Chemical abundances of s- and r-process elements in the Solar Vicinity

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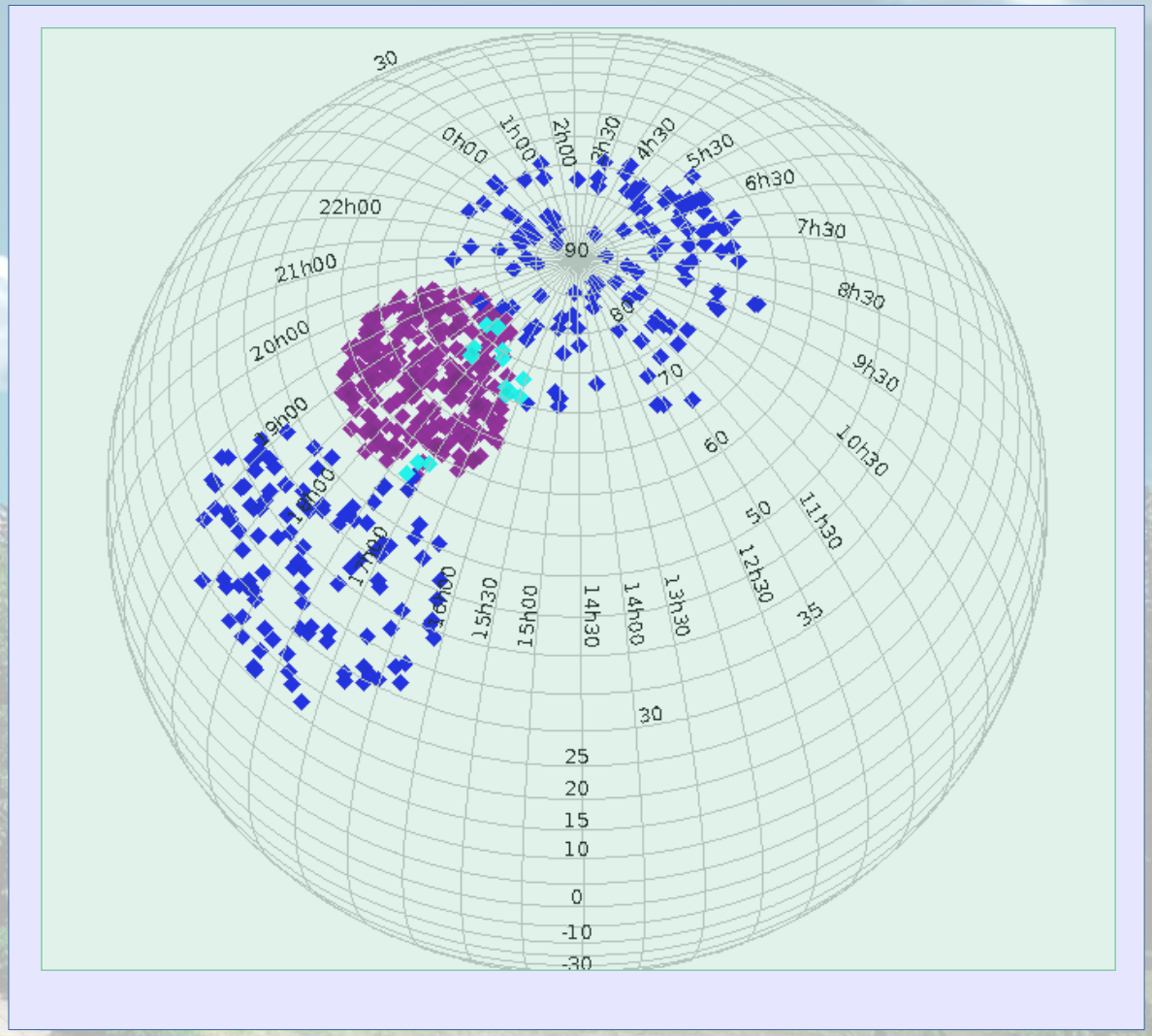
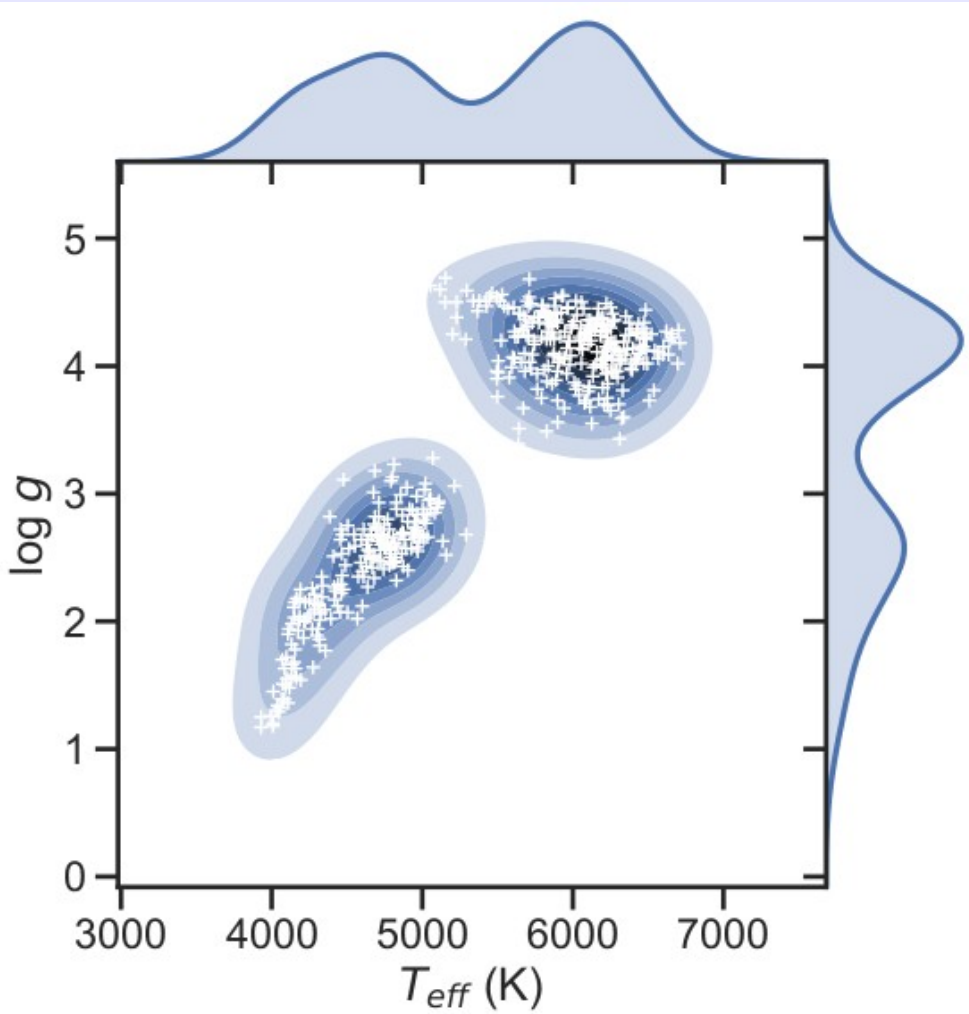
The chemical composition of stars are keys to unravel the structure and evolution of the Galaxy. Neutron capture elements offer increasing potential for this. We analyze the abundances of 10 neutron capture elements for a sample of more than half a thousand bright FGK spectral type dwarf, subgiant and giant stars in the solar neighborhood. We study them in combination with their kinematics and ages in the different substructures of the Galactic disk, and relate them to the lighter elements, as well as investigate their possibilities to serve as cosmic clocks.

