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Laboratory Astrophysics in Support of the Study of Nucleosynthesis[1]

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One of the outstanding questions in our understanding of the Universe is how the elements were made. Only a few of the lightest or primordial nuclei were made just after the Big Bang. Other light nuclei up to the iron (Fe)-group are made by fusion reactions in the interior of stars. Heavier nuclei are made primarily via neutron-capture events which are categorized as either slow or rapid, the s-process or r-process, respectively. Although s-process neutron-capture is fairly well understood, the r-process, which occurs in neutron dense (explosive) environments, remains more elusive. In recent years, progress has been made in the understanding of r-process nucleosynthesis through the study of elemental abundances in metal-poor stars. These stars, which are among the oldest objects in our Galaxy, contain a fossil record of the elemental mix of the surrounding interstellar medium when they formed. The improvement of both the accuracy and precision of elemental abundances in metal-poor stars has required a long-term effort to improve the necessary laboratory data – first for the rare earth elements and more recently for the Fe-group. In this talk I will describe our laboratory effort measuring atomic transition probabilities, which are determined from a combination of radiative lifetimes and emission branching fractions. I will then show some examples of the application of our laboratory data to the determination of metal-poor star elemental abundances and discuss insights that can be gleaned from these improved data.

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