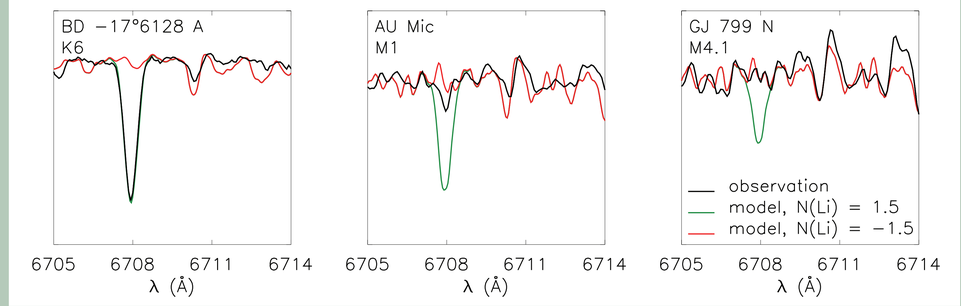
Lithium Depletion in the β Pictoris Moving Group

Jennifer Yee, Eric Jensen, & Blair Reaser (Swarthmore College)

ABSTRACT

The β Pictoris Moving Group (BPMG) is young (~12 Myr old) and nearby (10–50 pc; Zuckerman & Song 2001) making it ideal to test models of pre-main sequence (PMS) lithium depletion. Theoretical models predict specific patterns of lithium depletion during the PMS lifetime of low mass stars, relating the lithium abundance of a late-type PMS star directly to its age, but ***the models must be calibrated with empirical data***.

Our data reveal discrepancies with the theoretical predictions of PMS lithium depletion that indicate potentially significant errors in lithium abundance ages. Furthermore, ***it appears that M stars deplete lithium at a much faster rate than models predict, making the detection of late-type post-T-Tauri stars difficult.***

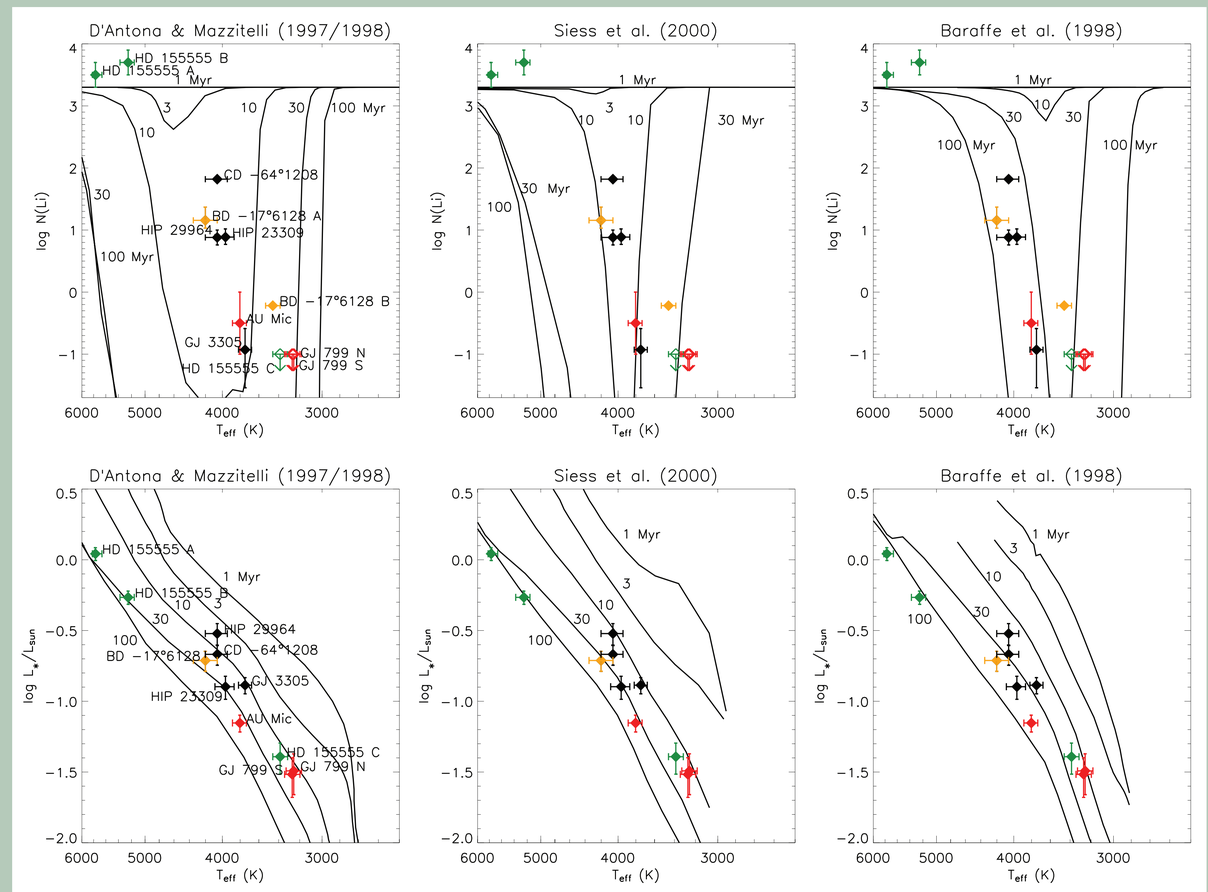


The figure above shows observed, high S/N spectra for three stars of different spectral types from our sample (black) plotted with synthetic spectra from PHOENIX of lithium abundance log N(Li) = 1.5 and log N(Li) = –1.5 (Johnas & Hauschildt 2006). It is evident that the amount of lithium decreases with decreasing effective temperature, that lithium is clearly detected though significantly depleted in AU Mic (GJ 803), and that lithium is not detectable in the M4.1 star GJ 799 N.

COMPARISON WITH OTHER WORK

Song, Bessell, & Zuckerman (2002) observed another binary system in the BPMG, HIP 112312. This system consists of an M4 star and an M4.5 star in which the latter has a strong Li I line while the former does not. Including that data in our analysis shows the expected increase in lithium abundance at extremely cool temperatures but is still inconsistent with model predictions.

Similar inconsistencies between isochrone-fitting ages and lithium-depletion ages were observed by White & Hillenbrand (2005) in their work on St 34, a lithium-depleted, M3 classical T Tauri binary system. Using the BCAH98 models, White & Hillenbrand found a distinctly younger age for the system from its location on the H-R diagram than from its observed lithium depletion.



The figure above shows our newly measured lithium abundances* for the twelve stars overlaid on three sets of models: D'Antona & Mazzitelli (1997,1998), Siess, Dufour, & Forestini (2000), and Baraffe, Chabrier, Allard, & Hauschildt (1998). Notice that the ages predicted by the location on the H-R diagram and by the location on the corresponding lithium abundance plot differ for any individual star. Taking the stars as a group, it is apparent that ***the models do not correctly predict the observed patterns of lithium depletion.*** Of particular interest are stars in multiple systems (shown in color: HD 155555 A/B/C; BD –17°6128 A/B; and AU Mic / GJ 799 N/S). Within each system the components are coeval, yet they appear to have significantly different ages on the lithium abundance plots.

*Abundances for the spectroscopic binary HD 155555 AB were taken from Randich, Gratton, & Pallavicini (1993).

We gratefully acknowledge the support of the National Science Foundation through grant AST-0307830.

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Presented at 207th AAS meeting, Seattle, WA, January 7, 2007. Contact Jennifer Yee (jyee1@swarthmore.edu) for more information or for preprints. Full-sized version on-line at http://astro.swarthmore.edu/~jensen/publications/