[Y/Mg] as a Stellar Chronometer Combining Asteroseismic and Chemical Data

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Introduction: Stellar Ages and Chemical Clocks
Stellar age cannot be measured directly, and indirect indicators are needed. In recent years, abundance ratios such as [Y/Mg] have shown strong potential as chemical clocks—tools that link elemental abundances to stellar ages. When combined with asteroseismology and precise astrometry, these clocks provide powerful insights into Galactic chemical evolution.

Figure 1. The 1.65-meter Ritchey-Chrétien telescope used to observe the stars analyzed in this study.

Data and Methods: Spectroscopy and Asteroseismology
We analyzed ~200 stars observed with the Vilnius University high-resolution Echelle Spectrograph (VUES) and the 1.65 m telescope (Fig. 1) at the Molėtai Astronomical Observatory in Lithuania (Fig. 2). Yttrium and magnesium abundances were determined spectroscopically. Asteroseismic ages were derived using TESS light curves, processed via the Lightkurve package, and analyzed through scaling relations and Bayesian inference with MESA and PARSEC isochrones.

Figure 2. The Molėtai Astronomical Observatory.

Figure 3. [Y/Mg] vs. asteroseismic age for thin- and thick-disc stars. Thin-disc stars are color-coded by mean galactocentric distance: blue (<7.5 kpc), green (7.5–8.5 kpc), and pink (>8.5 kpc).

[Y/Mg]–Age Relation: Thin vs. Thick Disc Stars
Our results (Fig. 3) confirm a strong [Y/Mg]–age correlation for thin-disc stars, consistent with previous studies (e.g. Nissen 2015). However, this correlation depends on Galactic location: stars at different galactocentric distances show distinct trends (Viscasillas Vázquez et al. 2022). In contrast, thick-disc stars show negligible correlation, indicating that [Y/Mg] is not a reliable age indicator for this population (Tautvaišienė et al. 2021).

Implications for Galactic Archaeology
The spatial dependence of the [Y/Mg]–age relation emphasizes the importance of combining chemical abundances with asteroseismology and Gaia astrometry. Chemical clocks like [Y/Mg] must be calibrated for different Galactic environments to improve stellar age estimates and to trace the formation history of the Milky Way more accurately.

Literature.
Nissen, P. E. 2015, A&A, 579, A52
Viscasillas Vázquez, C., Magrini, L., Casali, G., et al. 2022, A&A, 660, A135
Tautvaišiene, G., Viscasillas Vázquez, C., Mikolaitis, Š., et al. 2021, A&A, 649, A126

Acknowledgements.
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RCL
Research Council of Lithuania

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related works:

I. MINCHEV (WEDNESDAY): Chemical clocks and their time zones: exploring the cosmic time evolution of [s/Mg] in the Milky Way

G. CASALI (FRIDAY): Unlocking stellar ages with s-process elements: Calibrating chemical clocks using Kepler data

Challenge: Stellar ages are not directly measurable—we rely on indirect indicators.

Chemical clocks: Abundance ratios like [Y/Mg] and more generally [s-/α] show strong sensitivity to stellar age (e.g. Nissen, A&A 579, 2015). **10 YEARS AGO!**