Abundances were determined using high-resolution spectra by a differential line-by-line spectrum synthesis and accounting for the hyperfine-structure effects. The results were compared with the models of the Galactic chemical evolution. We used the Gaia space mission data in determining stellar locations and computed linear regressions of neutron-capture element abundances in respect to the mean galactocentric distances and distances from the Galactic plane.

Context of the research

- 506 FGK spectral type stars, (V < 8 mag)
- Preliminary ESA PLATO and NASA TESS fields
- Elements: Sr, Y, Zr, Ba, La, Ce, Pr, Nd, Sm, Eu
- 3800 < Teff < 6900 K
- +0.9 <log g < +4.7
- −1.0 < [Fe/H] < +0.5



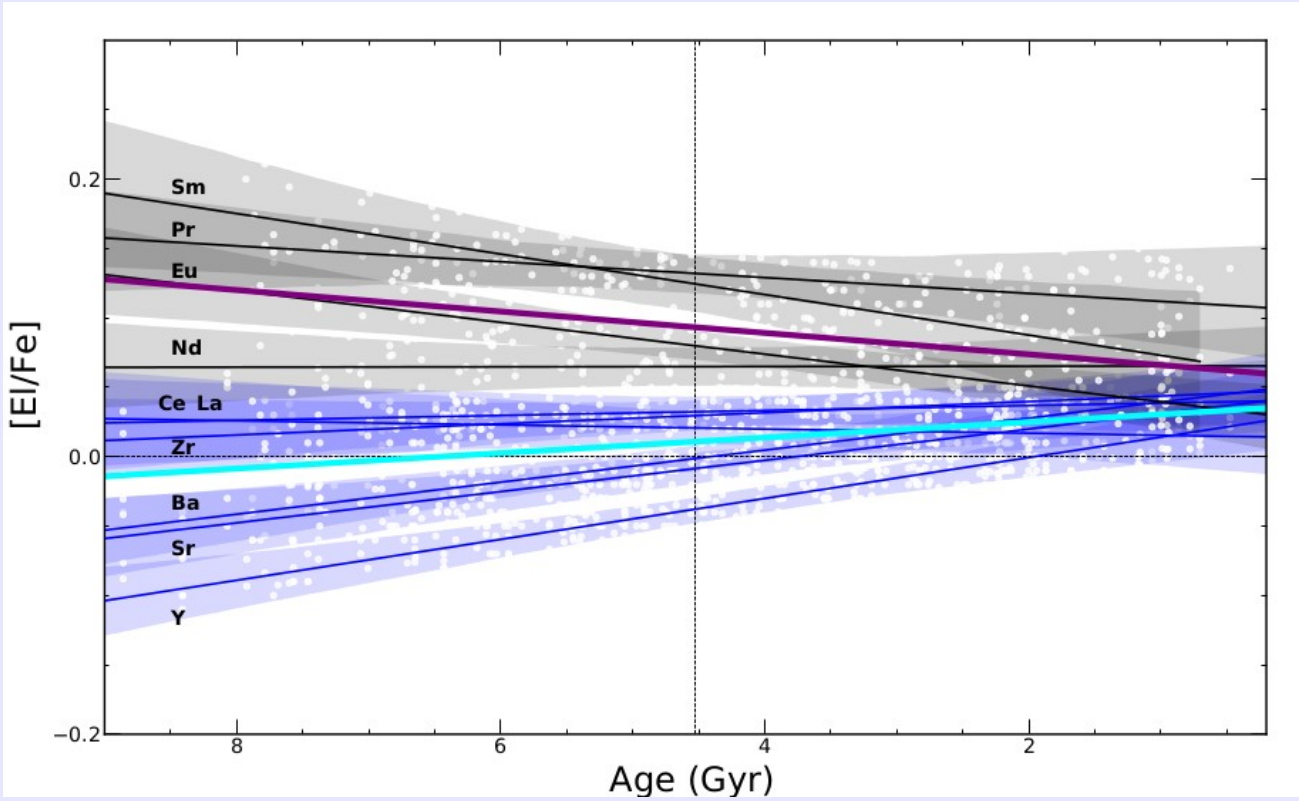


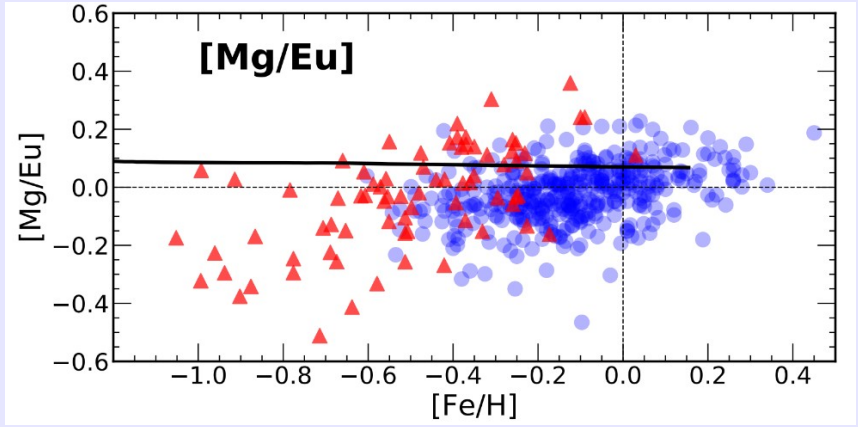
Description of the work / project / methodologies

