near-quantum motion of neighbouring collective motional modes. *NH*

QUANTUM INFORMATION

Spin metrology

Science **339,** 1187–1191 (2013)

While studying the electronic spin of a single trapped atomic ion, Yinnon Glickman and co-workers from the Weizmann Institute of Science in Israel discovered a set of spin states that are invariant under photon scattering. States that do not change under coupling to the environment are potentially useful for realizing robust quantum control applications and protecting quantum information. The researchers investigated spin initialization, readout and rotations of a single trapped $^{88}Sr^{+}$ ion by applying a combination of optical and radiofrequency pulses. First, they aligned a 422 nm laser beam and a magnetic field along the y and z directions, respectively. They then used a polarization analysis unit to characterize the polarization of the scattered photons. The x-elongated ellipsoid in the Bloch-sphere representation clearly revealed the emergence of a spin measurement basis that is invariant. To demonstrate that this state was a measurement basis, the researchers analysed the polarization of photons scattered by ions with different initial spin states. *NH*

EMITTERS

Space for gain

Appl. Phys. Lett. **102,** 133110 (2013)

The emission rate of a light emitter can be enhanced by placing it near a metal surface. However, if an emitter is placed too close to a metal, its emission can be 'quenched' by excited states decaying via nonradiative channels. This occurs because of coupling to high-loss modes in the metal that rapidly convert electromagnetic energy into thermal energy. There is therefore an optimum distance of an emitter from a metal surface at which the emission enhancement is maximized. Esmaeil Heydari and colleagues in Germany have now reduced quenching by fabricating an optimal-thickness spacer layer between a gain medium and gold nanoparticles. The thickness of the spacer layer tunes the coupling between the gain medium and the metal particles, which controls the level of quenching. Their set-up contains 80-nm-diameter gold particles in a colloidal solution on a glass slide. The gold particles were spin coated with polyvinylpyrrolidone to create spacer layers with thicknesses of 15–70 nm. An optically active polymer containing toluene was then spin-coated onto the polyvinylpyrrolidone spacer layer. When optically pumped at 532 nm, the hybrid polymer–gold system lased at a wavelength of 633 nm; optimal performance was obtained for a 30-nm-thick spacer layer. *DP*

MAGNETO-OPTICS

Femtosecond switching

Nature **496,** 69–73 (2013)

Ultrafast all-optical switching of magnetism using coherent spin manipulation is one potential route for pushing today's magnetic memory and logic devices to terahertz switching speeds. However, demonstrations have so far been limited to the picosecond and nanosecond regimes. Now, by establishing a 'colossal' magnetization component from an antiferromagnetic ground state, Tianqi Li and co-workers from the USA and Greece have switched the antiferromagnetic ordering in $Pr_{0.7}Ca_{0.3}MnO_3$ to ferromagnetic ordering on a timescale of 120 fs using a pump photoexcitation intensity of 5.8 mJ cm^{-2}. They observed a huge temperature-dependent magnetization with a photoexcitation threshold behaviour, which they attribute to a non-equilibrium spin-exchange mechanism. Femtosecond-laser-excited coherence between electronic states can switch the magnetic order by abruptly destroying the delicate balance between competing phases of correlated materials. *RW*

X-RAYS

Imaging electrons

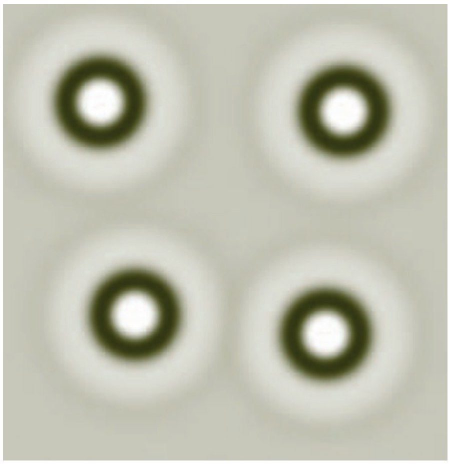
Phys. Rev. Lett. **110,** 137403 (2013)

Observing the motion of electrons during chemical or biological processes is of interest as it can provide important insights into the mechanisms involved. Although scattering short X-ray pulses from electronic wave packets is a promising approach for realizing this goal, there are still some questions about the feasibility of achieving such imaging. Now, Gopal Dixit and co-workers in Germany have theoretically proposed a way to image the instantaneous electron density of the wave packet by ultrafast X-ray phase contrast imaging in the far field. The team suggests that the technique can be used to obtain information about dynamical changes in the spatial electron probability distribution at different points in time. The approach may also provide the Laplacian of the instantaneous electron density, which can be used to garner details of the internal structures of the wave packet. This may be useful for understanding complex bonding and topology of charge distributions in complex systems. The researchers emphasize that inelastic scattering processes, which are a problem for far-field ultrafast scattering, do not affect ultrafast X-ray phase-contrast imaging. *DP*

CAVITY SOLITONS

Rocking phase bistability

Phys. Rev. A **87,** 043802 (2013)



Cavity solitons continue to attract much scientific and technological interest from the nonlinear science community. Kerr cavities, which consist of an optical resonator containing a dispersive third-order nonlinear medium (such as silica), have long been considered a useful means of generating cavity solitons. An investigation by Germán de Valcárcel and Kestutis Staliunas from Spain now reveals that the properties of a Kerr cavity can be drastically changed by a modulation technique based on the concept of 'rocking' — the forcing of a self-oscillatory system at a frequency close to its natural one but with a variable amplitude. The system becomes phase bistable when the sign of the injection amplitude is alternated by following a sinusoidal modulation in time (temporal rocking) or space (spatial rocking). Simulations using the damped nonlinear Schrödinger equation with parametric amplification indicate that the system supports one- and two-dimensional phase-bistable spatial patterns such as bright- and dark-ring cavity solitons and labyrinths. The researchers point out that the system is potentially attractive for applications in optical information storage and processing as it offers three logic states (off, plus and minus states). *RW*

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