

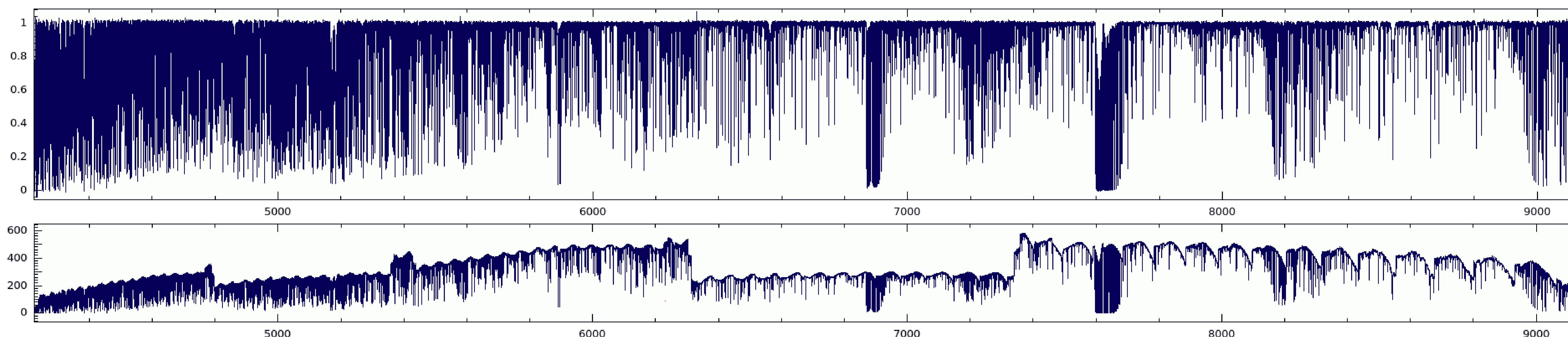
# A chemical abundance analysis of the ancient planet-host star Kepler-444

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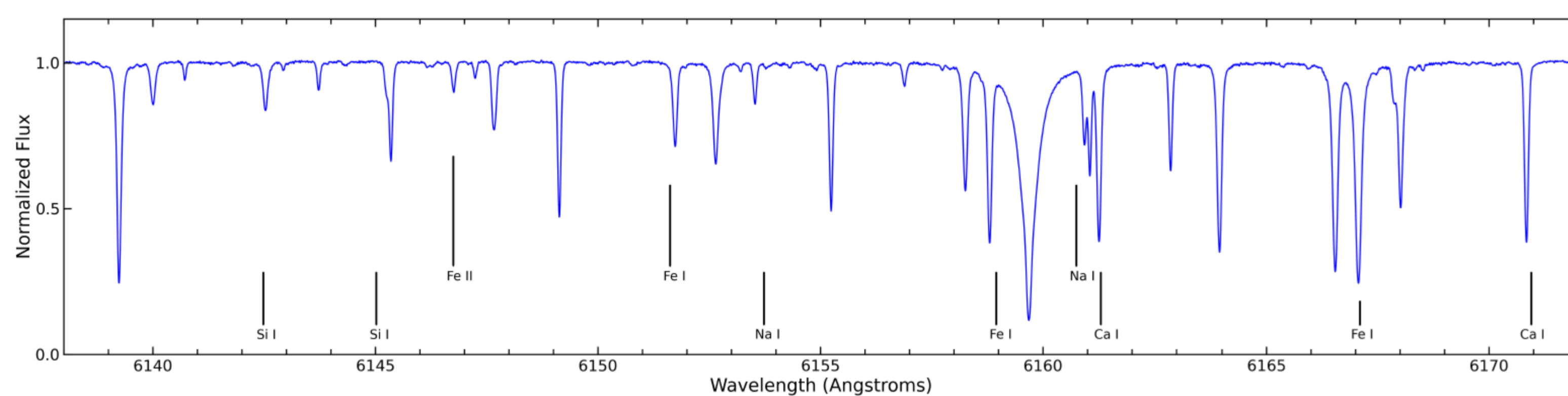
**Abstract.** We obtained a very high resolution and high S/N spectrum of the KOV multi-planet host Kepler-444. With a spectral resolution of up to  $R=250,000$ , a continuous wavelength coverage from 423 nm to 912 nm, and S/N ratio in the continuum of between 150–550:1 (blue to red), this spectrum enables us to determine abundances and isotope ratios with a precision at the 1% level.

**Context.** KEPLER photometry revealed five transiting planets with radii between those of Mercury and Venus and orbits within 0.1 AU of the star (i.e., within the orbit of Mercury). Most astounding though is the old age of the host star of  $11.2 \pm 1.0$  Gyr from asteroseismology (Campante et al. 2015, ApJ 799, 170). These author's spectroscopic analysis of a Keck/HIRES spectrum ( $R=60,000$ ,  $S/N \approx 200$ ) yielded  $T_{\text{eff}}=5046$  K and  $\log g=4.6$

together with sub-solar abundances of Fe as well as Si and Ti (two  $\alpha$ -elements) leading to a moderately large  $[\alpha/\text{Fe}]$  index of 0.26 dex. The two basic conclusions from these results are that (low-mass) planet formation was already ongoing shortly after the universe was created and that the chemical composition of the pre-stellar material did not have to be metal rich.



**Fig.** Top. Condensed view of the Kepler-444 deep PEPSI spectrum. The wavelength coverage is complete from 423 to 912 nm with an average dispersion of  $10 \text{ m}\text{\AA}/\text{pix}$  and average spectral resolution of 220,000. The bottom panel shows the S/N ratio per pixel. The deep spectrum is made up by 6–10 individual exposures, each typically 20min. Five of the six cross dispersers were employed. Note that there were less exposures for CD-V, seen in the middle with lower S/N.



**Fig.** Kepler-444 spectral region between 6140Å and 6170Å. A selection of the lines measured in this region are labeled.