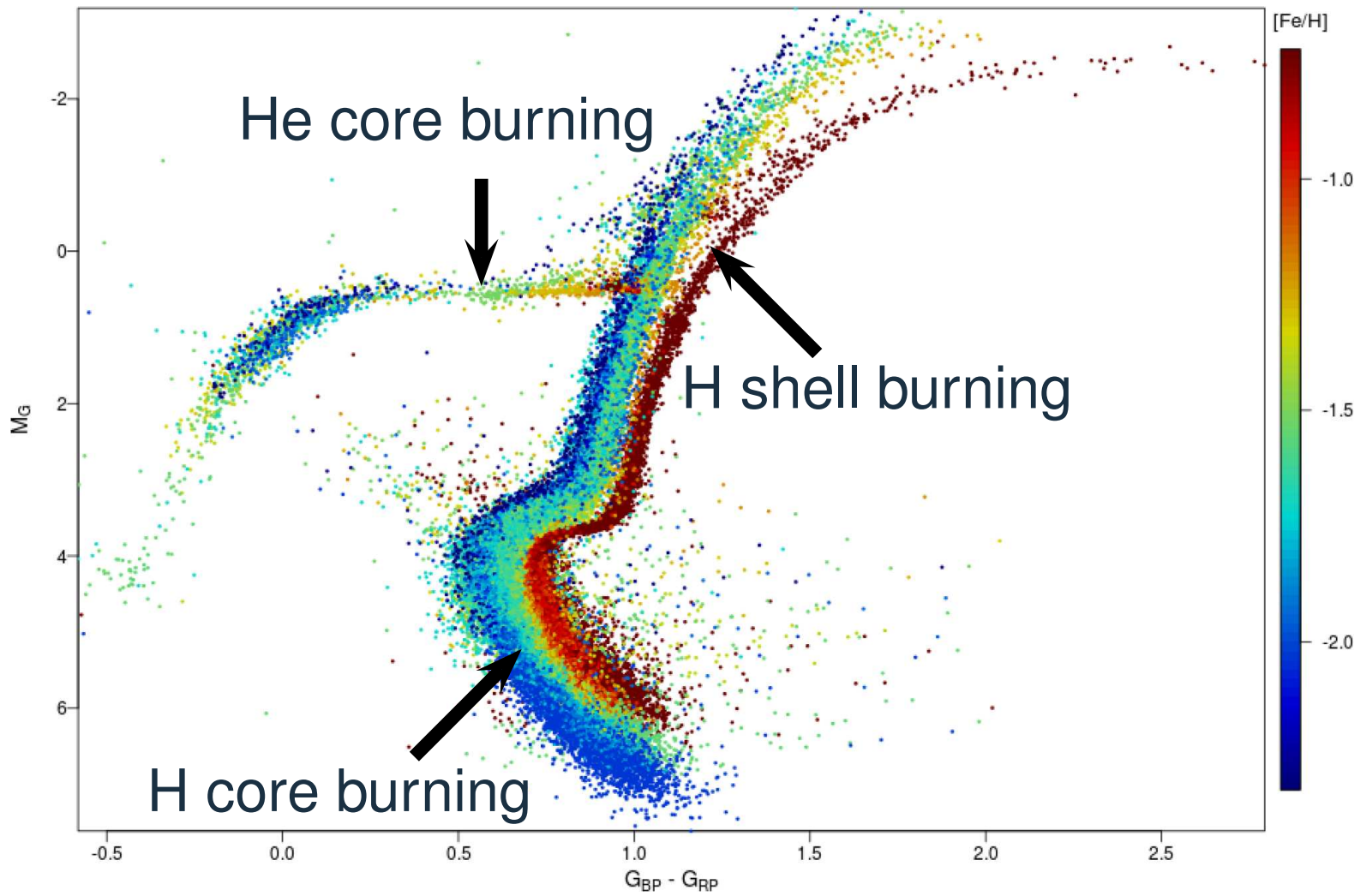

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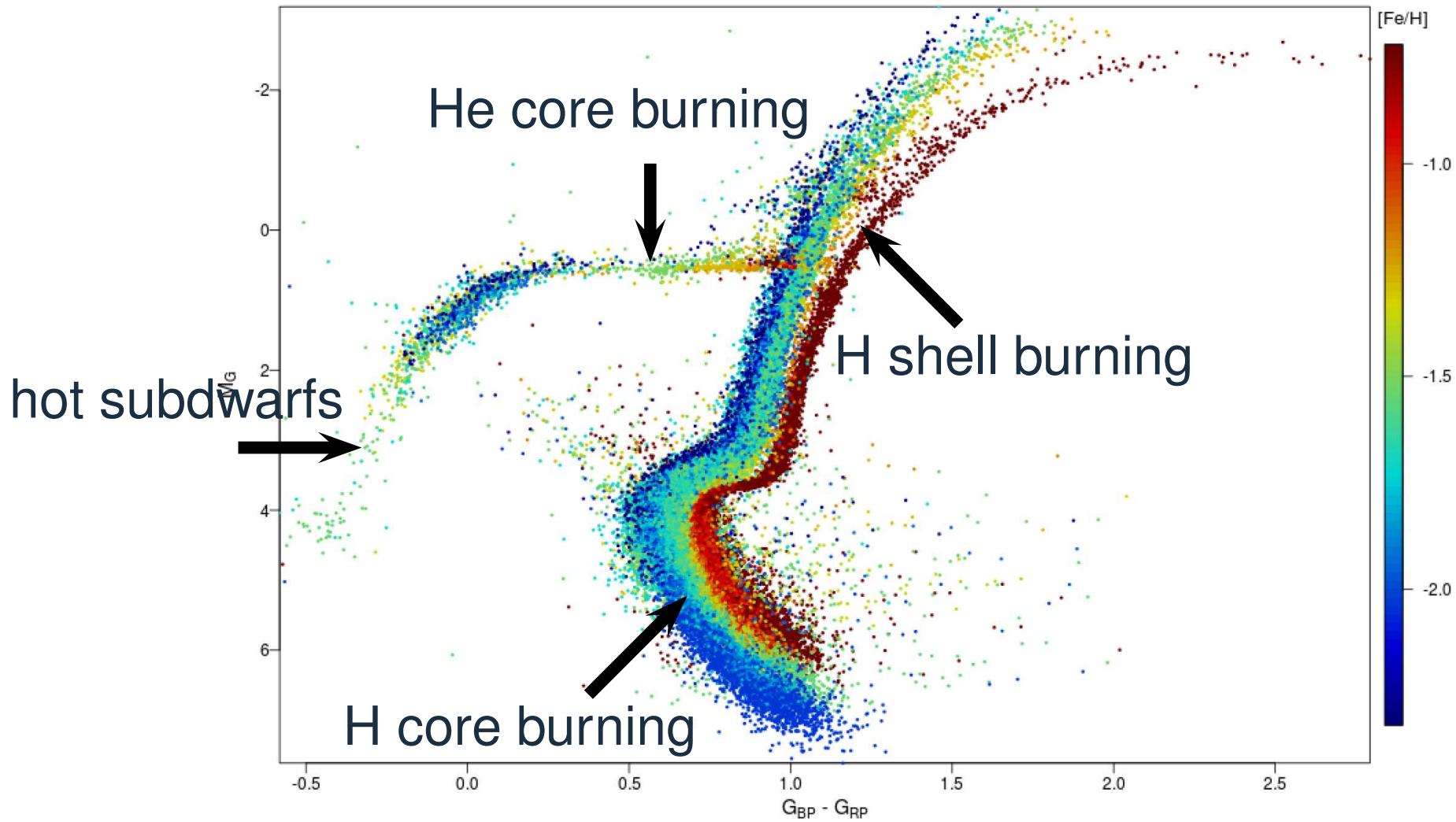

