Lanthanides in stellar atmospheres

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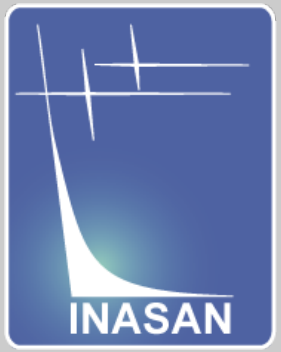
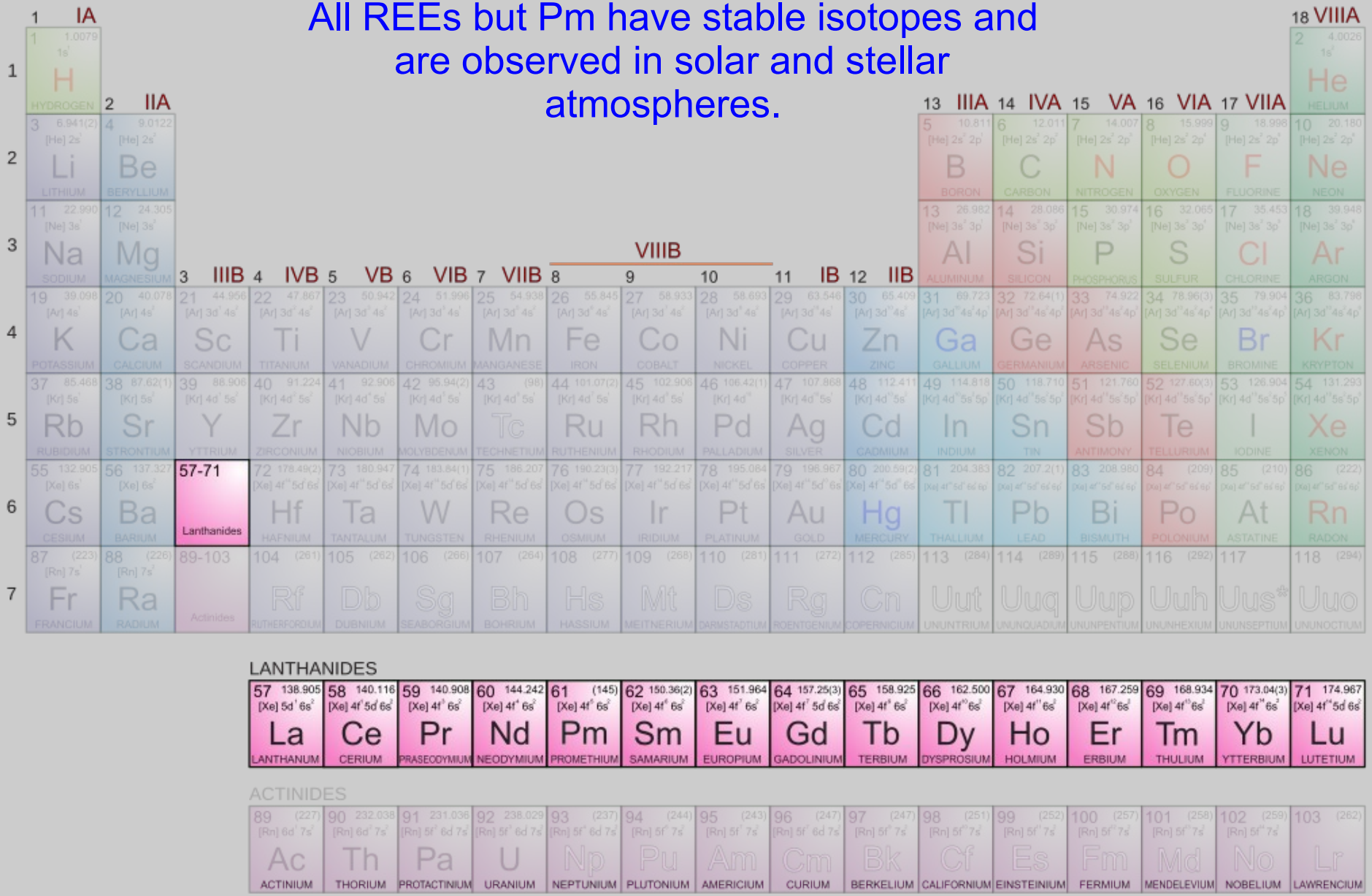


"The Periodic Table through Space and Time", September 10-13, St. Petersburg

Lanthanides or the rare-earth elements (REE) constitute a compact group of 15 elements from the 6th period of Mendeleev table.
All REEs but Pm have stable isotopes and are observed in solar and stellar atmospheres.



