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What's the matter with lithium?

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Big-bang nucleosynthesis (BBN) has long provided a boundary between the possible and the impossible in particle physics and cosmology. Now that there are often stronger constraints from the laboratory and from the cosmic microwave background, BBN provides an important cross-check, a window into times long before recombination, and a set of initial conditions for the nuclear history of universe. However, some nagging issues remain for BBN, and probably none are as vexing as the Li/H ratios in low-metallicity turnoff stars of the Galactic halo. Since the early 1980's, the remarkably consistent Li/H ratios among these stars have been seen as evidence of the primordial Li/H, and the lack of star-to-star scatter has been matched by a lack of publication-to-publication scatter over time. The problem with this very consistent picture is that the measured Li/H is lower than the prediction of BBN by about a factor of 3, presenting us with a quandary: depletion of lithium after BBN by such a large factor without introducing scatter seems possible but not certain; stellar model atmospheres do not seem uncertain enough to provide a factor of 3; the uncertainties on the nuclear cross sections involved in BBN cannot accommodate a factor of 3; a few solutions with "exotic" early-universe physics beyond the standard model exist, but have weak motivation beyond BBN. An additional puzzle has cropped up in the last few years, as previous hints of a relatively constant ^{6}Li/H ratio in halo stars have developed into a substantial data set. This is not predicted at all by standard BBN. I will review these developments, the several ways one might try to explain them, and the difficulties involved in establishing these explanations without contradicting known facts. Work supported by DOE contract DE-AC02-06CH11357.