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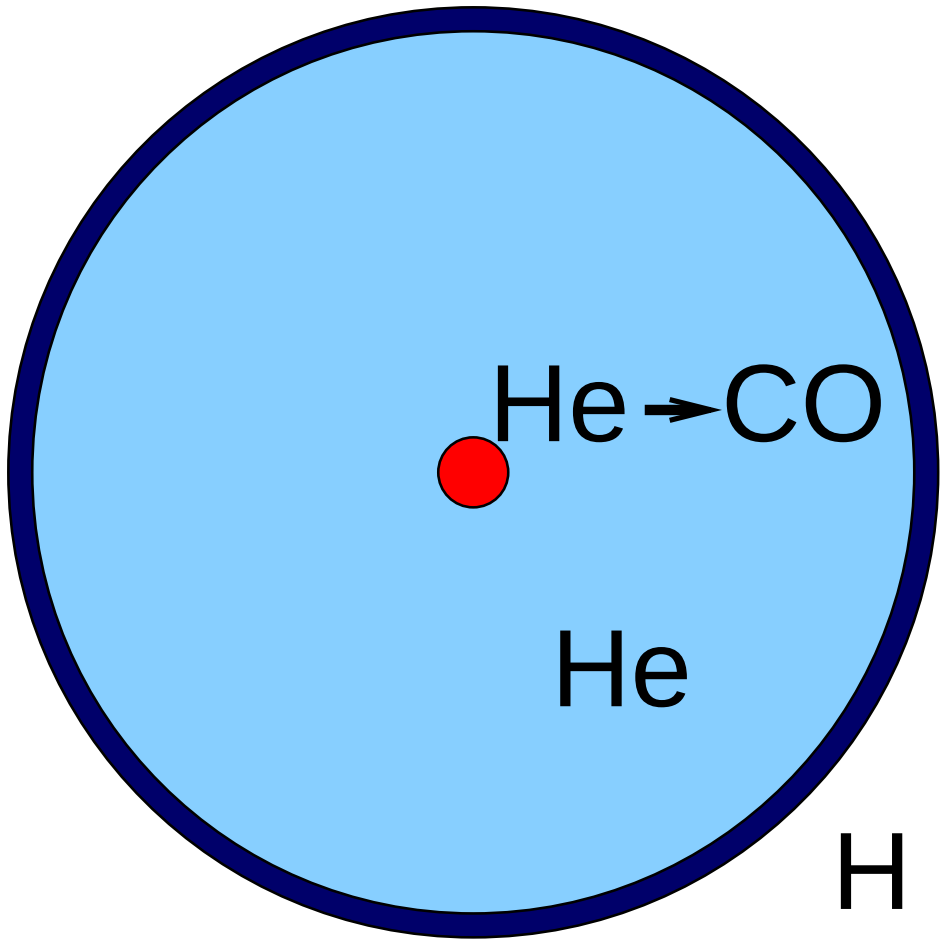
Typical structure of hot subdwarfs