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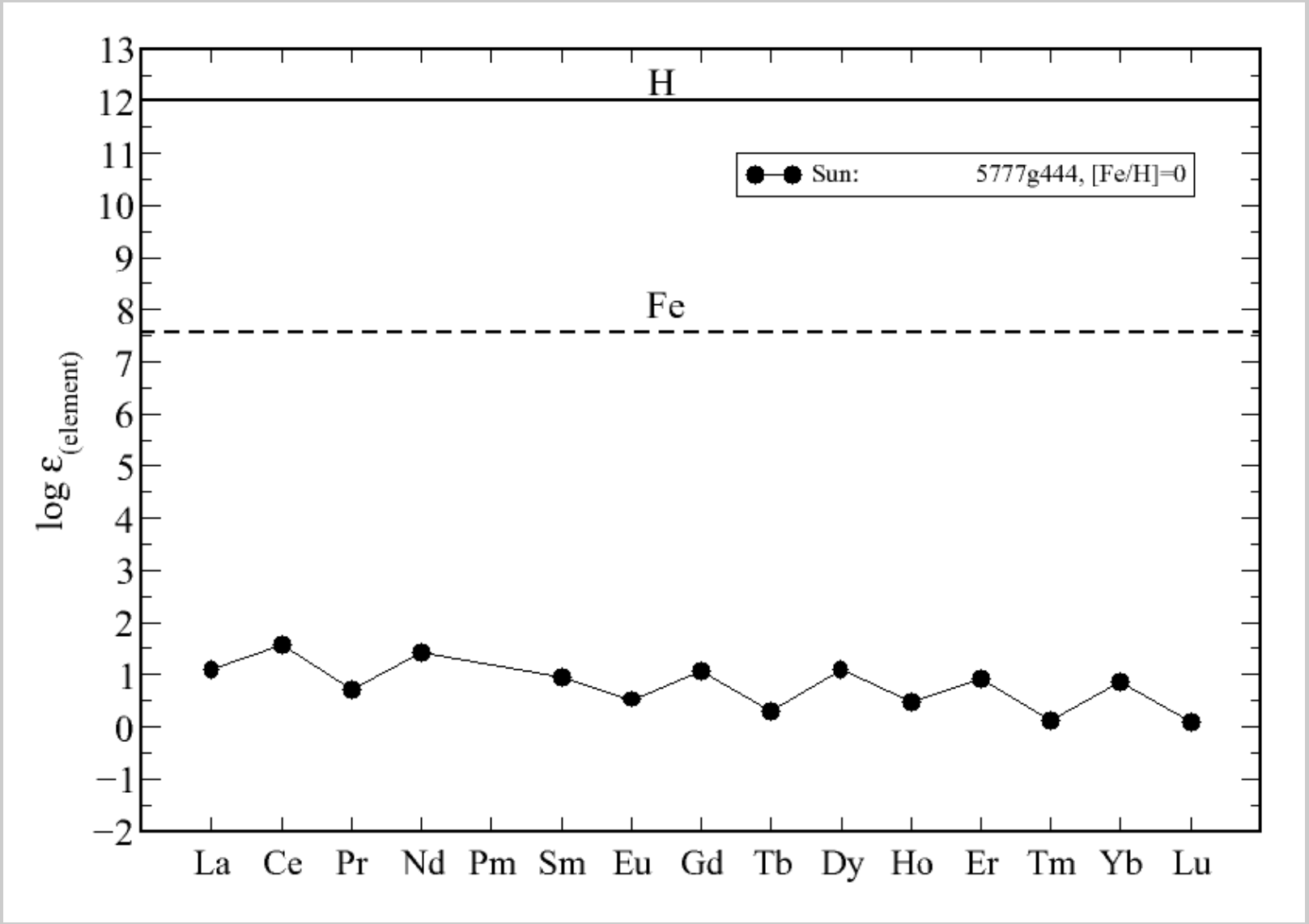
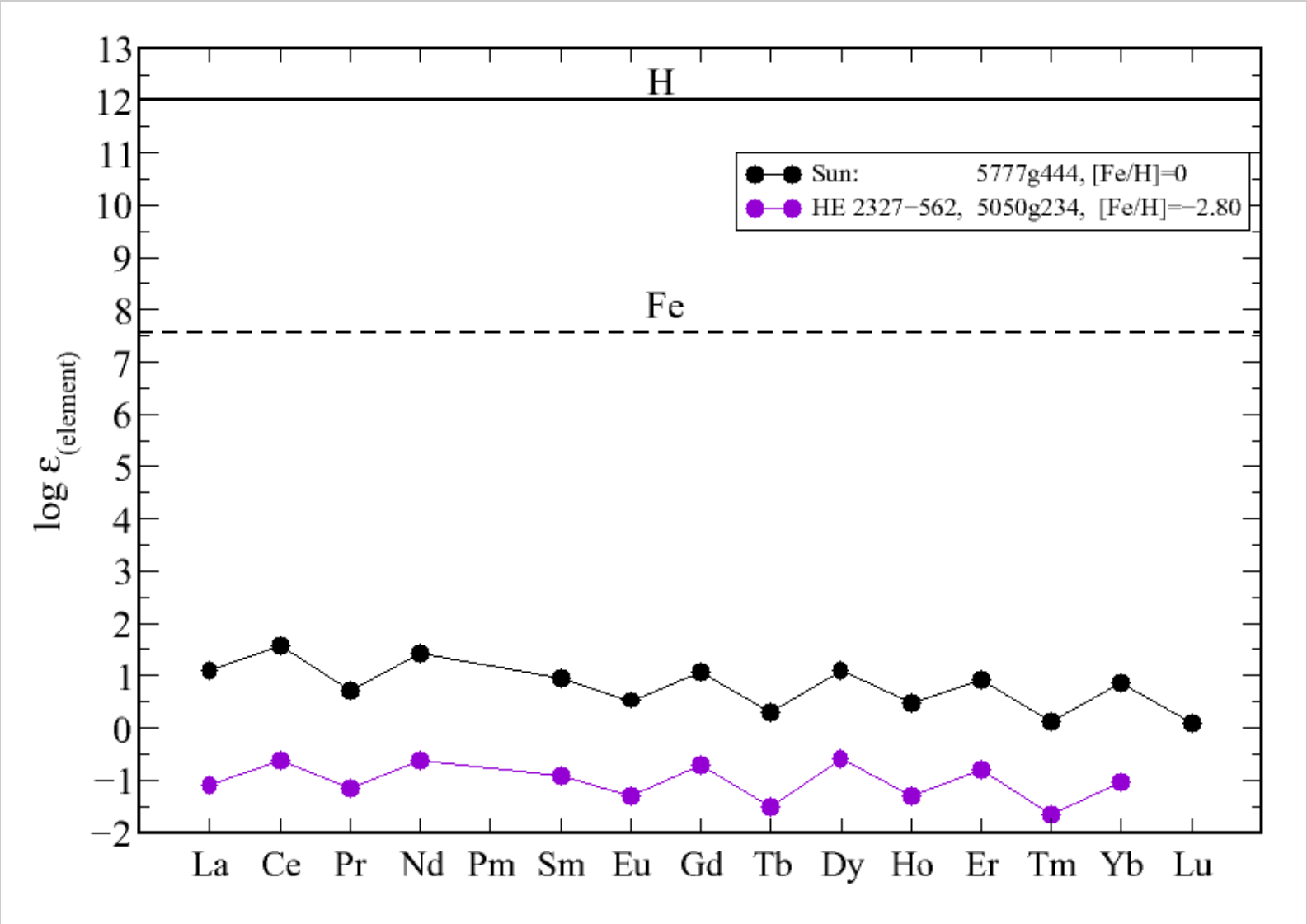
REE abundances in solar atmosphere



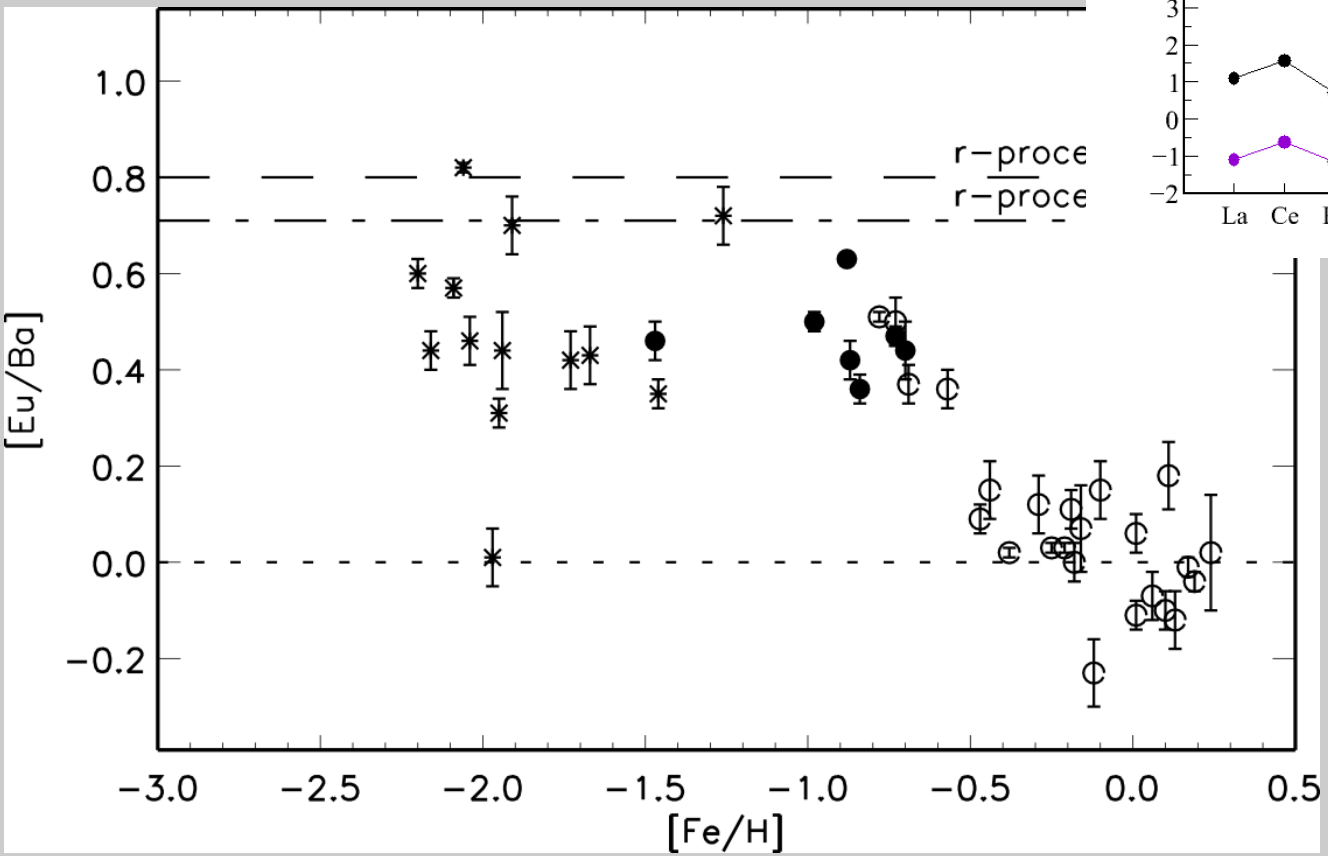
REE abundances in stellar atmospheres of different metallicity