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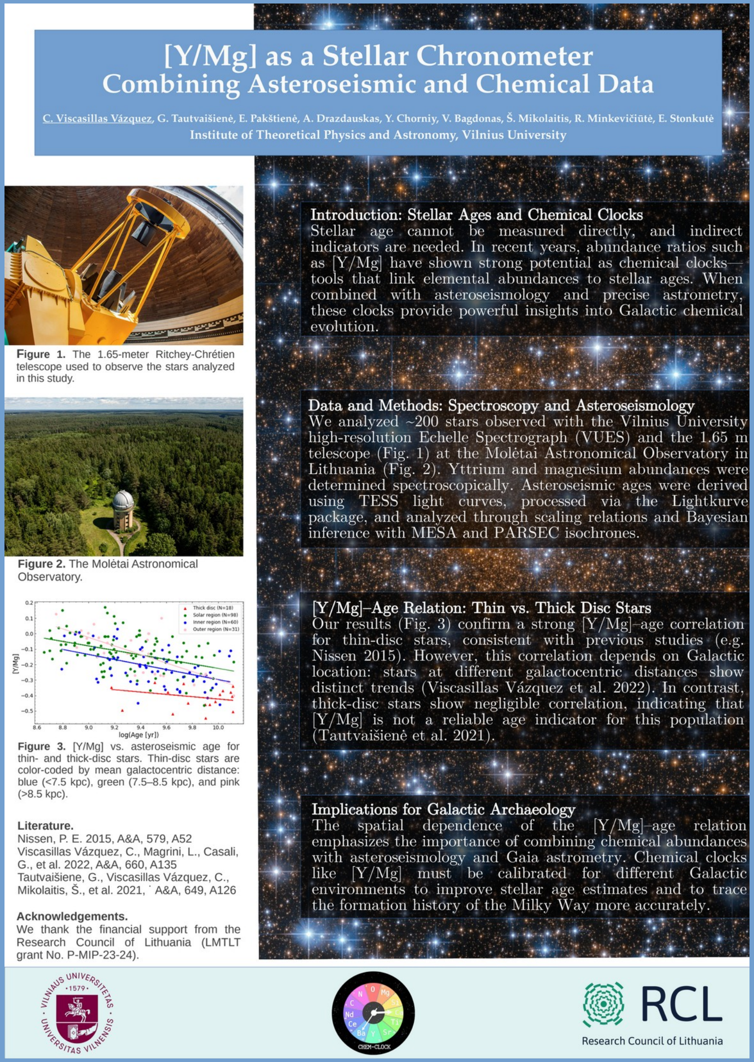

