

**SEMINARIO**  
**Departamentos de Física Teórica I y II**  
**Universidad Complutense de Madrid**

**CONFERENCIANTE:** Robin Côté

Department of Physics, University of Connecticut, United States

**TITULO:** Rydberg Electrons in a Bose-Einstein Condensate

**LUGAR:** FACULTAD DE CIENCIAS FÍSICAS UCM

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**ABSTRACT:**

Impurities in a Bose-Einstein condensate (BEC) have attracted much attention and motivated the investigation of a wide range of phenomena e.g., probing the superfluid dynamics or polaron physics in BECs. In this presentation, we explore Rydberg atoms immersed in a homogeneous BEC. We show that within the s-wave approximation, the interaction between the quasi-free Rydberg electrons and ground state atoms results in the exchange of collective excitations (phonons) leading to a Yukawa potential. Under appropriate conditions, we find two regimes: for a small healing length, the Yukawa potential is short-ranged, and distorts the BEC locally, "mapping" the electron density onto the BEC density. For a large value, the attractive Yukawa interaction is able to bind Rydberg atoms and form a new type of "ultra-long-range" molecule. We discuss the conditions leading to such bindings, and how such "synthetic" Coulomb potentials can be generated between neutral particles and their sign can be modified by using different Rydberg states for the two impurity atoms.