

Spectral analysis of two He-enriched sdO-stars: HZ44 & HD 127493

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Astrophysical context

Hot subluminous stars come in two flavours: sdO and sdB stars. They display peculiar helium abundances, spanning a range between 10^{-4} and 10^3 times the solar value. The majority of sdO stars have atmospheres dominated by helium with hydrogen being a trace element only and, therefore, are termed He-sdO. Helium-poor sdOs exist too, though at lower numbers, but mixed composition objects are rather rare.

Both HD 127493 and HZ 44 are known to be of mixed H/He composition and excellent spectra at optical and ultraviolet wavelengths are available.

Given that the few mixed H/He objects that have been studied in the past tend to show peculiar atmospheric abundances, such as extreme enrichment in iron-group and trans-iron elements (Naslim et al. 2013), we decided to investigate the composition of HD 127493 and HZ 44 in more detail.

The origin of this extreme enrichment is not yet fully understood, but radiatively driven diffusion and therefore a highly stratified atmosphere has been proposed as an explanation. In order to understand which conditions favor this process, a bigger sample of these peculiar stars would be essential.

The available UV spectra of these stars are very useful as they give access to many chemical species that do not show spectral lines in the optical. For example lines of Ge, Sn, and Pb were identified in the FUSE spectrum of HZ 44 by O'Toole (2004).

Atmospheric parameters

We fitted optical spectra of both stars with non-LTE TLUSTY/SYNSPEC model grids (for T_{eff} , $\log g$, $\log N(\text{He})/N(\text{H})$) to determine their atmospheric parameters (see **Fig. 1**). Results are shown in **Table 1**.

	Instrument	Grid	T_{eff} (K)	$\log g$	$\log \frac{N(\text{He})}{N(\text{H})}$
HD 127493 (new)	FEROS	HHeCNSi	42100 ± 200	5.61 ± 0.05	0.33 ± 0.20
- Hirsch (2009)	FEROS	HHeN	42484 ± 250	5.60 ± 0.05	0.62 ± 0.30
HZ 44 (new)	CAFOS,TWIN,ISIS	HHeCNO	39200 ± 400	5.65 ± 0.15	0.1 ± 0.20

Table 1: Atmospheric parameters of HD 127493 and HZ 44.