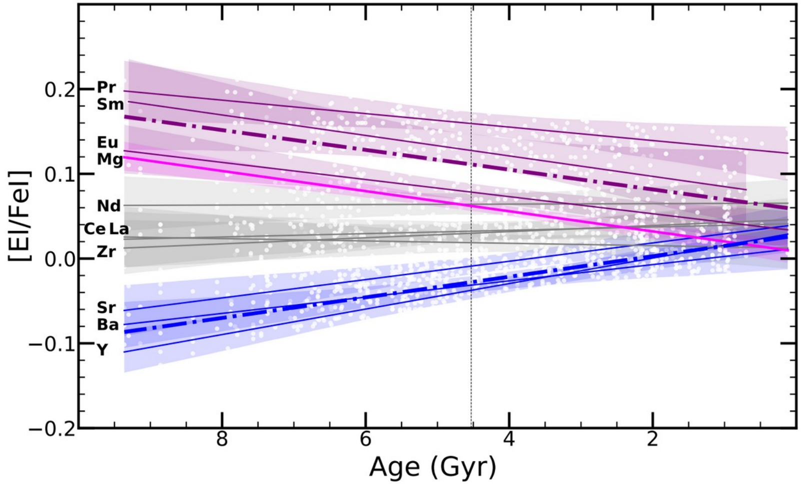

Tautvaišienė, Viscasillas et al. (2021), A&A 649, A126

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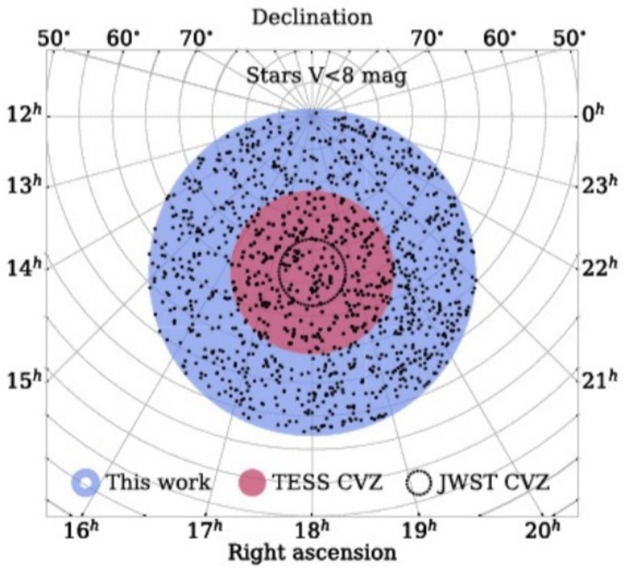
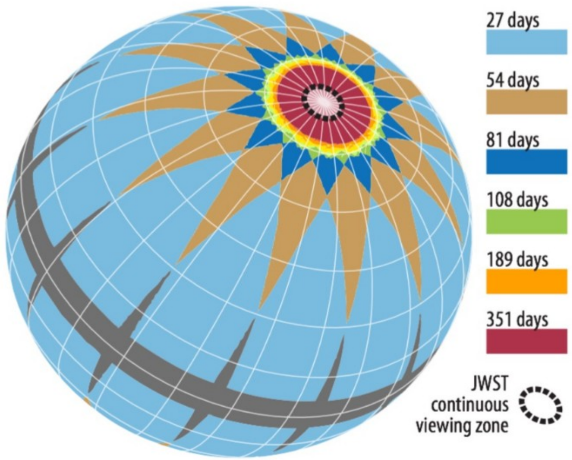
Lietuvos mokslo taryba

CHEM–CLOCK

Data: ~200 stars observed with the VUES spectrograph on the 1.65 m telescope (Molėtai Observatory, Lithuania).