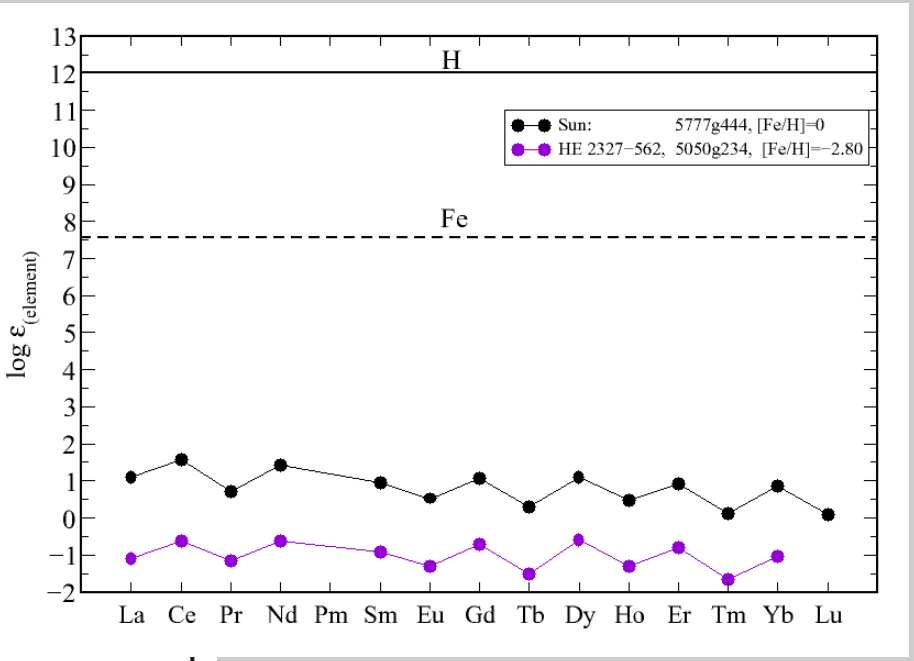


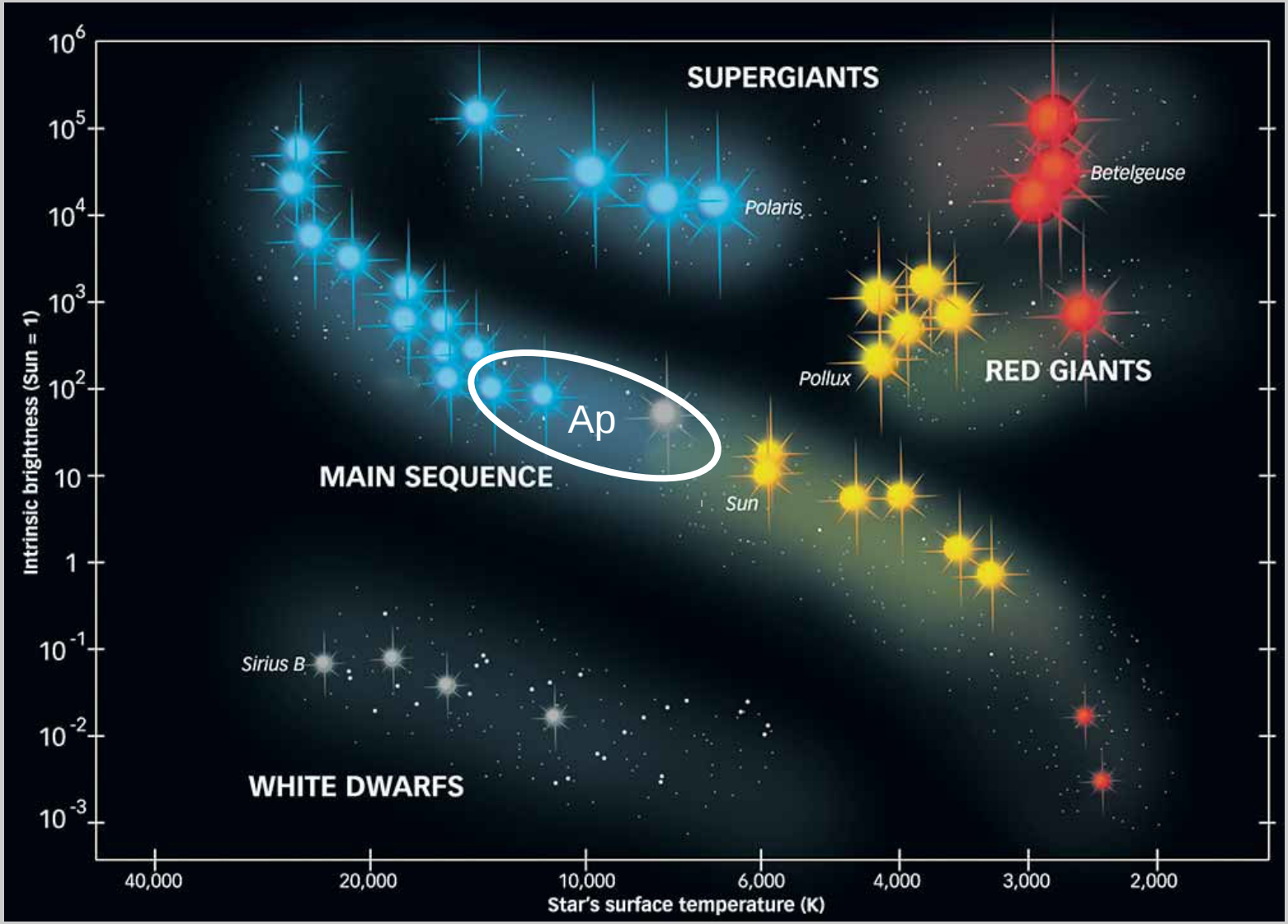
Data for HE 2327-562 are taken from Mashonkina et al. A&A 516, A46 (2010)

