Ultrahigh-Density Spin-Polarized H and D

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ABSTRACT

High-density spin-polarized hydrogen (SPH) isotopes are crucial for the measurement of spin-dependent effects in atomic, particle, nuclear, and plasma physics. For example, controlling the nuclear spin polarization in fusion reactions offers important advantages, such as larger reaction cross sections, control over the emission direction of products, and in some cases suppressing unwanted neutron emission.

However, many applications are limited or precluded by the inability to produce high densities: Polarized laser fusion and laser ion acceleration of hydrogen isotopes require densities of at least 10^{18} and 10^{19} cm^{-3}, respectively. In contrast, conventional methods such as spin-exchange optical pumping (SEOP) or Stern-Gerlach spin separation produce low densities of only $\sim 10^{13}$ and $\sim 10^{12}$ cm^{-3}, respectively.

Recently, our group has demonstrated the production of ultrahigh-density, highly spin-polarized H and D atoms via the photodissociation of various Hydrogen and Deuterium Halides (HCl, DI, HBr). Photofragment ion imaging on DI showed an almost 100% degree of electron polarization of D fragments, which is then converted to 60% nuclear polarization 1.6 ns after the photodissociation. We propose various mechanisms explain this depolarization, but we postulate that occurs mainly due to the formation of DI-D intermediate species, rather than via collisions.

By using a pickup coil that monitors the magnetization induced by the polarization transfer between the electrons and nuclei, we are capable of experimentally determining the number density of polarized particles produced by the molecular dissociation. With this method, we directly measure the spin-polarized number densities to be at the order of 10^{19} cm^{-3}.

REFERENCES

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