different magnetic fields. We study this system numerically using the Gross-Piteavskii equation, and find that various "structures" emerge depending on the spin-orbit, trap, and interaction parameters, such as the formation of oppositely rotating vortices in the two different spin components, or stripes, or spin-domain formation. We discuss progress towards realizing this system with our BEC experiments in the laboratory.

T01 88 Toward Magneto-Optical Trapping of Polyatomic Molecules LOUIS BAUM, IVAN KOZYRYEV, ZOE ZHU, PHELAN YU, JOHN M. DOYLE, *Harvard University* Three dimensional confinement of atoms inside a magneto-optical trap (MOT) revolutionized atomic physics and along with evaporative cooling led to the development of ultracold atomic gases in the quantum degenerate regime. Recently, groundbreaking experimental and theoretical work in molecular physics culminated with the creation of MOTs for diatomic molecules trapped below 1 mK [1-3]. Building on these achievements and our previous work on laser cooling of polyatomic molecules [4], we will present our progress towards creating a RF MOT of a triatomic radical, CaOH. Our experimental and theoretical results indicate that laser cooling can also be extended to hexatomic symmetric top molecules, e.g. $CaOCH_3$. Non-zero vibrational angular momentum of linear triatomics and finite projection of rotational angular momentum onto the body frame of symmetric top molecules result in linear Stark shifts, enabling novel quantum science applications.

[1]Norrgard *et al.*, PRL **116**, 063004 (2016).
[2]Truppe *et al.*, Nat. Phys. **13**, 1173 (2017).
[3]Anderegg *et al.*, PRL **119**, 103201 (2017).
[4]Kozyryev *et al.*, PRL **118**, 173201 (2017).

T01 89 Optical Dipole Trapping of Holmium* CHRISTOPHER YIP, DONALD BOOTH, HUAXIA ZHOU, *University of Wisconsin-Madison* JEFFREY COLLETT,† *Lawrence University* JAMES HOSTETTER,‡ *Honeywell* MARK SAFFMAN,§ *University of Wisconsin-Madison* Neutral Holmium's 128 ground hyperfine states, the most of any non-radioactive element, is a testbed for quantum control of a very high dimensional Hilbert space, and offers a promising platform for quantum computing. Previously we have cooled Holmium atoms in a MOT on a 410.5 nm transition and characterized its Rydberg spectra. We report here on the first optical dipole trapping of Holmium with a 532 nm wavelength trap laser. The trap lifetime is close to 1 sec., limited by photon scattering from nearby transitions. The trapped atoms are used to measure the dynamic scalar and tensor polarizabilities which are compared with calculations based on measured oscillator strengths. We also report progress towards narrow line cooling and magnetic trapping of single atoms.

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T01 90 Atomic properties of actinide ions with particle-hole configurations MARIANNA SAFRONOVA, *University of Delaware* ULYANA SAFRONOVA, *University of Nevada, Reno* MIKHAIL KOZLOV, *Petersburg Nuclear Physics Institute of NRC, Russia* We study the effects of higher-order electronic correlations in the systems with particle-hole excited states using a relativistic hybrid method that combines configuration interaction and linearized coupled-cluster approaches. We find the configuration interaction part of the calculation sufficiently complete for eight electrons while maintaining good quality of the effective coupled-cluster potential for the core. Excellent agreement with experiment was demonstrated for a test case of La^{3+}. We apply our method for homologue actinide ions Th^{4+} and U^{6+} which are of experimental interest due to a puzzle associated with the resonant excitation Stark ionization spectroscopy (RESIS) method. These ions are also of interest to actinide chemistry and this is the first precision calculation of their atomic properties.

T01 91 Demonstration of metrologically relevant spin-squeezing in free space with an ensemble of ^{87}Rb atoms YUNFAN WU, ONUR HOSTEN, *Stanford Univ* RAJIV KRISHNAKUMAR, *Caltech/INQNET* JULIAN MARTINEZ, BENJAMIN PICHLER, MARK KASEVICH, *Stanford Univ* CQED TEAM Entangled atomic states such as spin-squeezed states can overcome the atomic projection noise that limits the precision of atomic sensors. Various experiments have successfully demonstrated such states. For precision sensing applications requiring the atoms to be freely moving, such as fountain clocks and atom interferometers, the homogeneity of the prepared squeezed states is crucial for their successful retrieval. In this work, we initially generated 12dB spin-squeezed states using an optical-cavity that uniformly interacts with 500,000 ^{87}Rb atoms trapped in an optical lattice. Then we released these atoms into free space and recaptured them back into the lattice after a variable duration. The final state of the atoms was then measured with the help of the cavity. We characterized the degradation in squeezing as a function of release time, and modeled it including the effects of atom loss and loss in atom-cavity coupling homogeneity. We demonstrated the retrieval of spin-squeezing in free space for up to 2ms limited by our ability to recapture the atoms. This result is a crucial step towards implementing metrologically relevant spin-squeezed atomic sensors in free space.

T01 92 Quadratic optomechanical interaction in the reversed dissipation regime HYOJUN SEOK, *Department of Physics Education, Kongju National University* JAE HOON LEE, *Center for Time and Frequency, Division of Physical Metrology, Korea Research Institute of Standards and Science* Cavity optomechanics is an important platform for which the interaction between light and the motional degrees of freedom of a mechanical oscillator can be engineered for specific objectives such as cooling the mechanical state or amplifying the electromagnetic field. Here we theoretically examine an optomechanical resonator coupled to both mechanical and optical reservoirs in the reversed dissipation regime. We show that in the case of quadratic coupling between the electromagnetic field and mechanical oscillator, the linewidth of the noise spectra of the cavity field is dependent on the mean phonon number of the mechanical oscillator. Using advanced fabrication methods for optomechanical devices, we propose to develop reservoir engineered optomechanical devices for temperature measurement in the quantum regime.

T01 93 Hydrodynamics in a uniform Fermi Gas* XIN WANG, LORIN BAIRD, STETSON ROOF, JOHN THOMAS, *North Carolina State University* We are working towards trapping a strongly interacting ultracold Fermi gas of ^{6}Li atoms in a uniform box potential. The potential is created by applying repulsive blue-detuned beams shaped by Digital Micromirror Devices (DMD). The DMDs are more flexible compared to diffractive optics as they are capable