- $\sim 0.47\ M_\odot$ He core cloaked by tiny H layer

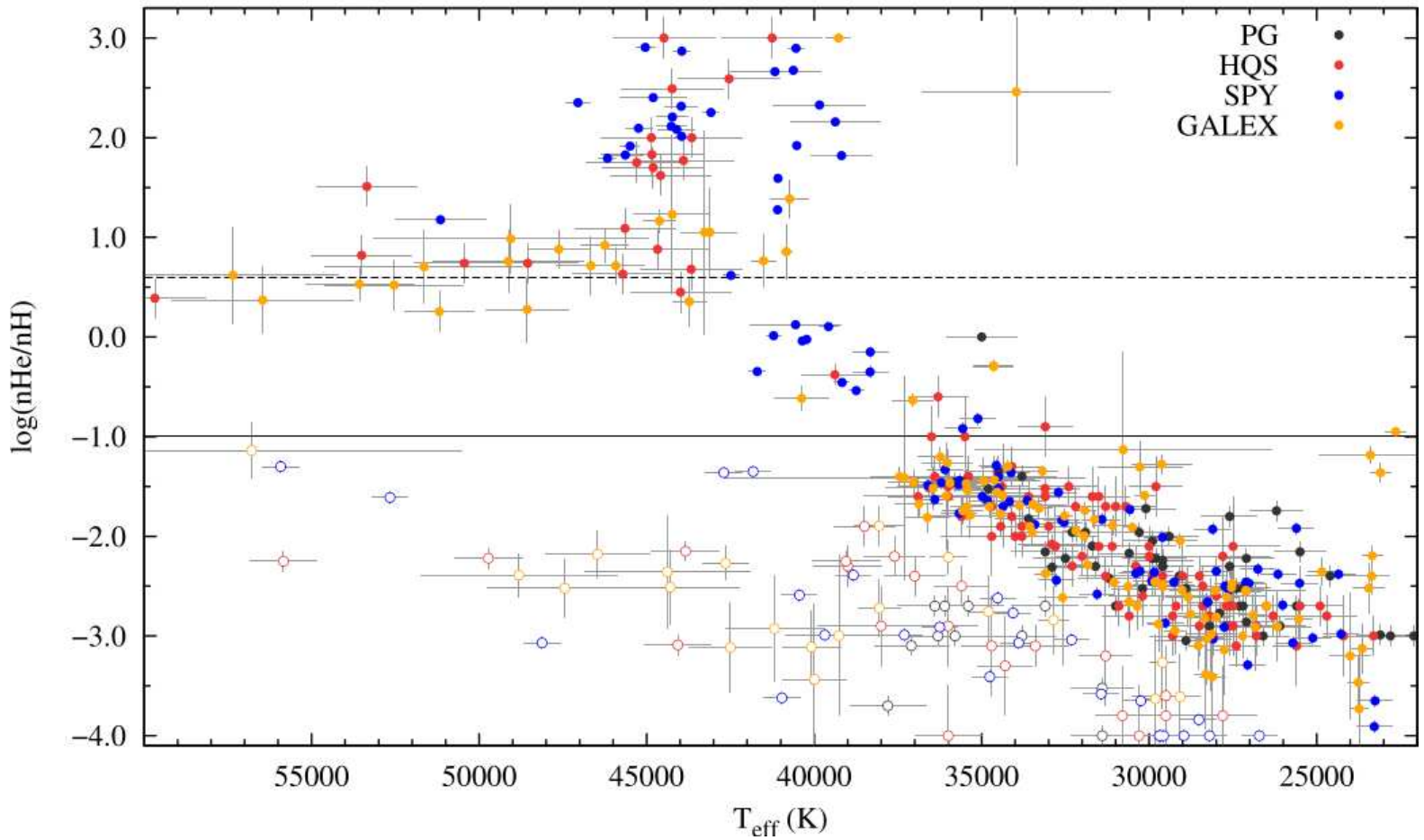
hot subdwarfs

How to make a hot subdwarf?

- progenies of red giants stripped off envelope (e.g. due to binary interaction, Han et al. 2007)
- merger of two white dwarfs (Iben & Tutukov 1984, Saio & Jeffery 2000)
- helium flash on the white dwarf cooling track (Brown et al. 2001, Battich et al. 2018)

hot subdwarfs

H and He dominated subdwarfs

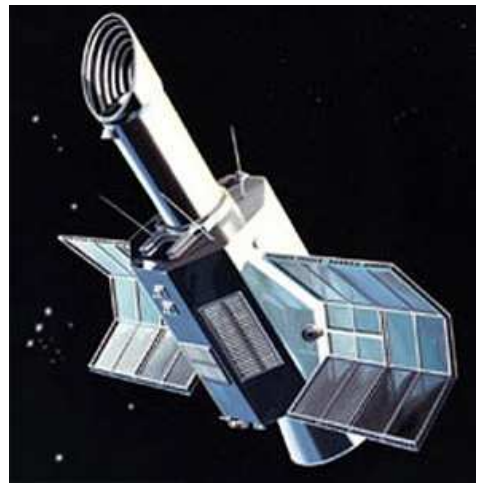


- He abundance as a function of effective temperature (Németh 2016)

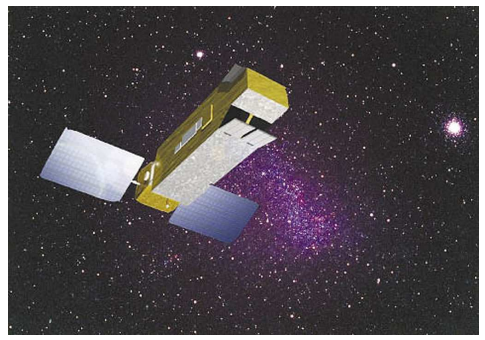
Analysis of four hot subdwarfs

- optical spectroscopy: UVES@UT2 (ESO, Paranal)

- UV spectroscopy: IUE



- UV spectroscopy: FUSE



analysis

Analysis of four hot subdwarfs

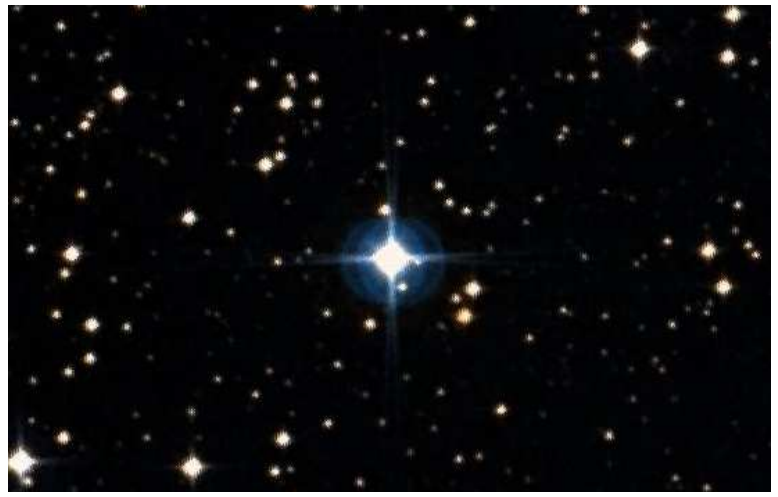
- NLTE model atmospheres TLUSTY (Lanz & Hubeny 2007)
- spectrum synthesis code SYNSPEC (Lanz & Hubeny 2017)

