Old Dominion University
Department of Physics

Virtual Colloquium

Tuesday, March 16, 2021
3:00 pm

"Searching for new physics with trapped molecular ions"

Dr. Matt Grau
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Abstract: Precision tests of parity (P) and time-reversal (T) symmetry violation in molecular systems can place stringent bounds on beyond Standard Model physics, searching for new particles with masses of more than 10 TeV/c^2. In particular, finding new mechanisms for T -violation could resolve the mystery of the matter-antimatter asymmetry of the universe, and quantifying P-violation in low energy systems would provide a better determination of electroweak nucleon couplings, which are among the most poorly constrained parameters in the Standard Model. Trapped molecular ions are an ideal system in which to investigate these phenomena, as they possess features such as large internal electric fields and co-magnetometer states that greatly enhance sensitivities to exotic physics while allowing excellent rejection of systematic errors. I will discuss an experiment in which we performed spectroscopy on an ensemble of molecular ions with better than 1 mHz absolute precision which bounded the T -violating electron electric dipole moment (EDM) d_e at the 10^{-28} e cm level [1]. Complementary experiments on nuclear systems, such as searches for magnetic quadrupole moments (MQM) and measurements of nuclear spin-dependent parity violation (NSD-PV), have the potential to place similarly powerful bounds on new physics in hadronic matter. Looking forward, a new paradigm of experiment working with single ions will enable enhanced levels of control and sensitivity by leveraging quantum-logic state detection and preparation techniques [2–4]. This level of precision will allow us to place new bounds on T -violation in the hadronic sector, perform stringent tests of Standard Model parity violation predictions, and search for axion-like dark matter candidate particles [5].

References

[1] W. B. Cairncross, D. N. Gresh, M. Grau, K. C. Cossel, T. S. Roussy, Y. Ni, Y. Zhou, J. Ye, and E. A. Cornell, Phys. Rev. Lett. **119**, 153001 (2017).
[2] P. Schmidt, T. Rosenband, C. Langer, W. Itano, J. Bergquist, and D. Wineland, Science **309**, 749–752 (2005).
[3] F. Wolf, Y. Wan, J. C. Heip, F. Gebert, C. Shi, and P. O. Schmidt, Nature **530**, 457–460 (2016).
[4] C.-w. Chou, C. Kurz, D. B. Hume, P. N. Plessow, D. R. Leibrandt, and D. Leibfried, Nature **545**, 203–207 (2017).
[5] B. M. Roberts, Y. V. Stadnik, V. A. Dzuba, V. V. Flambaum, N. Leefer, and D. Budker, Phys. Rev. Lett. **113**, 081601 (2014).

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