Speaker: **Prof. Javier Madroñero, Universidad del Valle, Cali, Columbia**

Title: **Stable Dynamical Structures in Complex Quantum Systems: From the Stochastic Dynamics of Trapped Ions to Nondispersive Wave Packets in Helium**

Date: **Wednesday, July 1, 11:00 am (s.t.)**

Place: **Seminar room 915**

Title: **Stable Dynamical Structures in Complex Quantum Systems: From the Stochastic Dynamics of Trapped Ions to Nondispersive Wave Packets in Helium**

Complex quantum systems often exhibit the coexistence of regular and chaotic dynamics, giving rise to robust structures that survive despite strong interactions, external driving, and environmental perturbations. In this talk, I will present a series of theoretical studies aimed at understanding, characterizing, and controlling such stable dynamical structures in atomic and hybrid quantum systems.

The first part of the presentation focuses on hybrid atom-ion systems, where the dynamics of trapped ions immersed in ultracold atomic gases are investigated using stochastic approaches based on the Langevin equation and event-driven molecular dynamics simulations. These methods provide insight into sympathetic cooling, energy relaxation processes, dynamical stability, and the role of micromotion in radio-frequency multipole traps.

The second part is devoted to the dynamics of strongly correlated two-electron states in helium subjected to periodic and static electric fields. Using a spectral configuration-interaction approach based on Coulomb-Sturmian functions combined with Floquet theory and complex scaling, we identify long-lived Floquet resonances associated with frozen-planet configurations and demonstrate the existence of nondispersive wave packets in fully three-dimensional helium. Particular emphasis will be placed on the stabilization mechanisms induced by external fields and on the connection between quantum localization and classical phase-space structures.

Taken together, these studies illustrate how stochastic methods, nonlinear dynamics, and quantum-spectral approaches provide complementary perspectives on the emergence and control of stable dynamical structures in complex quantum systems.