$\Rightarrow$ fitting of observed spectra

H dominated

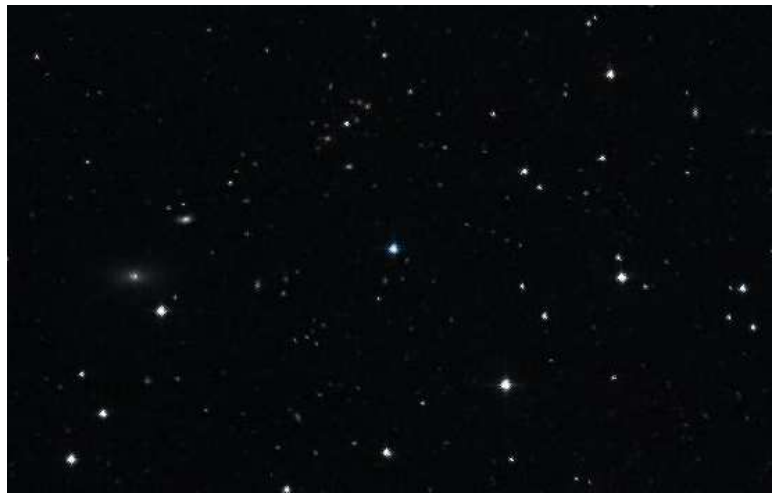
Two H dominated subdwarfs

HD 49798



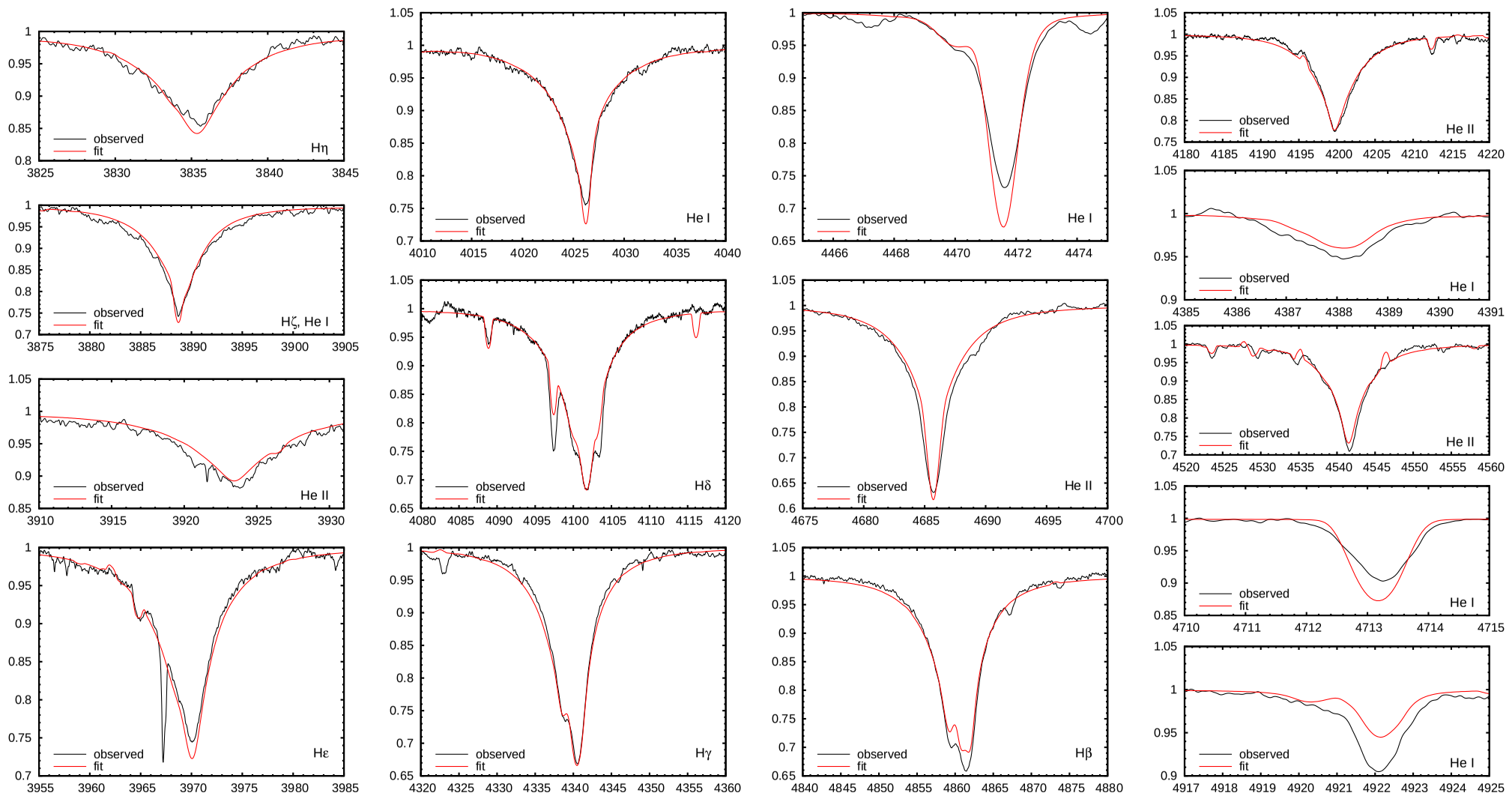
very strong X-ray emission: $1.3 \times 10^{32}\,\mathrm{erg\,s^{-1}}$ (Mereghetti et al. 2016)

