Institut de recherche sur les lois fondamentales de l'univers
Département de Physique Nucléaire

ESNT Seminar

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Bat 703, DPhN salle de séminaires 135, CEA Saclay, Orme des Merisiers

Alexander TICHAI
CEA ESNT

Recent advances in *ab initio* nuclear structure theory

In recent years the *ab initio* treatment of the nuclear many-body problem has seen tremendous progress such that the A-body Schrödinger equation can be solved from first principles using realistic nuclear Hamiltonians with a sound link to QCD. However, it is yet unclear (1) how to describe genuine open-shell nuclei from an *ab initio* perspective and (2) how to overcome the curse of dimensionality in many-body approaches that prevents relaxing many-body approximations. Additionally, the large uncertainties arising from the input Hamiltonian make a direct comparison with experimental observations challenging, requiring extensive interaction benchmarks far away from shell closures and for large mass numbers in the future.
Exploiting symmetry breaking in the many-body expansion enables for addressing nuclear observables in arbitrary open-shell systems. The recently introduced Bogoliubov extension of many-body perturbation theory serves as an example for a computationally light-weighted approach well-suited for benchmarking ground-state energetics along medium-mass isotopic chains [1]. In a complementary way, data pre-processing techniques help resolving the computational bottlenecks one is facing in state-of-the-art many-body implementations. Two particular strategies are discussed: (i) tensor factorization [2] and (ii) importance truncation [3]. Due to discarding many irrelevant tensor entries the original large-scale problem can be solved in a much smaller selected model space. The combination of novel many-body expansions and innovative tools from applied mathematics allows us for extending the range of *ab initio* applications and, thus, putting the next generation of nuclear Hamiltonians to a stringent test at low computational cost.

[1] A. Tichai, P. Arthuis, T. Duguet, V. Somà, H. Hergert, R. Roth, Phys. Lett. B **786**, 195 (2018).
[2] A. Tichai, R. Schutski, G. E. Scuseria, T. Duguet, Phys. Rev. C **99**, 034320 (2019).
[3] A. Tichai, J. Ripoche, T. Duguet, Eur. Phys. J. A **55: 90** (2019).