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# Observation of ultrastrong spin-motion coupling in nanofiber-based optical traps.

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Optical nanofibers have proven as versatile light-matter interfaces. Atoms can be trapped close to the nanofiber surface using the evanescent part of light fields propagating in the fiber [Fig.(a)]. Due to the wavelength-scale confinement, these light fields can show strong polarization gradients. Atoms then experience strong gradients of the vector ac Stark shift, which act as a spatially varying fictitious magnetic field [Fig.(b)]. The fictitious field gradients result in a coupling between the atoms' motion and spin, which is formally equivalent to the atom-photon coupling encountered in cavity QED [1].

We take advantage of this spin-motion coupling to manipulate cold cesium atoms in a nanofiber-based optical trap. First, we harness the spin-motion coupling to perform degenerate Raman Cooling [2]. The final temperature of the atoms can be inferred from a fluorescence spectroscopy measurement, and indicates cooling close to motional ground state. The detuning of the spin-motion coupling mechanism can be set by changing an offset magnetic field. When recording spectra across the spin-motion resonance [Fig.(c)], avoided crossing are clearly apparent. A fit on experimental data yields coupling strengths which are a significant fraction of the mode (trap) frequency, which sets our system clearly in the ultra-strong coupling regime [3].

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[1] Schneeweiss et al., PRA 98, 021801(R)
[2] Meng et al., PRX 8, 031054
[3] Dareau et al., PRL 121, 253603

## Choix de session parallèle

6.3 Nanofibre optique: une nouvelle plateforme pour l'optique et l'information quantique

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