BD+18° 2647



H dominated

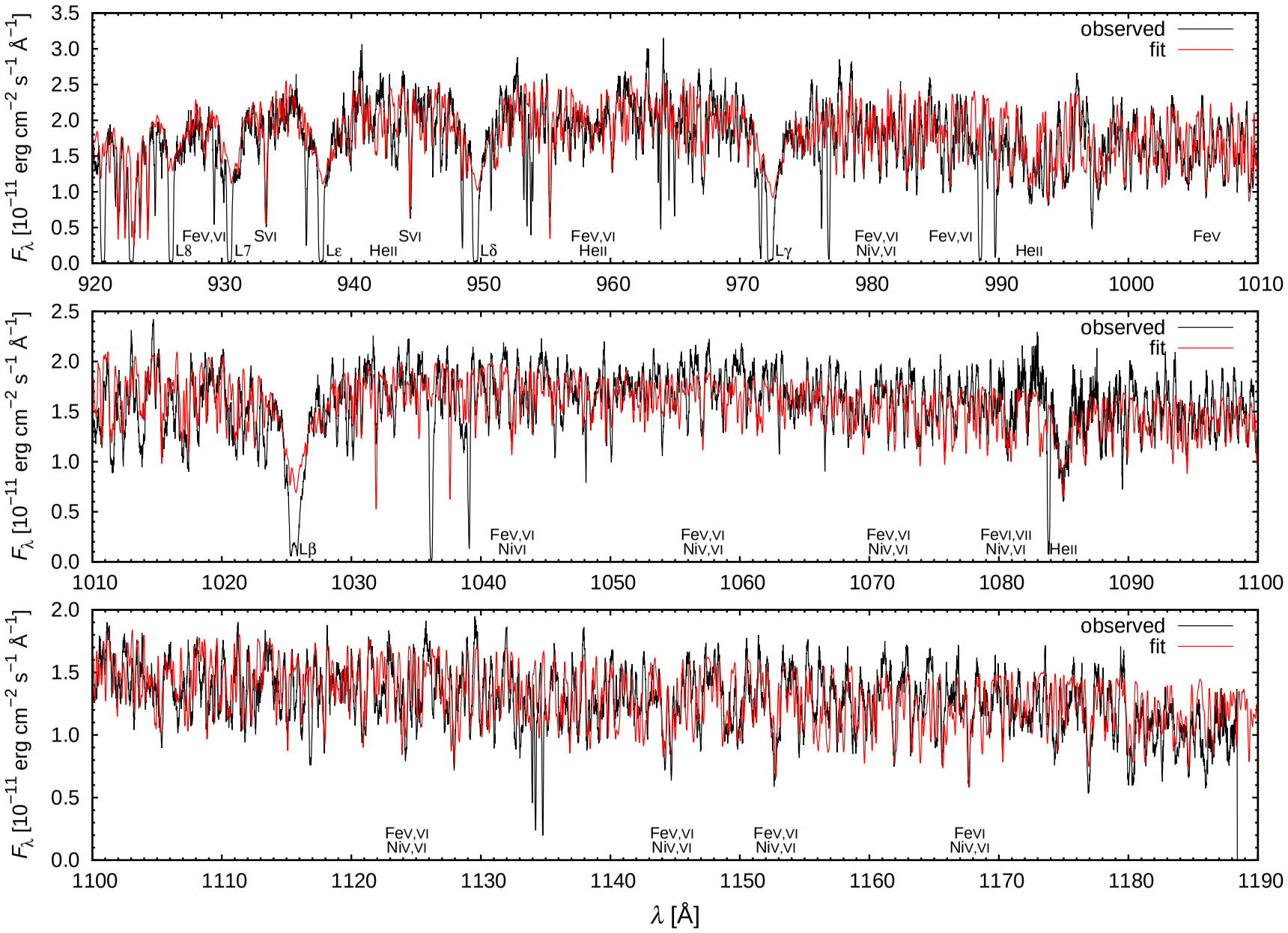
HD 49798: optical spectrum



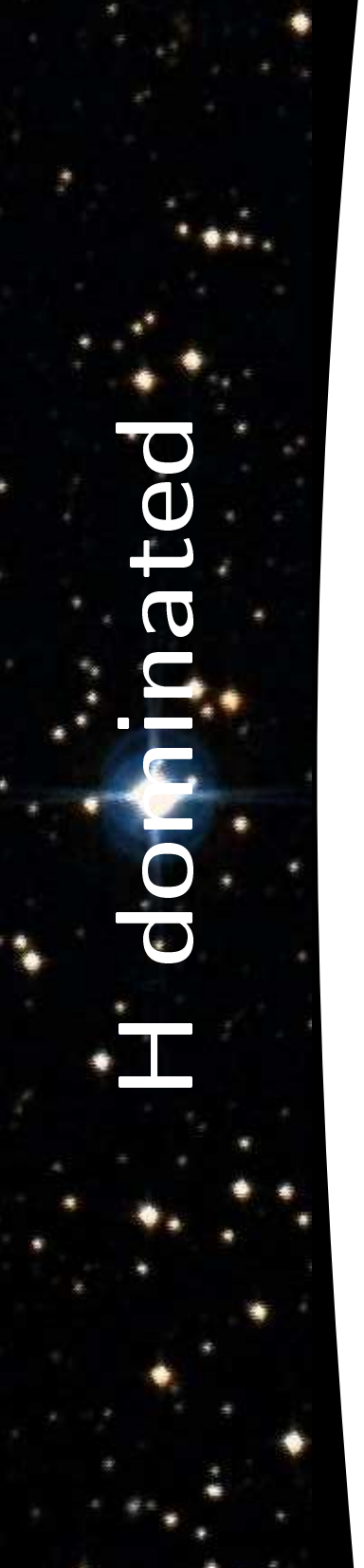
⇒ effective temperature and surface gravity