REEs in Galactic chemical evolution studies:

Fig.14 from Zhang et al. ApJ 509, id 225 (2016)

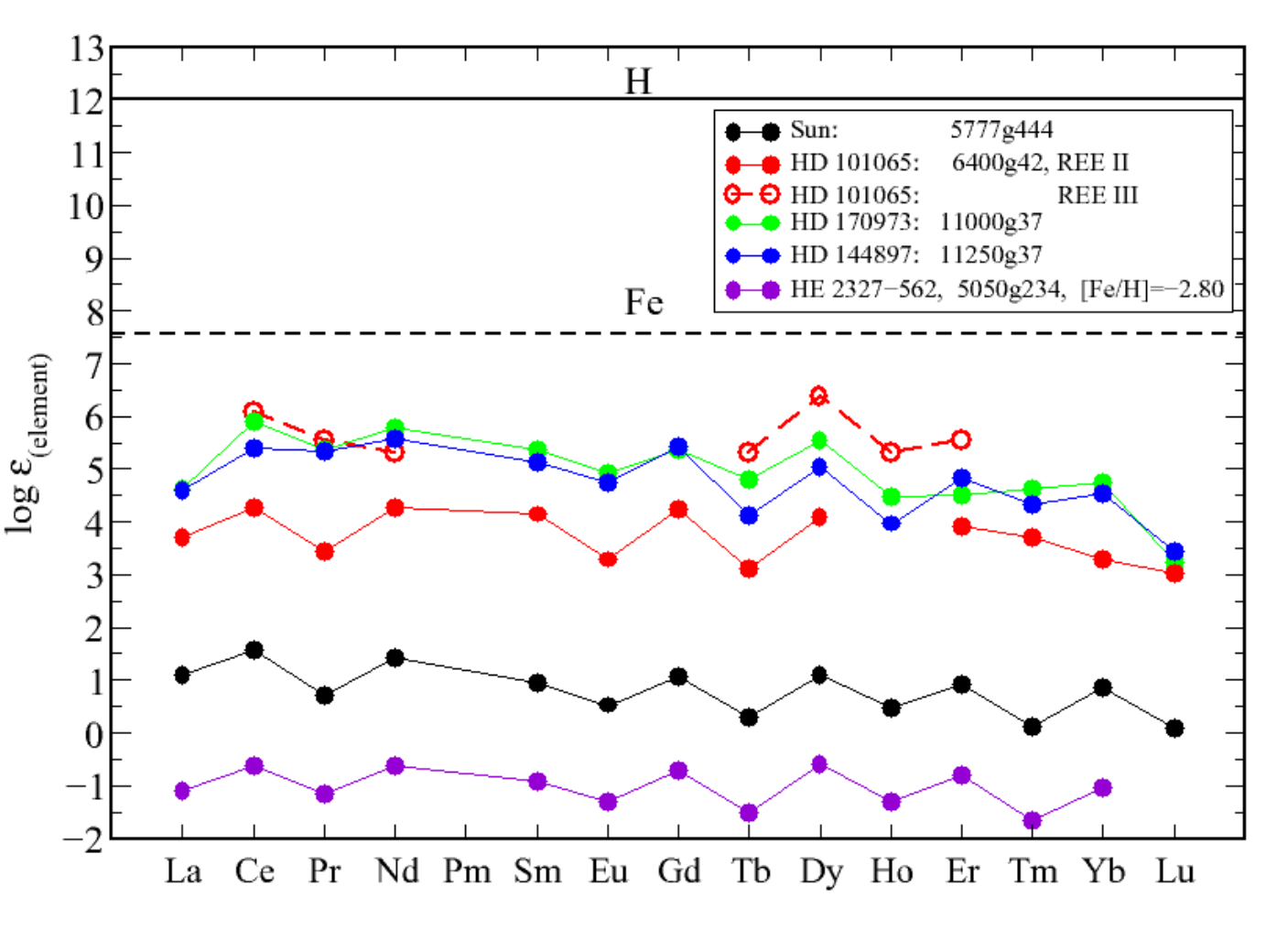





SUPERGIANTS
Betelgeuse
Polaris
Pollux
RED GIANTS
Ap
MAIN SEQUENCE
Sun
Sirius B
WHITE DWARFS
Intrinsic brightness (Sun = 1)
10^6
10^5
10^4
10^3
10^2
10
1
10^{-1}
10^{-2}
10^{-3}
40,000
20,000
10,000
6,000
4,000
3,000
2,000
Star's surface temperature (K)

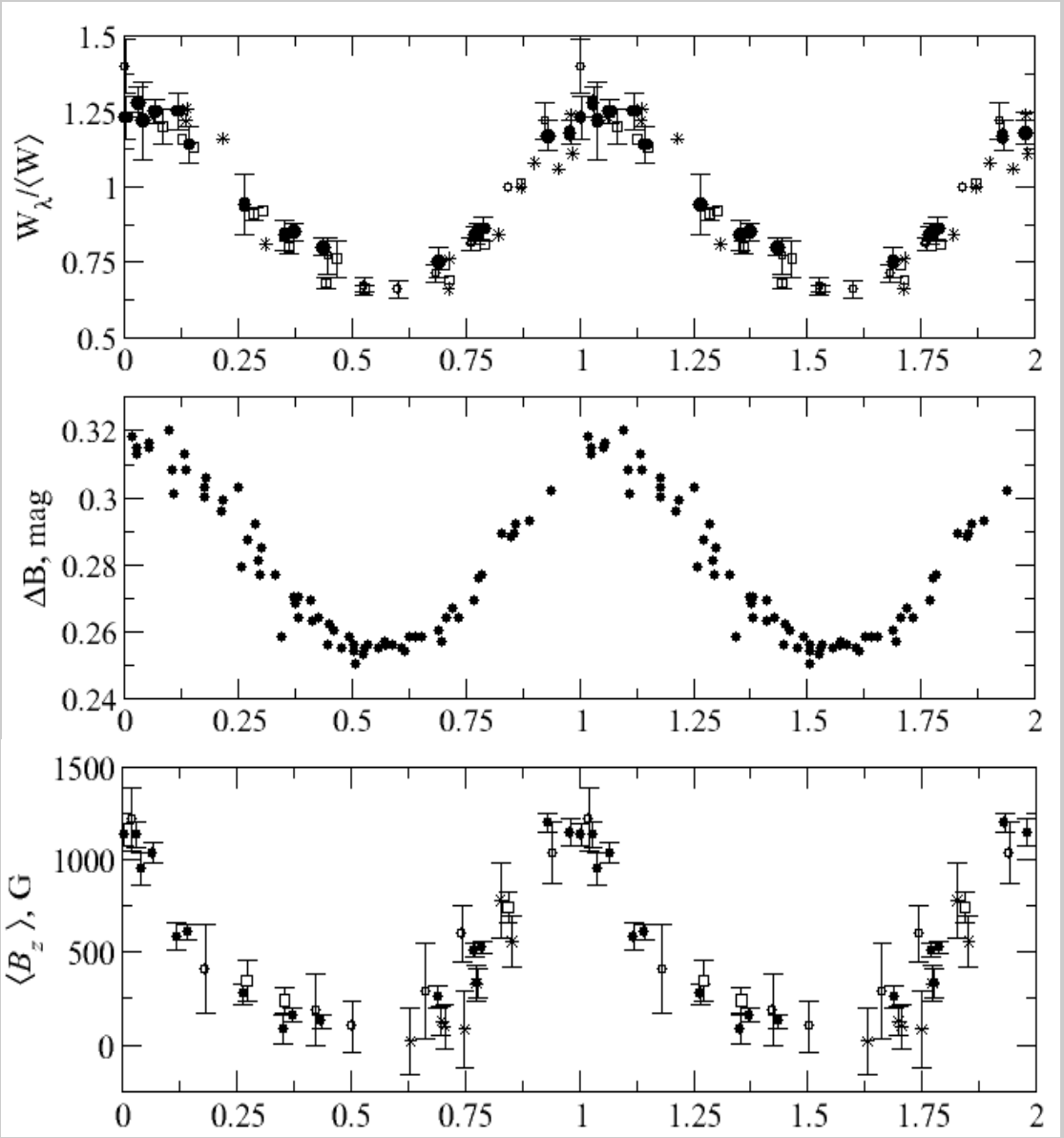
REE abundances in the atmospheres of magnetic chemically peculiar (Ap) stars

