MAR09-2008-002960

Abstract for an Invited Paper
for the MAR09 Meeting of
the American Physical Society

## Optical Detection and Control of Single Magnetic Ions in Photonic Microcavities[1]

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As the density of magnetic information storage scales upwards, the number of magnetic moments in each bit decreases. This pathway ends with the need to manipulate a single spin, a requirement that is also important for nascent information processing schemes including quantum computation. Current demonstrations of coherent single spin control include electron spins in semiconductor quantum dots and nitrogen-vacancy centers in diamond [3] . Single magnetic ions in semiconductors have also emerged as an intriguing spin system due to their surprising ability to be manipulated in zero-field. Manganese (Mn) ions in gallium arsenide (GaAs) are strongly exchange coupled to the charge carriers and can be rapidly controlled either optically or electrically in bandgap- engineered heterostructures. Recently we demonstrated optical control and readout of a small ensemble of Mn ion spins in a GaAs quantum well without magnetic materials or applied magnetic fields[4]. In the limit of low doping levels, their spin lifetimes increase with decreasing concentration as the ions become isolated. Here we describe the spatially-resolved observation and manipulation of isolated Mn spins integrated within photonic microcavities. A single magnetically-doped GaAs quantum well is fabricated within both microdisk and vertical Fabry-Perot cavities in which their respective cavity modes are coupled to the neutral Mn acceptor emission. Scanning micro-photoluminescence measurements reveal cavity-coupled emission and a dramatic increase in the measured signal to noise ratio, thereby allowing direct imaging of narrow linewidth luminescence from the Mn moments. These Mn ion spins are optically polarized at zero-field, exhibit long spin lifetimes, and may be manipulated through a variety of techniques.

[1]This work was supported by the NSF and the ONR.

[2]In collaboration with R. C. Myers, G. Calusine, T.-L. Liu, and E. Hu.

[3]R. Hanson and D. D. Awschalom, *Nature* **453**, 1043 (2008).

[4]R. C. Myers, M. H. Mikkelsen, J.-M. Tang, A. C. Gossard, M. E. Flatté, and D. D. Awschalom, *Nature Materials* **7**, 203 (2008).