Improved Radiative Lifetimes, Branching Fractions, and Atomic Transition Probabilities for Nd II

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Radiative lifetimes measured using time-resolved laser-induced-fluorescence (LIF) are being combined with emission branching fractions from a Fourier transform spectrometer (FTS) to determine accurate absolute atomic transition probabilities for Nd II. This laboratory work on Nd II is part of a continuing effort to support astrophysical studies of heavy element abundances in metal poor Halo stars. Some metal poor Halo stars have greatly enhanced abundances of r- process neutron capture elements [e.g. 1]. Detailed abundance studies of Halo stars are revealing the relative importance of r-process versus s-process nucleosynthesis throughout the Galaxy's history, insights on the r-process, and constraints on the age of the Galaxy [2].

The method of determining transition probabilities has recently been applied to Eu II and La II [3,4]. These elements are of particular interest in the study of Halo stars because Eu is a nearly pure r- process element and La is a nearly pure s-process element. Improved transition probabilities have significantly decreased the scatter in solar abundances of these elements determined using different spectral lines. Decreased scatter and better overall accuracy are important for studies of Halo stars in which high S/N data is likely to be available for fewer lines.

Existing sets of Nd II transition probabilities yield a large scatter in abundance values from different spectral lines. Solar system Nd was produced by both the r-process and s- process. Improved Nd abundances will provide an interesting test of the conjecture that metal poor Halo stars with enhanced r-process abundances have scaled solar r-process abundances.

The time-resolved LIF experiment at UW is being used for the Nd II radiative lifetime measurements. A hollow cathode discharge is used as a source to produce a slow Nd ion beam. This experiment has been used for studies on more than 40 spectra since it was built in 1980. Systematic uncertainties are understood and controlled to the 5% level.

Fourier transform spectra of Nd hollow cathode lamps recorded using the 1-m FTS at the Natl. Solar Observatory are being analyzed to determine the branching fractions. Extensive tests were performed to verify that the lamps are optically thin. Spectra from lamps with both Ar and Ne fills are being analyzed to identify blends of metal lines with buffer gas lines. Absolute transition probabilities accurate to 5 to 10% are being determined.

References:

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