see also the poster S03-008
by A. Romanovskaya

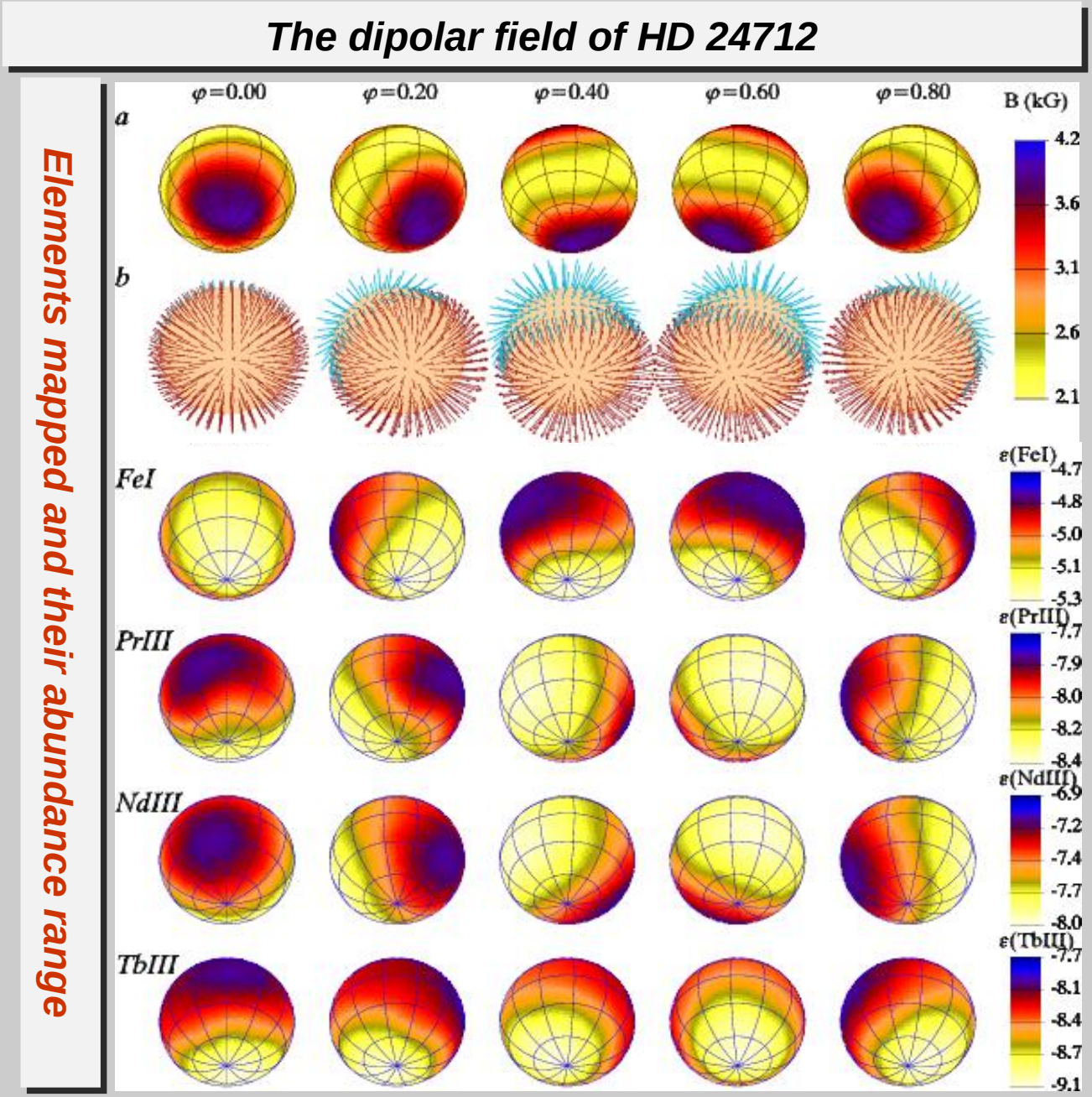


	Magn. field
HD 101065	2.3 kG
HD 170973	<1 kG
HD 144897	8.8 kG

Surface inhomogeneity: Periodic variations of the REE lines intensity. Oblique rotator model of Ap stars.

