



ID de la contribución : 14

Tipo : no especificado

Femtoscopia as a new venue for nuclear physics: alpha-alpha scattering

viernes, 4 de septiembre de 2026 11:00 (25)

We present the first fully theoretical description of the $\alpha\alpha$ femtoscopic correlation function, establishing two-particle correlations as a complementary probe of low-energy $\alpha\alpha$ dynamics. Our framework incorporates Coulomb-distorted scattering states, Bose symmetrization, decay feed-down, higher partial waves, finite-range corrections, experimental momentum resolution, and source-size effects within the Koonin-Pratt formalism. We compare predictions from several competing descriptions of the $\alpha\alpha$ interaction and show that, despite the limited precision of the available decades-old measurements, the existing data already exhibit sensitivity to competing interaction models and to short-distance finite-range effects. Future high-precision measurements will enable quantitative constraints on the low-energy $\alpha\alpha$ interaction, establishing $\alpha\alpha$ femtoscopia as an independent benchmark for microscopic nuclear-interaction models with implications for stellar nucleosynthesis.

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Clasificación de la sesión : Friday morning (Session 2)