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Recent Advances in the Measurement of Rare-Earth Metal Oscillator Strengths Using Laser-Induced Plasmas

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Laser-induced plasmas offer a quick and convenient way to produce high-temperature (˜50,000 K) plasmas to serve as a source of highly excited ions. Emission from the plasma, when dispersed in a high-resolution Échelle spectrometer, can be used to measure the relative intensity of all the emission lines from an excited energy level. This allows the determination of the level's branching ratios (branching fractions). The branching ratios of hundreds of thermally-populated energy levels can thus be measured simultaneously. Our recent work has focused on measuring the relative intensities of emission lines from neutral and doubly ionized species of rare-earth metals. As well, we are improving on current measurements in singly-ionized species. Rare-earth metals are of significant importance to astronomers and astrophysicists for their appearance in chemically peculiar and galactic halo stars. Experimental parameters have been extensively studied to characterize plasma emission for these species at various observation times after the laser pulse, at various background pressures, and various laser pulse energies. I will also discuss recent experimental design advances to improve light collection efficiency from the plasma yielding increased signal to noise, more accurate oscillator strengths, and the possibility of measuring previously unobservable emission lines. We are also investigating the use of new ablation target materials to alter plasma density. Our future work will consist of incorporating an optical parametric oscillator to resonantly excite specific energy levels within the plasma. This should increase emission line intensity and reduce line blending.

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