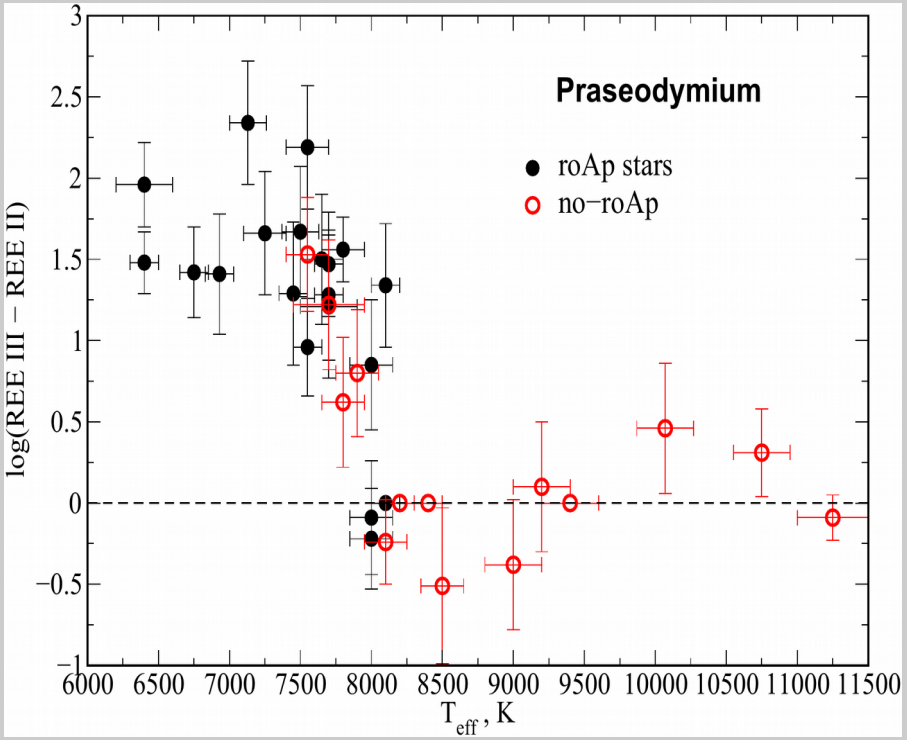


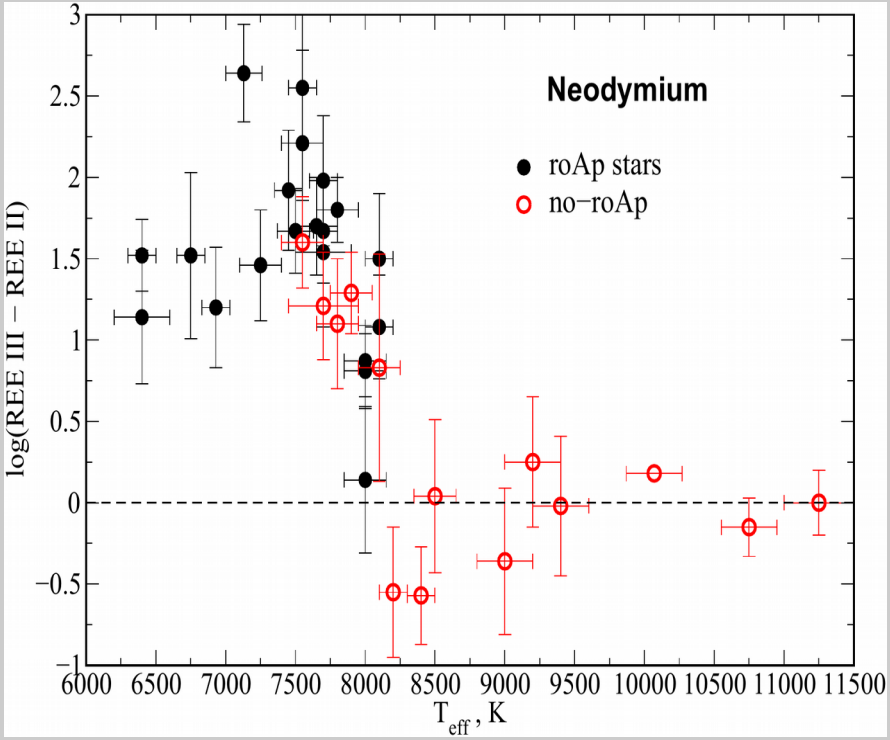
Surface distribution of the magnetic field, Fe and REE abundances in Ap stars:



From Luftinger et al. A&A 509, A71 (2010)

Vertical abundance gradients of the REE in Ap atmospheres: REE-anomaly

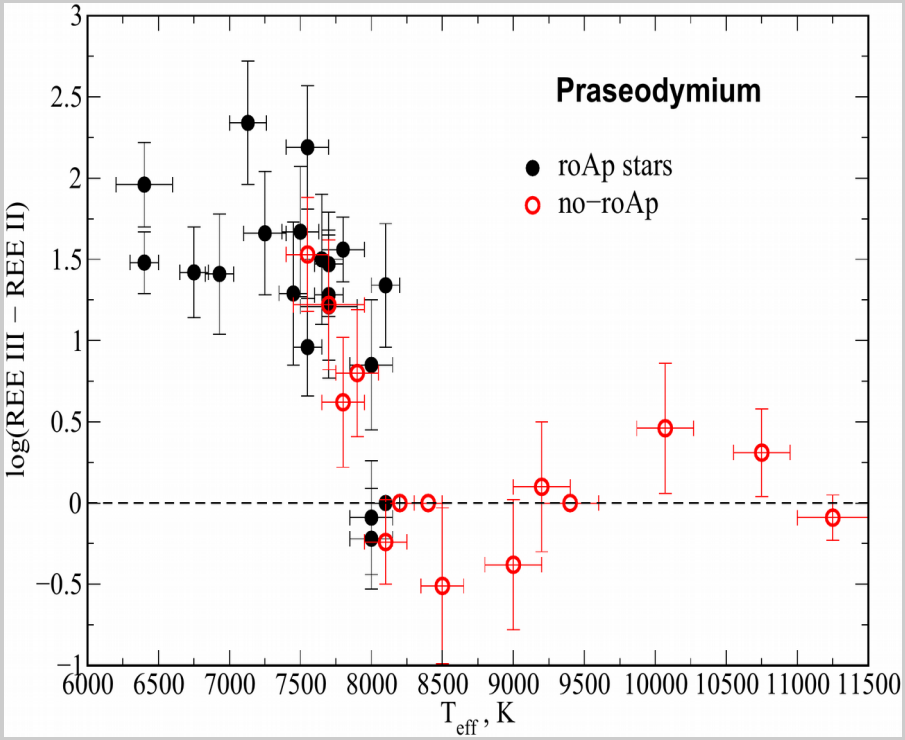


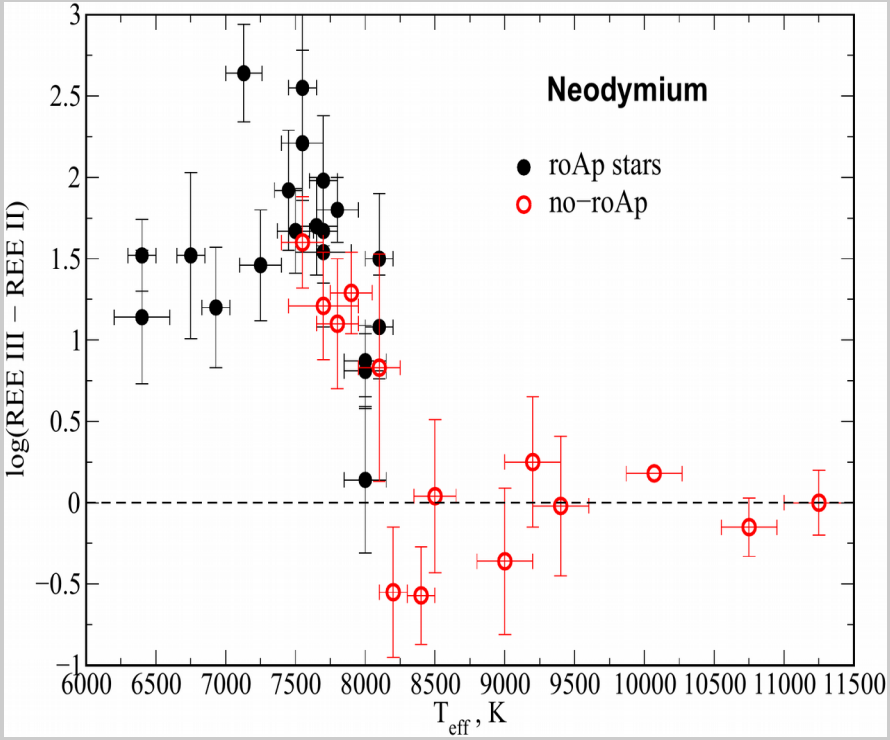


Ryabchikova et al. A&A 423, 705 (2004)