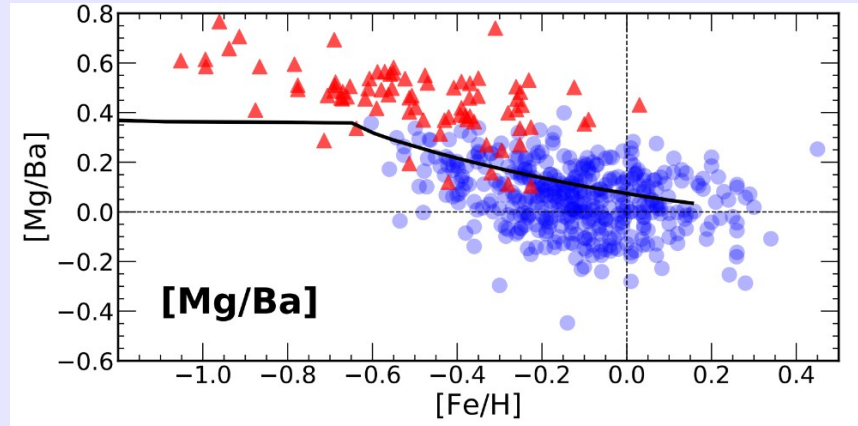
- SPFOT survey. Moletai Astronomical Observatory (MAO) 1.65 m telescope
- Vilnius University Echelle Spectrograph (VUES) (Jurgenson et al. 2014, 2016). Modes R=30000, R=60000
- Mikolaitis et al. (2018, 2019) and Tautvaišiene et al. (2020a): abundances of 24 chemical species.
- Tautvaišiene et al. (2020b) – A&A in preparation: abundances of 10 neutron capture elements. Total: 34 el.
- Abundances were determined by a differential line-by-line synthesis of spectral lines
- MARCS 1D model atmospheres and hfs effects
- Gaia-ESO Survey line-list
- Ages: UniDAM code (Mints & Hekker, 2017)
- Kinematics: Gaia DR2 with Galpy code (Bovy, 2015)
- Models: Prantzos+2018; Pagel & Tautvaisiene+1997

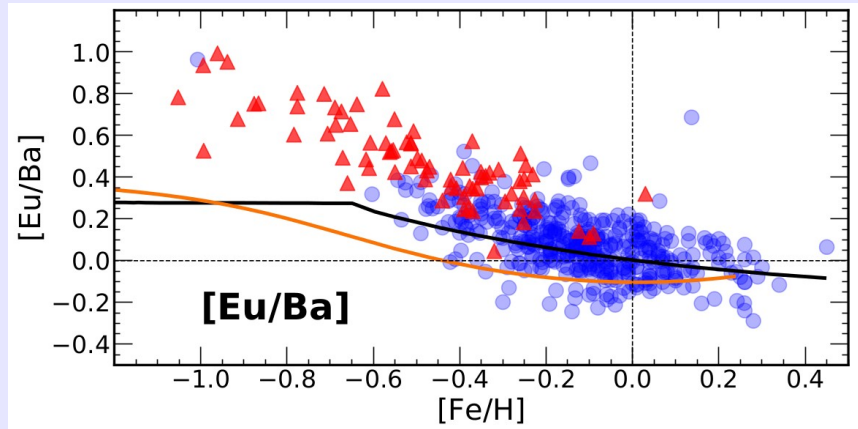
Results

- Different gradients of r- and s-process dominated elements
- Neutron-capture elements can be used as cosmic clocks for non solar-type stars
- [Y/Mg] gradients decreases with increasing metallicity
- [Mg/Eu] ratio suggests that the NSMs may have contributed to the r-process abundances









Impact and prospects for the future

We investigate a detailed behavior of neutron capture elements in the Solar neighborhood. In future we need:

- to increase a sample by stars of the thick disk to achieve precision in spatial and temporal gradients.
- to increase a sample of the thin and thick disk stars to make a more statistically significant study of the [Y/Mg]-age gradients in metallicity ranges.
- to study the [Y/Al]-age relation at different metallicity intervals.
- to study the potential of other s- and r-process elements in combination with alpha-el as potential galactic subcomponent separators and age indicators.
- to extend the study to other regions of the Galaxy, as well as to confirm the results using stellar clusters.