Abstract Submitted for the MAR13 Meeting of The American Physical Society

Entanglement between a single quantum spin and a photon through ultrafast frequency downconversion to telecom wavelengths KRISTIAAN DE GREVE, Stanford University (currently at Harvard University), LEO YU, PETER MCMAHON, Stanford University, JASON PELC, Stanford University (currently at HP Labs, Palo Alto), CHANDRA NATARAJAN, NA YOUNG KIM, Stanford University, EISUKE ABE, Stanford University and NII, Tokyo, Japan, SEBASTIAN MAIER, CHRISTIAN SCHNEIDER, MARTIN KAMP, Universitaet Wuerzburg, SVEN HOEFLING, Stanford University and Universitaet Wuerzburg, ROBERT HADFIELD, Heriot-Watt University, ALFRED FORCHEL, Universitate Wuerzburg, MARTIN FEJER, Stanford University, YOSHIHISA YA-MAMOTO, Stanford University and NII, Tokyo, Japan — We demonstrate highfidelity entanglement between a single InAs quantum dot electron spin, and the polarization of a spontaneously emitted single photon. With a magnetic field in Voigt geometry, the quantum dot's excited (trion) states are connected to the spin states in a lambda-configuration. We use these lambda-systems for all-optical spin manipulation, and spontaneous emission from one of the trion states gives rise to entanglement between both the polarization and color of the photon, as well as the spin state. Leakage of which-path information through e.g. the color of the photon obscures the spin-photon-polarization entanglement, which we overcome by a quantum erasure procedure. By time-resolved frequency conversion to a low-fiber-loss wavelength (1560 nm), we measure the photon arrival time with sub-10 ps resolution. Such ultrafast detection is inherently broadband, and incapable of distinguishing between the respective colors of the decay paths, providing the necessary quantum erasure. The conversion to 1560 nm also provides a means to extend the distance over which spin-photon entanglement can be maintained.

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Date submitted: 26 Nov 2012

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