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Quantum Chaos and Quantum Magnetism with 4f-Submerged-Shell Atoms[1] SVETLANA KOTOCHIGOVA, CONSTANTINOS MAKRIDES, ALEXANDER PETROV, Temple University, EITE TIESINGA, JQI, QuICS, and NIST — We report on a theoretical investigation of the quantum level statistics of ultra-cold gases of open-4f-shell Er and Dy atoms based on a recently-developed computational model that can evaluate their weakly-bound molecular structure. A large interaction anisotropy between these atoms due to the large orbital angular momentum of their electrons creates a rich electronic structure. We find that this structure and their relatively large mass generates an extremely dense spectrum of rotational and vibrational levels near the dissociation limits for magnetic field strengths up to 100 Gauss. We analyzed these bound-state energy spectra and Feshbach resonance locations for signatures of chaos. For example, we find that in contrast to many other atomic systems these weakly-bound molecules already have a chaotic level distribution even in the absence of a magnetic field. We also report on the feasibility to detect quantum magnetism in a system where pairs of erbium or dysprosium are trapped in sites of an optical lattice. We predict the existence of spinor oscillations, where the population of magnetic sub levels oscillates in time due to the presence of anisotropic atomic interactions. Their periods can be used to characterize these interactions at zero and small magnetic field.

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Svetlana Kotochigova
Temple University

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