

Department of Physics and Astronomy Colloquium Series

Tuesday October 8th 2024, 2:30pm in PSE 317

Speaker: Nora Brambilla

Institution: Technical University of Munich

Title: Nonrelativistic multiscale systems with Effective Field Theories

Abstract:

Nonrelativistic bound states lie at the core of quantum physics, permeating the fabric of nature across diverse realms, spanning particle to nuclear physics, and from condensed matter to astrophysics. These systems are pivotal in addressing contemporary challenges at the forefront of particle physics. Characterized by distinct energy scales, they serve as unique probes of complex environments. Historically, their incorporation into quantum field theory was fraught with difficulty until the emergence of nonrelativistic effective field theories (NREFTs).

In this talk, we delve into the construction of a potential NREFT (pNREFT), a framework that directly tackles bound state dynamics reimagining quantum mechanics from field theory. Focusing on heavy quarkonia, pNRQCD facilitates systematic definitions and precise calculations for high-energy collider observables. At the cutting edge, we investigate nonrelativistic bound states in intricate environments, like the newly discovered exotics X, Y, Z above the strong decay threshold and the behavior in out-of-equilibrium scenarios, such as quarkonium suppression in a Quark Gluon Plasma or dark matter interactions in the early universe. Our ability to achieve precision calculations and control strongly interacting systems is closely linked to bridging perturbative methods with nonperturbative tools, notably numerical lattice gauge theories.