Abstract:

Although usually ignored, quantum mechanics actually provides certainty--certainty that atoms of a given species can be prepared in identical states. This feature allows for atom-based definitions of the second and meter, precision measurements of fundamental constants, searches for physics beyond the standard model, and atomic sensors such as magnetometers, inertial sensors, and the global positioning system. On the other hand, quantum mechanics also imposes Heisenberg-like uncertainty principles that limit the precision of the above applications. We have demonstrated a top-down approach for surpassing the standard quantum limit on measurement precision. The technique is accomplished using a spectroscopically interesting ensemble of $10^6$ Rubidium atoms, does not require single particle addressability, works at relatively low atomic densities, and is expected to scale well with increasing ensemble size.