H dominated

BD+18° 2647 far-UV spectrum



⇒ elemental abundances



Derived parameters

Parameter	HD 49798	BD+18° 2647
effective temperature $T_{\rm eff}$ [K]	$45\,900 \pm 800$	$73\,000 \pm 2000$
surface gravity $\log g$	4.56 ± 0.08	5.95 ± 0.03
radius R [$R_\odot$]	1.05 ± 0.06	0.107 ± 0.011
mass M [$M_\odot$]	$1.46 \pm 0.32^*$	0.38 ± 0.08
He abundance $\varepsilon_{\rm He} = n_{\rm He}/n_{\rm H}$	0.74 ± 0.07	0.029 ± 0.010
mass-loss rate $\dot{M}$ [$M_\odot$ yr^{-1}]	2.1×10^{-9}	$< 10^{-12}$

* $M = 1.41 \pm 0.02\,M_\odot$ from X-ray orbital solution (Rigoselli et al. 2023)

H dominated

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nucleosynthesis

diffusion

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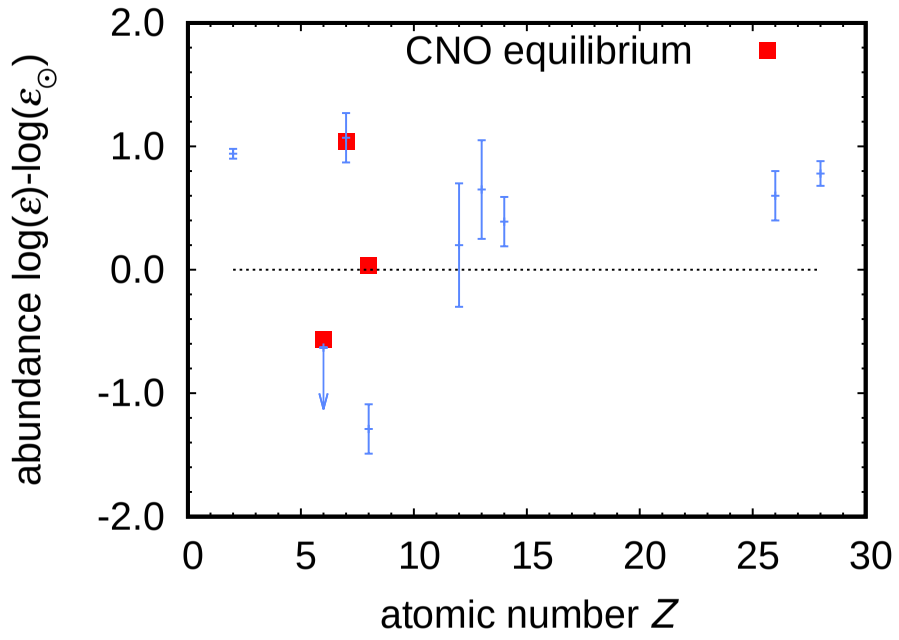
H dominated

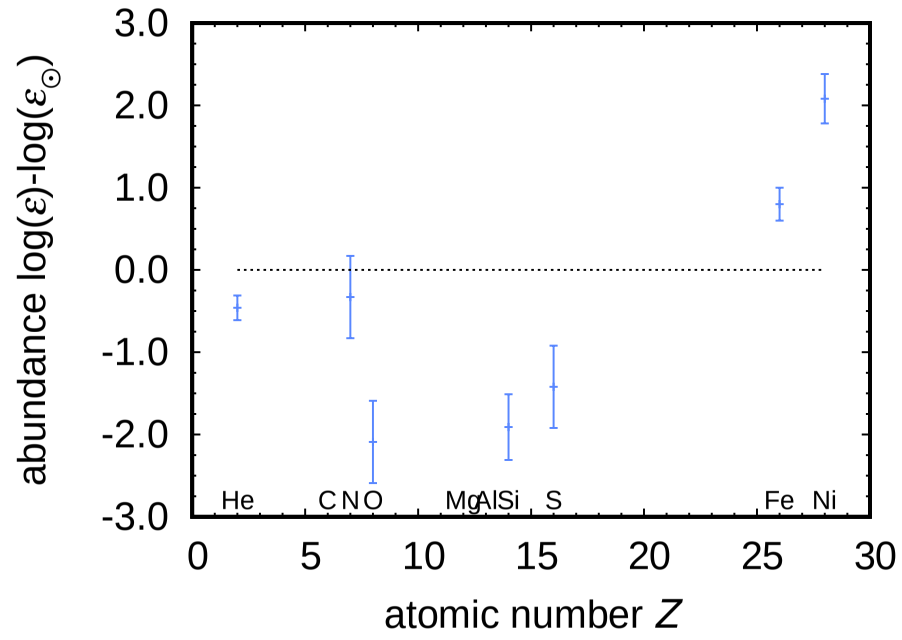
Abundances & evolutionary history

HD 49798



CNO processed material: stripping by the companion, origin of high mass unclear

BD+18° 2647



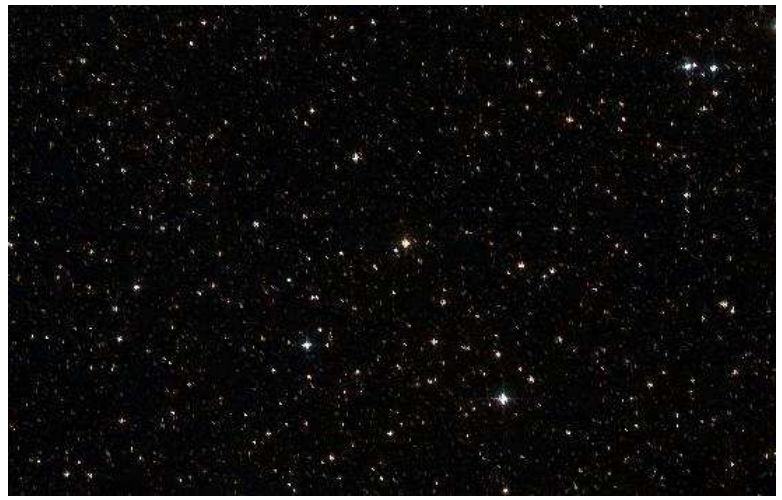
stripping + radiative diffusion (Michaud et al. 2011)

