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# Towards A Single Atom Microscope for Nuclear Astrophysics

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We are developing the technique of optically detecting individual atoms embedded in thin films of cryogenically frozen solids. Noble gas solids such as frozen neon are an attractive medium because they are optically transparent and provide efficient, pure, stable, & chemically inert confinement for a wide variety of atomic and molecular species. The excitation and emission spectra of atoms embedded in solids can be separated by up to hundreds of nanometers making optical single atom detection feasible. We propose to couple a single atom microscope (SAM) detector to a recoil separator with the goal of measuring rare nuclear reactions relevant for nuclear astrophysics. The recoil separator would minimize the heat load on SAM while allowing for isotope discrimination. This technique has the potential to capture and detect every product atom with near unity efficiency. Because of the additional selectivity provided by resonantly exciting the atomic transitions of the captured product atom, SAM would have a negligible false positive rate which would help loosen the often demanding beam rejection requirements imposed on recoil separators. Our primary focus and long term goal is to measure the Ne-22(He-4,n)Mg-25 reaction, an important source of neutrons for the s-process, in the astrophysically relevant center-of-mass energy regime. We will describe the SAM concept in more detail, some of the critical technical challenges, and our progress towards demonstrating optical single atom detection of atoms embedded inside of solid neon.

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