Revista Mexicana de Astronomía y Astrofísica Serie de Conferencias, 60, 106-107, (2026)
© 2026 Instituto de Astronomía, Universidad Nacional Autónoma de México
OPEN ACCESS https://doi.org/10.22201/ia.14052059p.2026.60.100

"XVII LARIM", Montevideo, Uruguay, November 27 - December 1, 2023.Volume Editors: Gonzalo Tancredi, Cecilia Mateu & Juan José Downes

Lithium depletion in solar analogs: age, mass and planet effects

Anne Rathsam[1], Jorge Meléndez[1], Gabriela Carvalho Silva[1] and Giulia Martos[1]

[1]*Instituto de Astronomia, Geofísica e Ciências Atmosféricas, Universidade de São Paulo, Rua do Matão 1226, São Paulo 05508-090, Brazil.*

Keywords: *stars: abundances, stars: evolution, stars: late-type, stars: solar-type*

Corresponding author: annerathsam@usp.br

The goal of this work is to evaluate the correlation between Li abundance, age, and mass. Our joint analysis of 151 solar-type stars confirms the strong Li abundance-age correlation reported by other works. Mass and convective mass also seem to be connected with Li abundance but with lower significance. We have found a link between the presence of planets and low Li abundances in a sample of 192 stars with a high significance.

Lithium (Li) is an important element for stellar astrophysics because it is destroyed at a temperature of 2.5×10^6 K, which is easily reached in the interior of stars. The base of the convective zone of main-sequence solar-type stars does not reach a temperature above $\sim 2 \times 10^6$ K. Thus, since the standard stellar model does not consider any mixing processes besides convection, the Li abundance of a single solar-type star should not change as the star evolves along the main sequence. However, these stars present a decay of Li abundance with stellar age (Carlos et al., 2019), indicating the existence of non-standard transport mechanisms. Many possible mechanisms were invoked, but there is still no model capable of explaining every characteristic regarding Li abundance.

Our sample consisted of 74 nearby solar twins and analogs (published in Rathsam et al., 2023) plus 79 solar twins from Carlos et al. (2019). The stars have solar metallicity (within $\pm$ 0.15 dex) and their mass ranges between 0.85 and 1.10 $M_\odot$.

We employed HARPS spectra (R $\simeq$ 115 000; 270 $\leq$ SNR $\leq$ 1000) taken from ESO's public database. To find the atmospheric parameters, we measured Fe lines via the line-by-line differential method and applied the spectroscopic equilibrium with the code q^2 (Ramírez et al., 2014). The masses and ages were found via a probability distribution from q^2. The Li abundances were determined via spectral synthesis of the 6707.8 Å line with the code MOOG. Convective masses were found via interpolation based on theoretical values from Spada et al. (2017).

Our results show a strong trend of lower A(Li) with larger age but with a much larger scatter than in the sample of solar twins from Carlos et al. (2019) (Fig. 2 in Rathsam et al. 2023). In particular, low-mass stars appear more Li-depleted. To evaluate the effect of age in A(Li) for solar twins, we selected stars with masses between 0.98 and 1.02 $M_\odot$ and performed an orthogonal distance regression. The resulting fit shows a strong correlation, with a significance of 14-σ.

The stars in our sample show lower A(Li) for lower mass or higher convective mass, which is consistent with what is predicted since low-mass stars present deeper convective envelopes and are expected to burn more Li. To quantify the influence those parameters on A(Li), we fitted the residuals of the relation found for solar twins as a function of mass and (convective mass)/mass for our entire dataset. The results show that while age is still the most important parameter governing A(Li), mass and convective mass also play a role (with a significance of 2-σ for mass and 5-σ for conv. mass/mass).

Finally, to test whether planet-host stars are more Li-depleted (which could be related to the process of formation of planetary systems, Meléndez et al. 2009), we included in our sample the stars from Martos et al. (2023). Out of 192 stars, 36 had confirmed orbiting planets. We then compared the Li abundance of planet hosts with the average or median abundance of non-hosts "twin" stars and found that planet-hosts appear more Li depleted by $\sim$ 0.2 dex, with a significance above 99% for our results (estimated via a t-test).

References

Carlos, M., Meléndez, J., Spina, L., et al. 2019, MNRAS, 485, 4052, doi: 10.1093/mnras/stz681

Martos, G., Meléndez, J., Rathsam, A., & Carvalho Silva, G. 2023, MNRAS, 522, 3217, doi: 10.1093/mnras/stad1177

Meléndez, J., Asplund, M., Gustafsson, B., & Yong, D. 2009, ApJ, 704, L66, doi: 10.1088/0004-637X/704/1/L66
Ramírez, I., Meléndez, J., Bean, J., et al. 2014, A&A, 572, A48, doi: 10.1051/0004-6361/201424244
Rathsam, A., Meléndez, J., & Carvalho Silva, G. 2023, MNRAS, 525, 4642, doi: 10.1093/mnras/stad2589
Spada, F., Demarque, P., Kim, Y.-C., Boyajian, T. S., & Brewer, J. M. 2017, ApJ, 838, 161, doi: 10.3847/1538-4357/aa661d

“XVII LARIM”, Montevideo, Uruguay, November 27 - December 1, 2023.Volume Editors: Gonzalo Tancredi, Cecilia Mateu & Juan José Downes