APR17-2016-020144

Abstract for an Invited Paper
for the APR17 Meeting of
the American Physical Society

Exploring non-standard stellar physics with lithium depletion[1]

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Standard models of stellar evolution generally rely on the assumption that the structure and evolution of stars are uniquely determined by their mass, composition, and age. This assumption is now known to be too simplistic, as there remain numerous features of the observed cluster and field stellar pattern which cannot be explained by standard stellar theory. One such discrepancy pertains to the evolving abundances of the light element lithium, which shows significant dispersions between stars of equal mass and age on the pre-main sequence, in defiance of standard predictions. Lithium is rapidly destroyed by proton capture in the deep interiors of stars, and consequently the Li abundance observed in a star's convective envelope encodes information about the evolution of the temperature of its interior, and about the history of material exchanged between the surface and hot central regions. This makes Li an extremely sensitive diagnostic of stellar physics. Identifying the ways in which standard lithium predictions differ from the observed pattern gives us a crucial laboratory for understanding how non-standard physical effects are influencing stellar structure and evolution. In this talk, I will argue that starspots, correlated with rotation, are the underlying driver of dispersion in lithium abundance on the pre-main sequence. Starspots are ubiquitously found on young, active stars, and may cover up to 50% of their surfaces. By modifying an existing stellar evolution code to account for spot effects on both the surface boundary conditions and the transport of energy in the interior, I will show that heavy spot coverage systematically increases the radii of the fastest spinning young stars. This effect cools their interiors, leading to a reduce rate of lithium destruction on the pre-main sequence. This insight demonstrates that stars of equal mass and age can have different stellar parameters, and holds important consequences for measuring the masses and ages of stars in young clusters. These are questions of deep importance to astrophysics, as young cluster ages anchor our knowledge of the formation timescale of planets, the lifetimes of circumstellar disks, and the accretion processes experienced by proto-stars.

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