He dominated

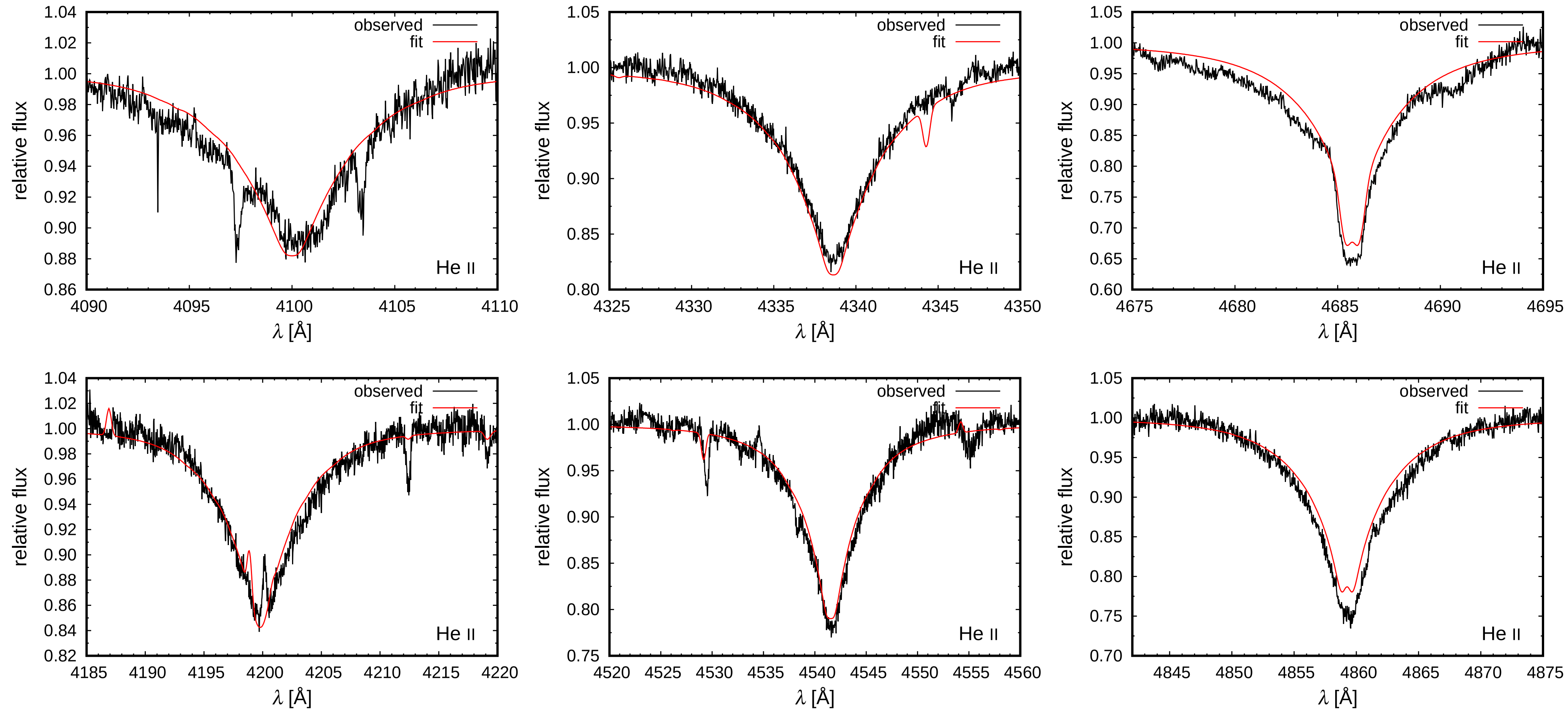
Two He dominated subdwarfs

CD–46 8926

CD–51 11879



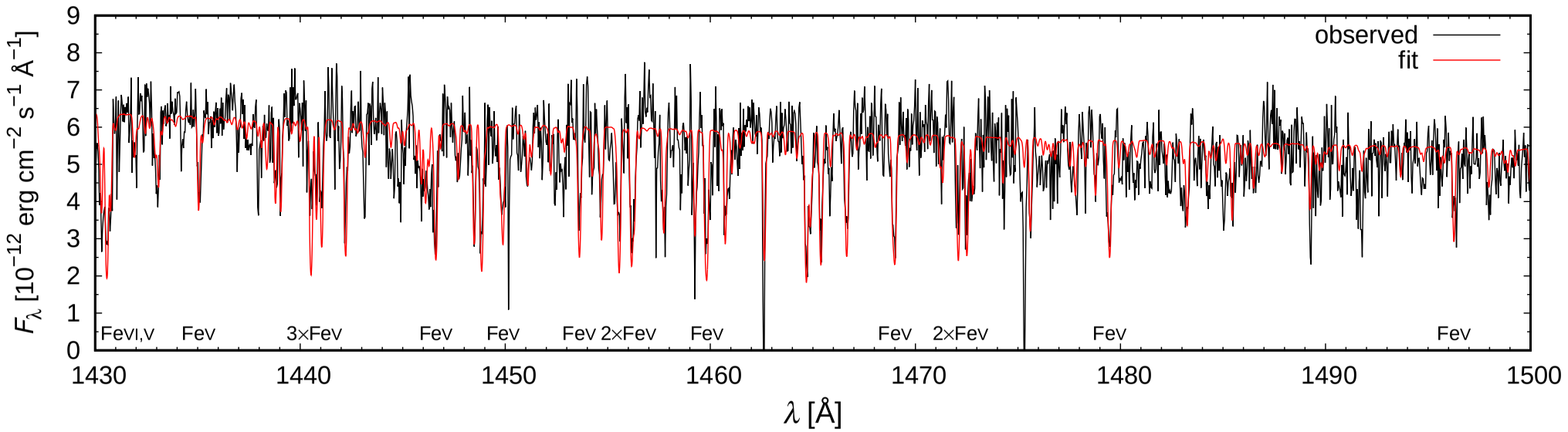
CD–46 8926: optical spectrum



⇒ effective temperature and surface gravity

He dominated

CD–51 11879 UV spectrum



⇒ elemental abundances

He dominated

He dominated

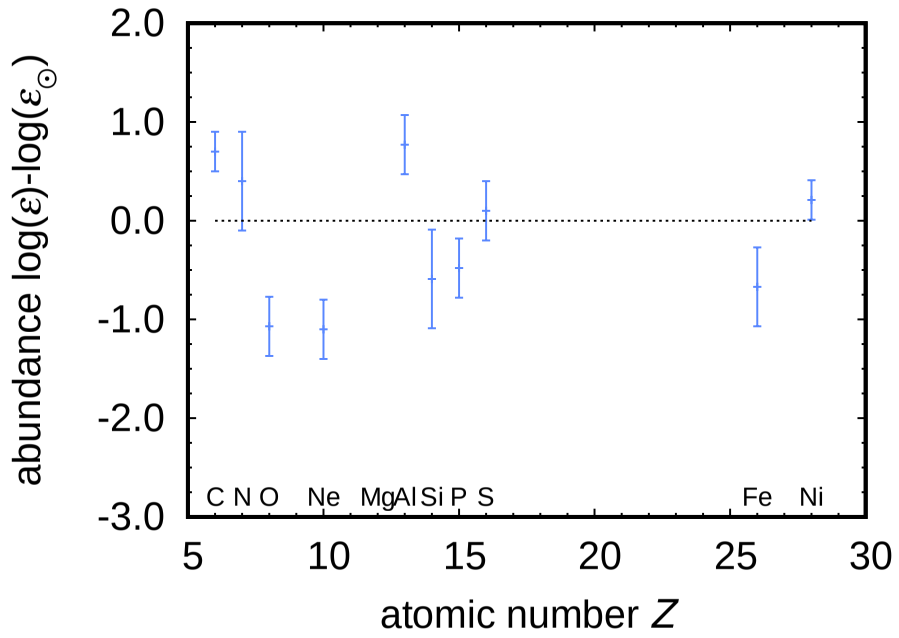
Derived parameters

	CD–51 11879	CD–46 8926
effective temperature $T_{\rm eff}$ [K]	$70\,500 \pm 2000$	$62\,600 \pm 3000$
surface gravity $\log g$ [cgs]	4.97 ± 0.10	5.23 ± 0.20
radius R [$R_\odot$]	0.37 ± 0.09	0.29 ± 0.05
