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Laser preparation of intense beams of vectorially polarized protons and tensorially polarized deuterons via molecular quantum beats.

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Lasers can be used to polarize the valance electrons in an atomic or molecular system [1]. However, if this is done rapidly (< 1ns), it can establish a quantum beating mechanism which transfers polarization to the nuclear spin and ultimately provides the means to control nuclear spin with optical fields. The increasing capabilities (photon flux) of modern commercial lasers and the fact that laser excitation can take place in short timescales allow preparing high-density nuclear polarized samples, within few ns and using table-top set-ups. We have recently shown how lasers can be used to create polarized deuterium atoms in a molecular beam [2]. Here we present our recent results where we demonstrate the preparation of vectorially polarized hydrogen and deuterium samples at nearly atmospheric pressure (10^19 cm^-3). We also present results where laser excitation is used to control the tensor polarization in deuterium nuclei [3] and discuss the optimization of these methods. We discuss how these can be scaled to surpass the polarized beam intensities and/or polarized target densities offered by state-of-the-art methods. Finally, we examine how further scaling may allow applications to polarized fusion in ICF and MCF [2].

1 T. P. Rakitzis et al., Science 300 1936 (2003)
2 D. Sofikitis et al., Phys. Rev. Lett. 118 233401 (2017)
3 N. C-M Bartlett et al., Phys. Chem. Chem. Phys. 11 142 (2009)

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