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Optical Control of Spatial Patterning of Nuclear Polarization in GaAs JONATHAN KING, University of California, Berkeley, YUNPU LI, LE PENG, MARIA TAMARGO, CARLOS MERILES, City College of New York, JEFFREY REIMER, University of California, Berkeley — We present new results on the optical polarization of nuclear spins in gallium arsenide. Previous work has identified the contact hyperfine interaction at shallow donors as the mechanism for helicity dependent nuclear polarization. We show a new regime, where donors are only partially occupied, where nuclear quadrupolar relaxation at shallow donors is the dominant mechanism. Since quadrupolar relaxation is helicity independent, the incident light polarization may be tuned such that the two relaxation mechanisms drive the nuclear spins to opposite signs of polarization. We show that incident light wavelength and power may be tuned to create spatial patterns of varying donor occupation in a single sample, which in turn creates a pattern of positive and negative nuclear polarization. We have developed an analytical mode which accurately describes the bulk NMR signal in terms of irradiation power and wavelength. We also present stray-field NMR imaging experiments showing direct observation of the patterned nuclear polarization.

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