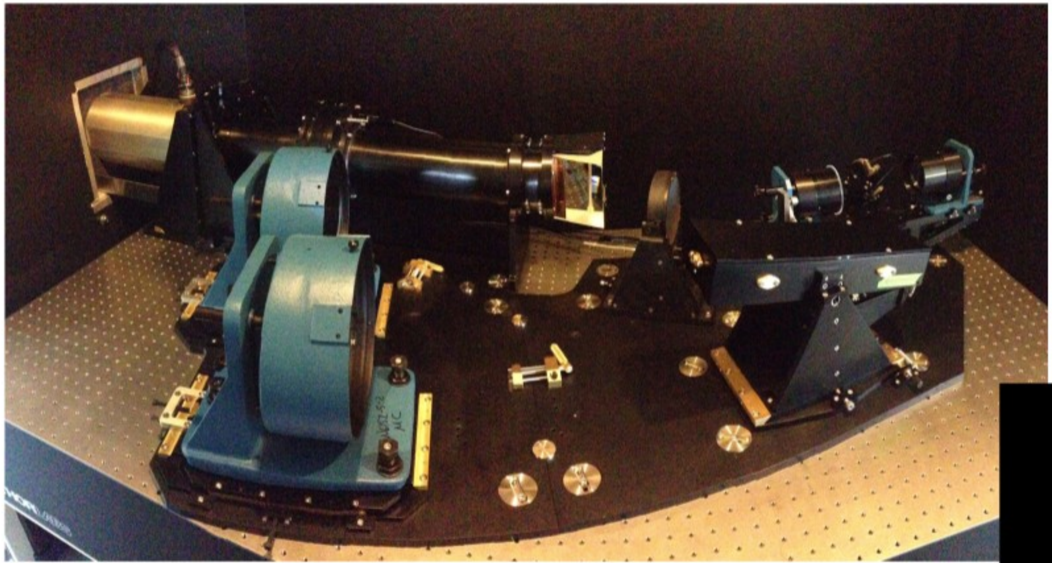


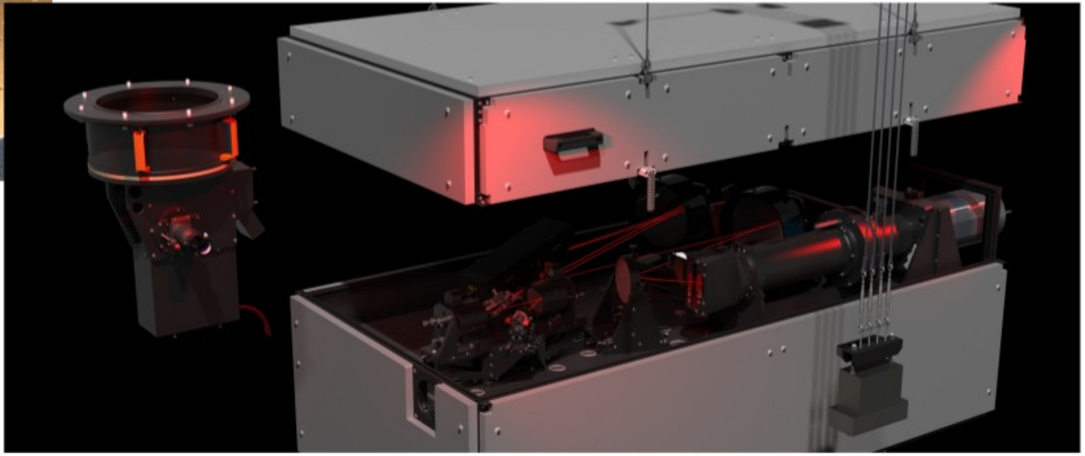
TESS northern sky: High-resolution spectra observed for all 1500 FGK stars up to V < 8 mag in the area centered on the TESS continuous viewing zone and up to 12 deg radius around it

SPFOT survey

Vilnius University Echelle Spectrograph (since 2016)

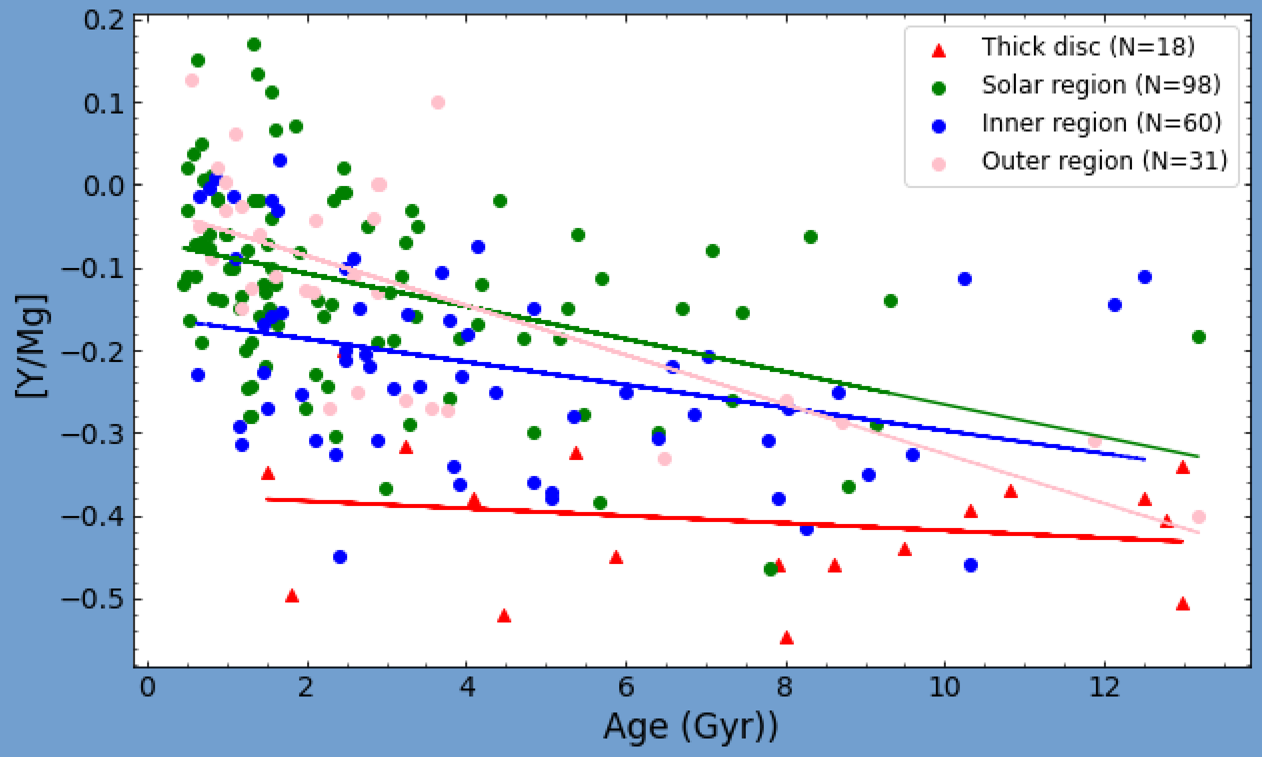
Resolutions R = 30 000, 45 000, and 60 000





From observations to science: All work was done in Lithuania.