Abundance results

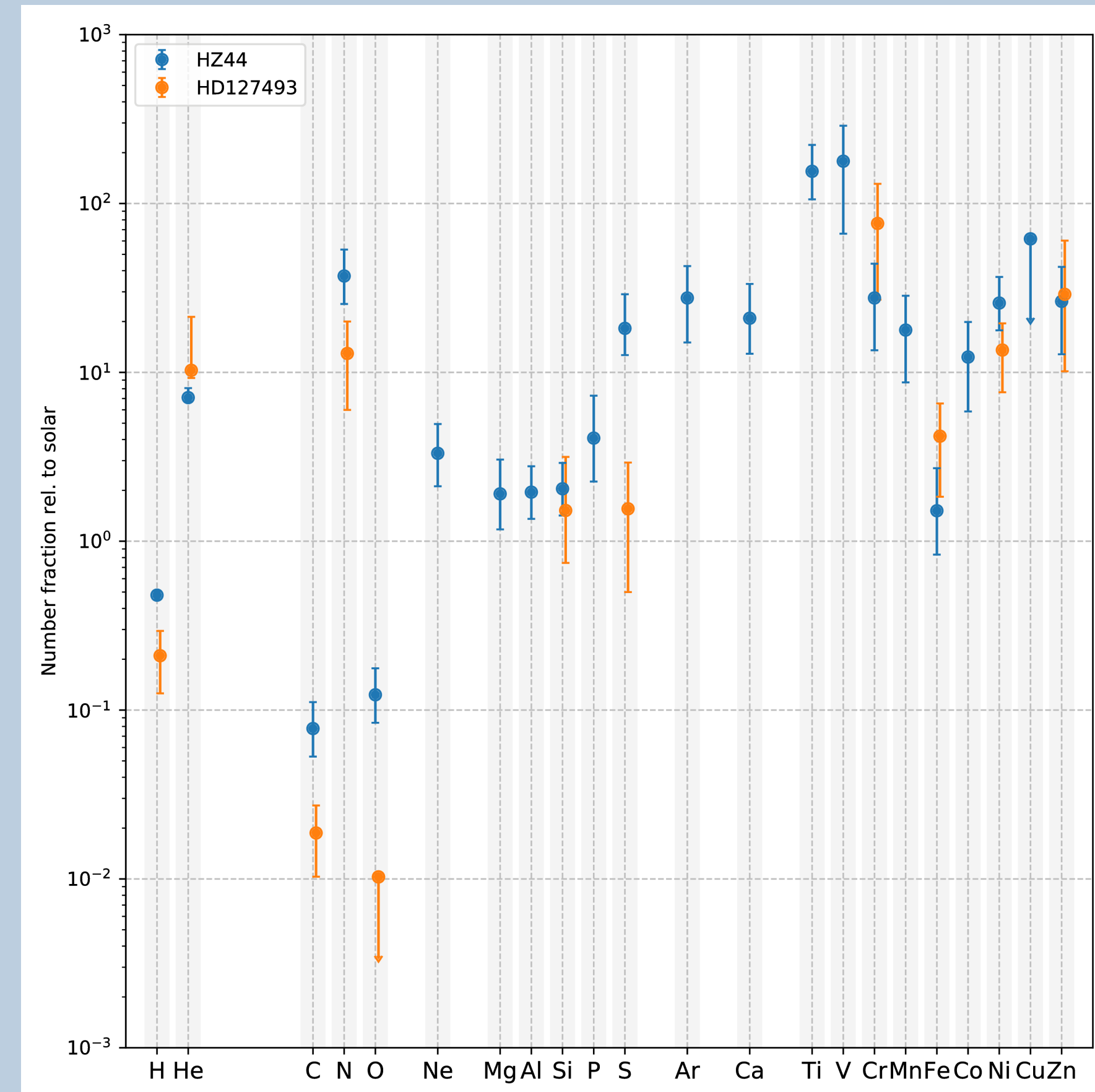


Fig. 2: Chemical abundances with respect to solar

Atmospheric fits

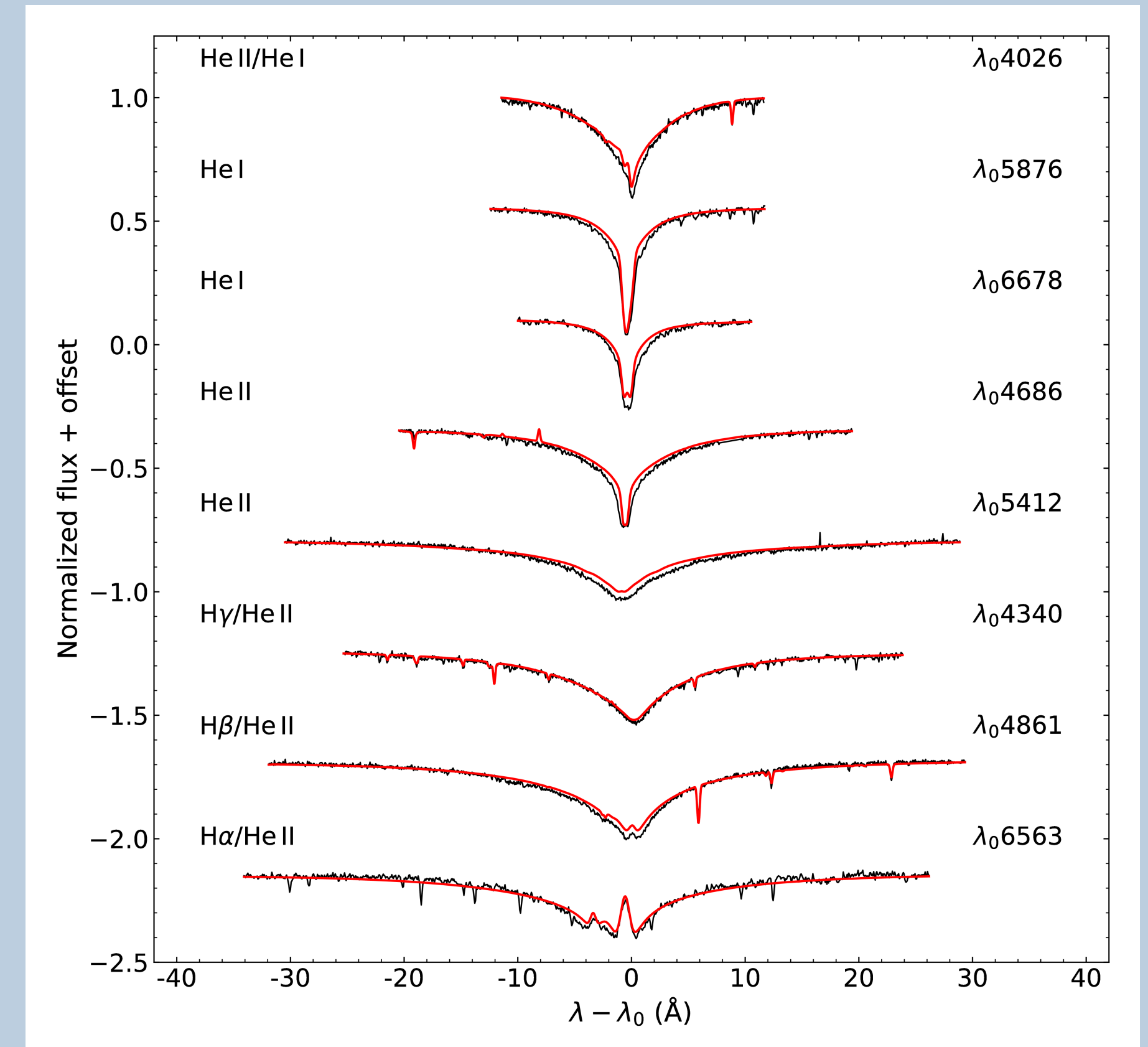


Fig. 1: FEROS spectrum of HD 127493 (black) and the 3D-grid fit (red), selection of lines.

Metal abundances

	Instrument	Range (Å)	R	S/N
HD 127493	IUE	1150 – 1970	10000	14
	GHRS	1225 – 1745	19000	40
	FEROS	3700 – 9200	48000	180
HZ 44	FUSE	905 – 1188	19000	30
	IUE	1150 – 1970	10000	10
	HIRES	3214 – 5990	37500	100

