

Proposal abstract

The proposed program will make use of recent advances in quantum manipulation of isolated atomic systems and atom-like systems in solid state to develop a new generation of quantum sensors of increasing sensitivity and sophistication. The program will include theoretical and experimental investigation of a broad array of techniques developed in quantum information science to (i) enhance the sensitivity, and temporal and spatial resolution of nanoscale magnetic, electric, and chemical sensors; (ii) develop novel methods to improve atomic clocks; and (iii) explore novel paradigms in quantum metrology such as quantum sensor networks. These techniques will be applied to problems ranging from magnetic resonance imaging of single molecules and the understanding of quantum dynamics of strongly interacting disordered systems to nanometer scale probing of complex materials and investigation of the feasibility and potential applications of quantum clock networks. Our program will be complimented by activities in material science, chemistry and nanofabrication. Combined together, these approaches will open up transformative new research directions in fields ranging from quantum metrology to life and material sciences. They can open the door for unique new capabilities in areas ranging from navigation to medical diagnostics. The program will include training of new generation of young scientists in these active research areas, which are directly relevant to DoD interests.