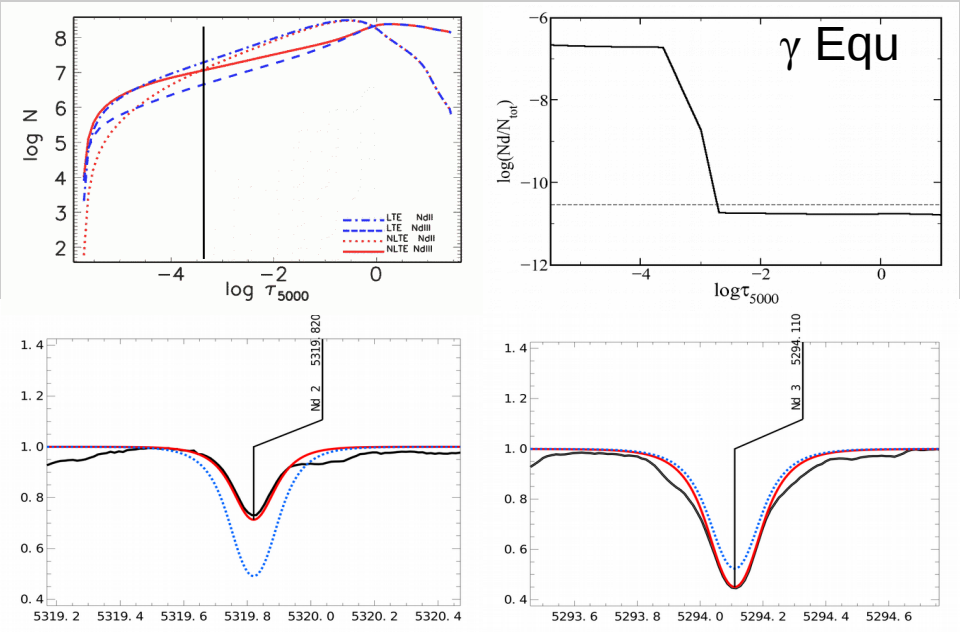
confirmed by Romanovskaya & Ryabchikova Astr. Letters 43, 252 (2017)

Vertical abundance gradients of the REE in Ap atmospheres: REE-anomaly





Ryabchikova et al. A&A 423, 705 (2004)

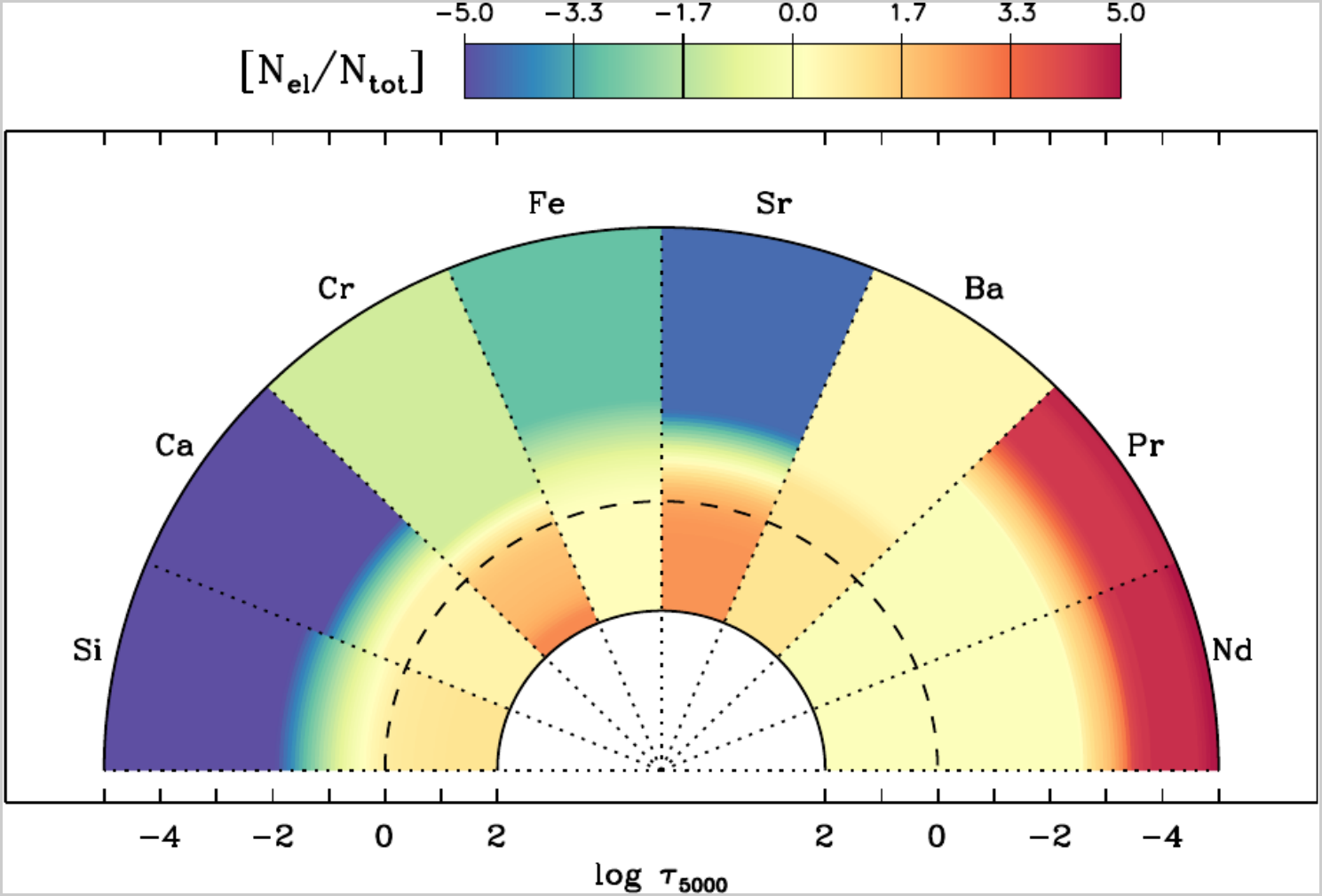


Empirical study of the REE stratification in Ap stars. Cases of Nd and Pr.

Mashonkina et al. A&A 441, 309 (2005) – Nd
Mashonkina et al. A&A 495, 297 (2009) – Pr

Schematic presentation of element abundance gradients in the atmosphere of roAp star HD 24712 "layered cake"

