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Lab Astro and the Origins of the Chemical Elements[1]

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Interpretation of the spectra of metal-poor Galactic halo stars is dependent on AMO laboratory data [1,2]. Metal-poor Galactic halo stars were born when the Milky Way was young and they provide a record of the chemical evolution of the Galaxy. Elements heavier than iron are produced via r(apid)-process and s(low)-process n(eutron)-capture mechanisms. The s-process mechanism, which occurs in certain AGB stars, is relatively well understood. The explosive r-process is not well understood. The r-process n-capture mechanism was dominant early in the Galaxy's history [3]. New large aperture telescopes make it possible to record high-resolution spectra with high signal-to-noise ratios on a growing number of metal-poor stars. In addition to mapping the chemical evolution of the Galaxy, these studies are yielding an increasingly well-defined r-process elemental abundance pattern which constrains models of r-process nucleosynthesis [1]. The next phase of this ongoing research will address challenges in modeling stellar photospheres. Peculiar trends in abundances of specific Fe-group elements as a function of stellar age or metallicity may be due to limitations in traditional one dimensional (1d) local thermodynamic equilibrium (LTE) models of stellar photospheres or may be due to poorly understood nucleosynthesis [4]. Efforts are now underway to test the Saha or ionization equilibrium in a variety of stellar atmospheres for several Fe-group elements using the best available spectroscopic data for selected transitions. More comprehensive spectroscopic data of improved accuracy and accurate collisional data, especially for inelastic collisions of H atoms with metal atoms and ions, will be needed to fully develop 3d/non-LTE models of photospheres [e.g. 5].

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