Université Paris-Saclay
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Séminaire de Physique Nucléaire Théorique

First-principles predictions of nuclear structure and reaction observables

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Nuclear physics is entering a particularly interesting time, with rare isotope beam facilities opening new, unexplored areas of the nuclear chart and offering a more comprehensive picture of nuclei already in our grasp. In France in particular, SPIRAL2 promises to shed new light on the N = Z and the super-heavy sectors, while ALTO will focus on exploring systems up —to A 165. Moreover, gravitational waves and the dawn of the multi-messenger astronomy era highlight the importance of nuclear inputs to, e.g., the r-process or the description of neutron stars.

In the meantime, nuclear theory has been reinvigorated by the development of ab initio methods that offer a systematically improvable description of finite nuclei and infinite matter rooted in the understanding of nuclear forces. Long limited to light nuclei, the development of lower-cost expansion methods and progress in interaction accuracy now allows for a description of nuclear properties up to ^{208}Pb. Nevertheless, a full description of all nuclei and infinite matter remains out of reach. Challenges in terms of nuclear interaction accuracy, description of heavy systems and especially extension of reaction capacities remain and need to be addressed for an extensive description of nuclear properties.

In this talk, I will showcase recent progress in the description of nuclear systems from first principles, and discuss strategies to lift remaining limitations towards an extensive and accurate description of nuclei and nuclear matter with quantified uncertainties.

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