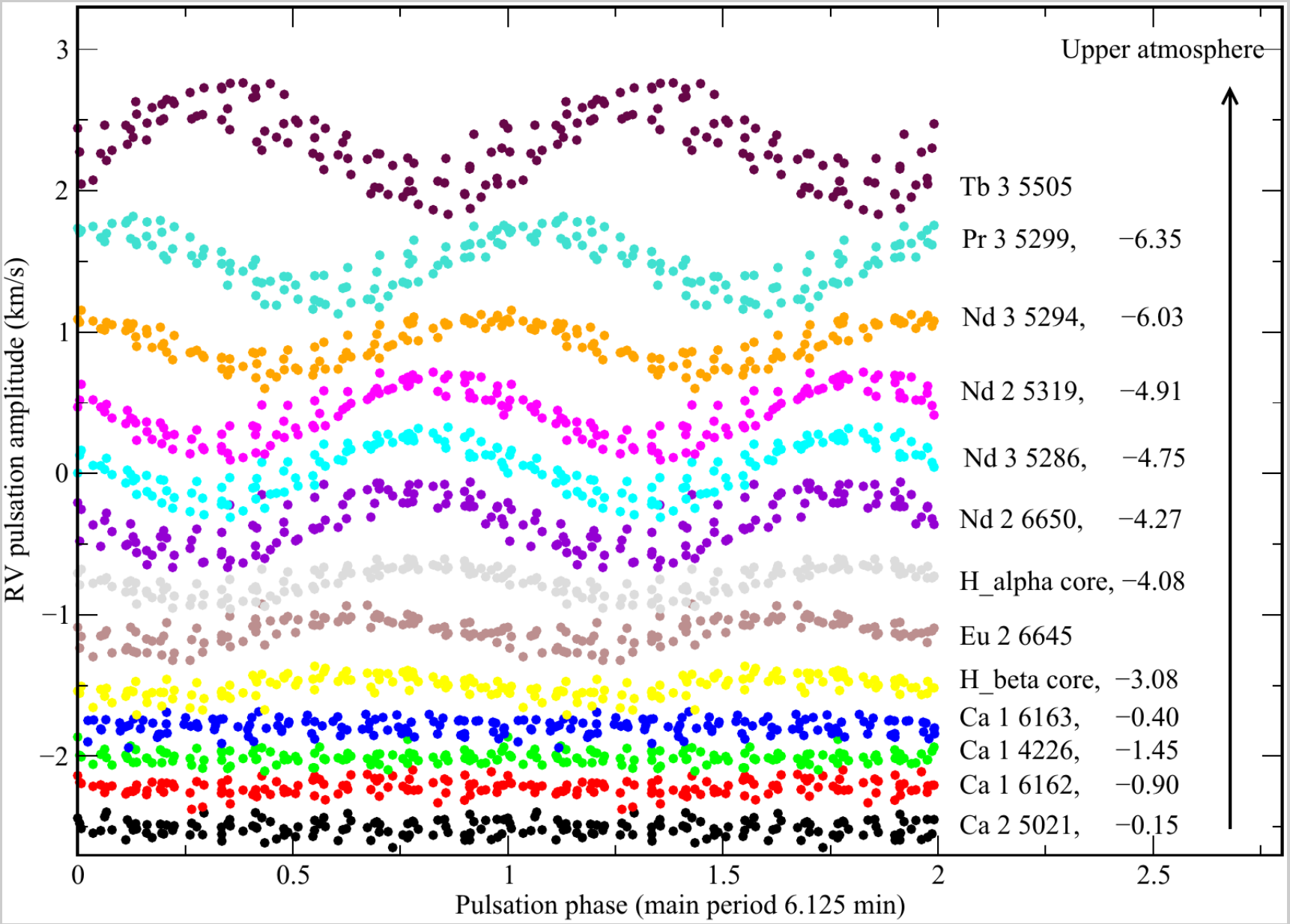
(based on the results from Shulyak et al. A&A 499, 879, 2009)

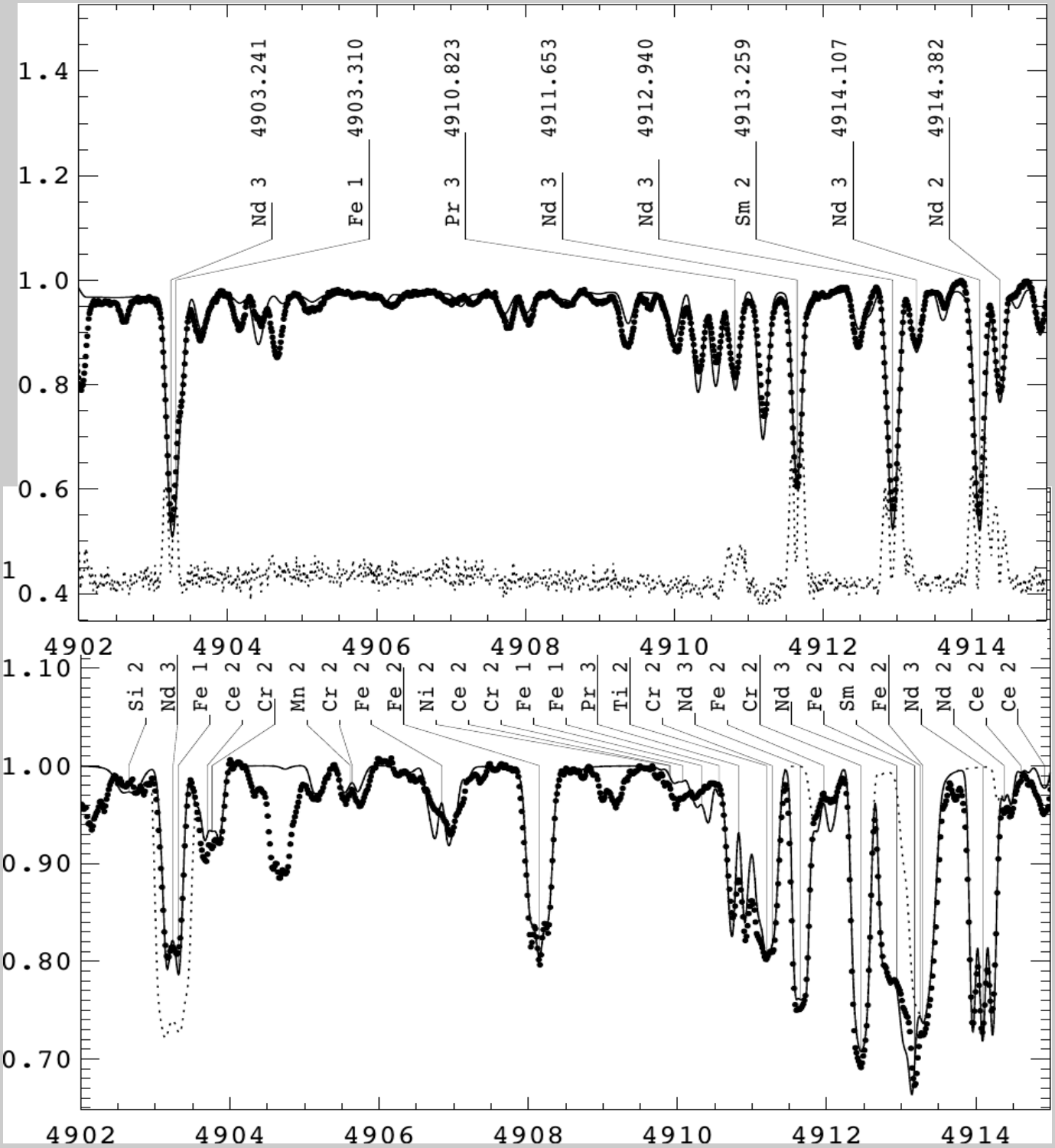


Pulsations in the atmospheres of cool Ap (roAp) stars:

HD 24712 (Ryabchikova et al. A&A 462, 1103-1112, 2007)

running waves in roAp atmospheres





Spectra of roAp-Ap stars as a laboratory for REE classification study.
(Ryabchikova et al. A&A 456, 329, 2006)

HD 24712 (roAp)
B_s=2.3 kG

HD 144897
B_s=8.8 kG

Thank you for your attention !