See Poster 7: GRANKINA A.



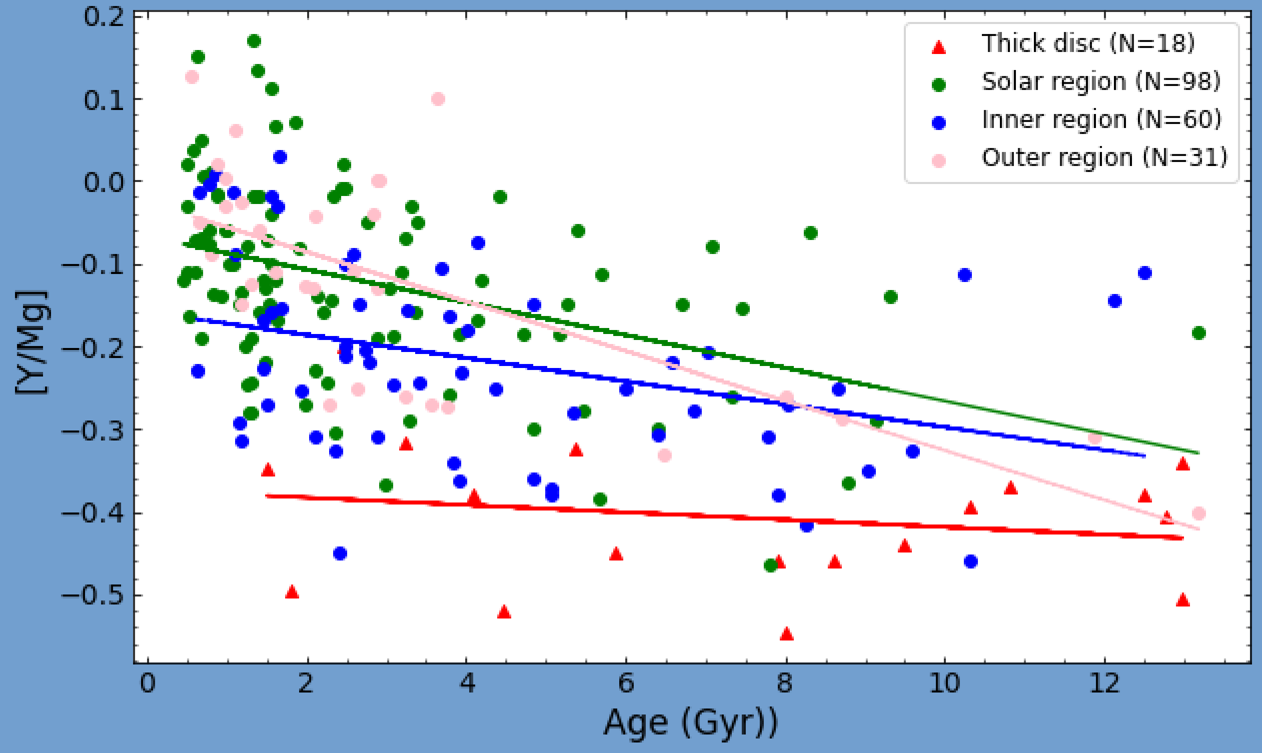
Our study confirms two key findings from previous works:

[Y/Mg] is not a reliable age indicator for thick-disc stars

→ in agreement with Tautvaišienė, Viscasillas et al. (2021), A&A 649, A126

In the thin disc, the [Y/Mg]–age relation depends on galactocentric distance

→ consistent with Viscasillas, Magrini, Casali et al. (2022), A&A 660, A135



See also Molero, Magrini et al. 2025. A&A 694
Magrini, Vescovi et al. 2021. A&A 646

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Work in progress!