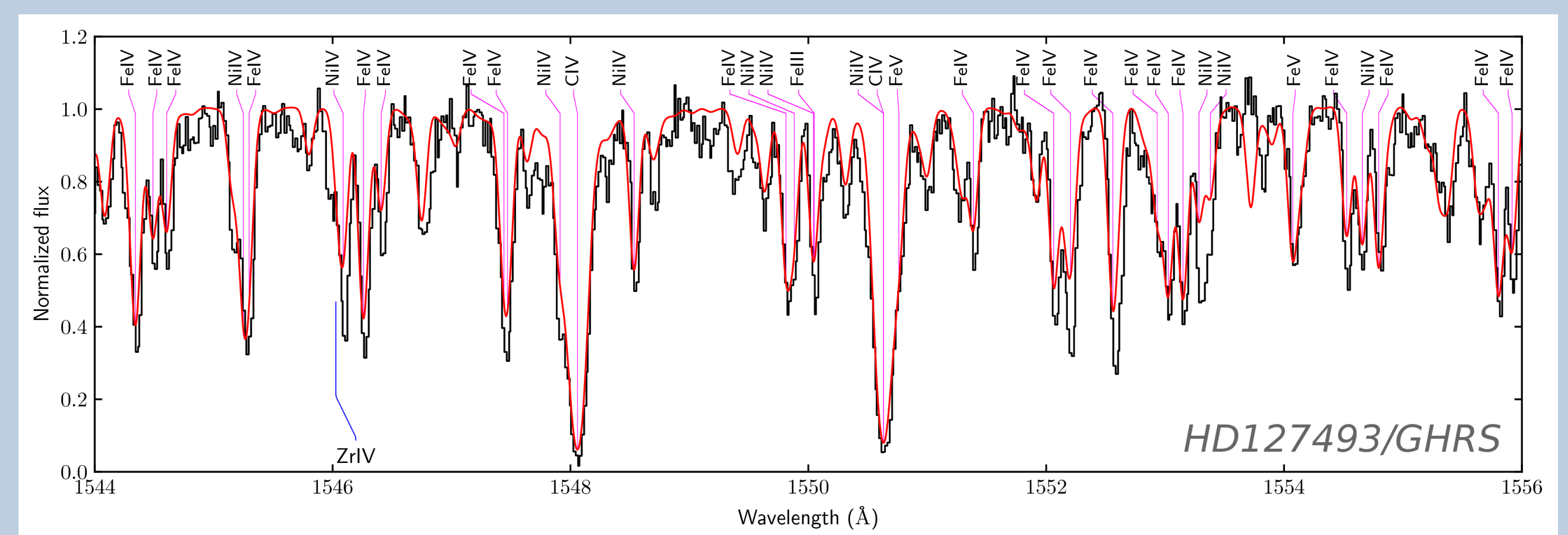
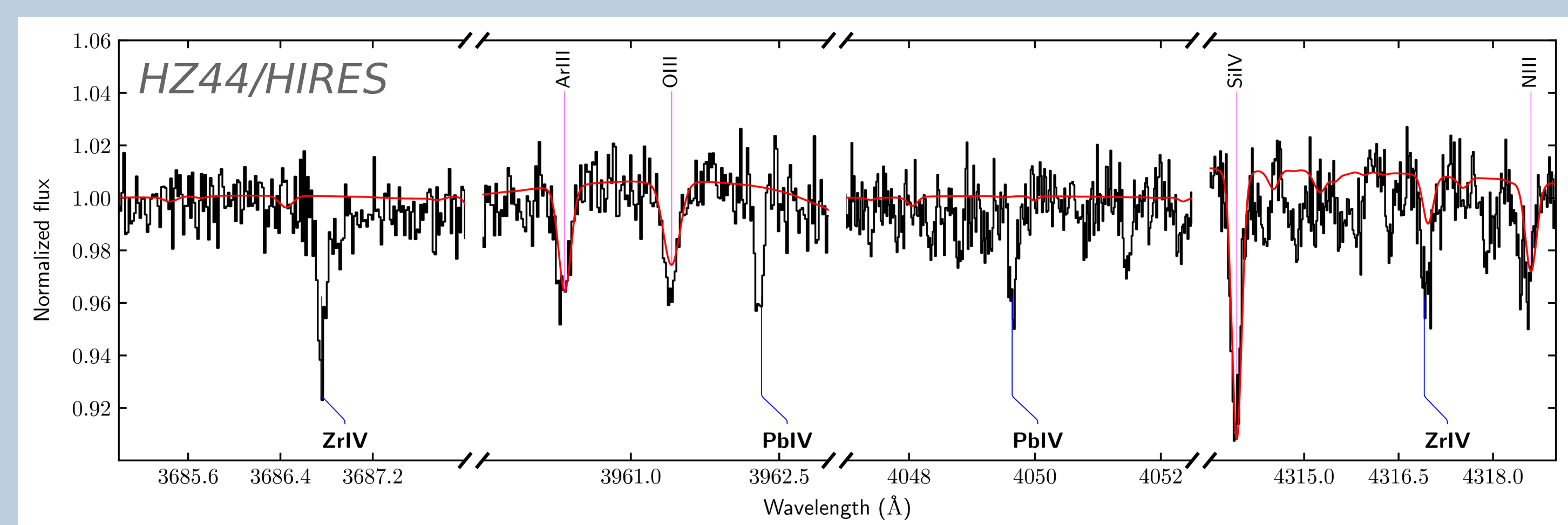
Table 2: Spectra used for the abundance analysis.

By combining optical and UV spectra (**Table 2**) we determined abundances for all elements for which model atoms and lines are available: C, N, O, Ne, Mg, Al, Si, P, S, Ar, Fe, and Ni. All other elements were included in LTE.

The HIRES spectrum of HZ 44 covers also the visual UV which allowed us to study the strong Ne and Ti lines in that spectral range.

Although the iron-group elements show many lines in the UV, especially Cr, a large number of photospheric lines are missing in our model. Many molecular and atomic interstellar lines are also superimposed on the photospheric FUSE spectrum of HZ 44 but are not modelled.

We observe the typical CNO bi-cycle abundance pattern, N is enriched, while C and O are depleted with respect to solar values (see **Fig. 2**).



Other light elements are slightly enriched. In fact, all elements heavier than Ar ($Z = 18$) for which we derived an abundance, except Fe, appear to be enriched.

Both stars show Ge IV and Pb IV lines in the UV range while HZ 44 additionally displays Pb IV and Zr IV lines in the optical (HIRES) range.

As far as we know Zr IV has so far been identified in the optical spectrum of LS IV-14 116 and HE 2359-2844. HZ 44 turns them into a trio of Zr stars.

Our next step will be to include Ge, Pb, and Zr in our synthetic spectra and derive their abundances. This could tell us whether the stars belong to the group of lead-rich He-sdOs discovered by Naslim et al. (2013). We will also look for the presence of more "heavy metals" such as Ga, Y, and Sn.

