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Trapped atomic ions for quantum-limited metrology.¹

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Laser-beam-manipulated trapped ions are a candidate for large-scale quantum information processing and quantum simulation but the basic techniques used can also be applied to quantum-limited metrology and sensing. Some examples being explored at NIST are: 1) As charged harmonic oscillators, trapped ions can be used to sense electric fields; this can be used to characterize the electrode-surface-based noisy electric fields that compromise logic-gate fidelities and may eventually be used as a tool in surface science. 2) Since typical qubit logic gates depend on state-dependent forces, we can adapt the gate dynamics to sensitively detect additional forces. 3) We can use extensions of Bell inequality measurements to further restrict the degree of local realism possessed by Bell states. 4) We also briefly describe experiments for creation of Bell states using Hilbert space engineering. This work is a joint effort including the Ion-Storage group, the Quantum processing group, and the Computing and Communications Theory group at NIST, Boulder.

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