Contribution ID: **16** Type: **not specified**

Precision Physics with Few-Electron Ions: Testing the Standard Model and Beyond

Tuesday 29 July 2025 11:30 (40 minutes)

High-precision spectroscopy of one- and few-electron ions provides stringent tests of the Standard Model in regimes of strong nuclear fields. Inner-shell electrons experience extreme binding, leading to relativistic dynamics and significant quantum electrodynamic contributions. Our theoretical framework includes rigorous treatments of these effects to enable accurate predictions of energy levels and other atomic properties. Precise measurements and calculations allow the determination of masses and electromagnetic properties of the particles which make up the ion. Moreover, few-electron ions serve as sensitive probes for physics beyond the Standard Model. By modeling hypothetical interactions, such as additional short-range forces, and quantifying their effects on observables, we derive competitive constraints on new physics parameters.

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