mass M [$M_\odot$]	0.47 ± 0.20	0.52 ± 0.31
He abundance $\varepsilon_{\rm He} = n_{\rm He}/n_{\rm H}$	> 20	> 10
mass-loss rate $\dot{M}$ [$\mathrm{M_\odot\,yr^{-1}}$]	2.5×10^{-9}	6.0×10^{-10}

He dominated

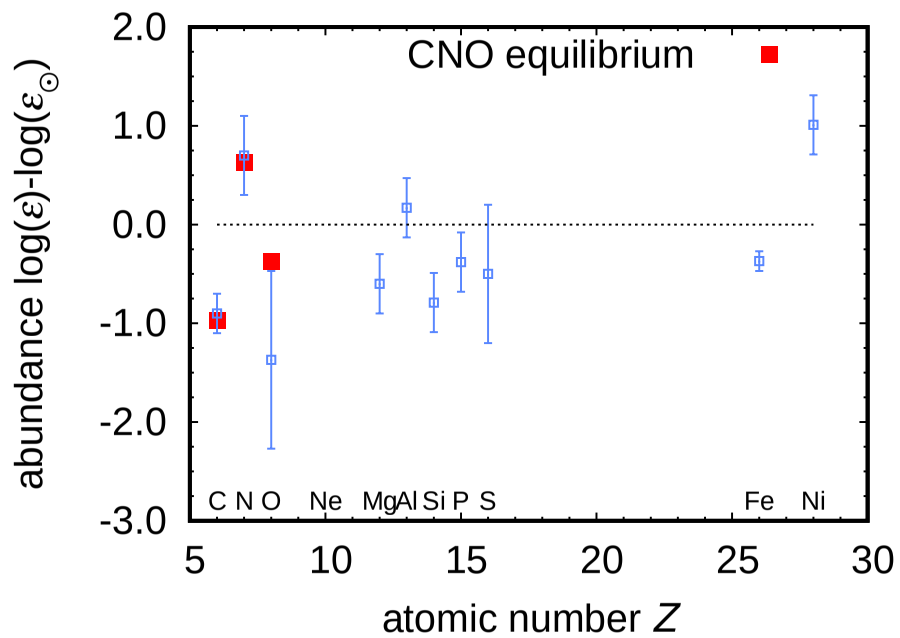
Abundances & evolutionary history

CD–46 8926



3α processed material: merger of hybrid CO–He and He white dwarfs (Justham at al. 2011)

CD–51 11879



CNO processed material: merger of He+He white dwarfs (Saio & Jeffery 2000)

Conclusions

- hot subdwarfs: stripped cores of helium burning stars
- abundances coming from nucleosynthesis trace evolutionary history

He dominated