Stony Brook University
The Graduate School

Doctoral Defense Announcement

Abstract

Collinear Laser Spectroscopy of Francium and Rubidium

with Amplitude Modulated Light

By

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A beamline has been developed to trap polarized francium ions to measure their nuclear g-factors. Francium, which has no stable isotopes, was created in a nuclear fusion reaction using the Stony Brook superconducting LINAC. Polarization of the nuclei can be achieved through optical pumping of the atomic beam with a suitable collinear laser beam.

We were able to convert 90% of a francium ion beam into an atomic beam by passing the beam through a short but dense region of Rb vapor. We determined the charge exchange cross section for 5 keV Fr ions with Rb atoms to be $(9 \pm 3)\times10^{-15}$ cm^2.

Once neutralized we performed collinear laser spectroscopy on francium and rubidium atomic beams. With larger intensity Rb beams we were able to study their energy loss in passing through a Rb vapor. We modulated the exciting laser to increase the sensitivity in detecting the fluorescence from small francium beams, giving us a modest increase in the signal to noise by a factor of 2.5. Using this method we were able to detect the atomic resonances in $^{208\text{-}210}$Fr.

Two ion traps were developed to cool and trap polarized francium ions and provide an environment for the g-factor measurement. Accurate g-factor measurements in francium isotopes will provide a test of the calculated electron density at the nucleus in preparation for parity non-conservation experiments.

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