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Three-nucleon forces with symmetry-preserving regulator

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Modern few- and many-body simulations of nuclei rely on precise nuclear forces and electro-weak currents. A powerful tool which makes such high-precision calculations possible without losing connection to Quantum Chromodynamics (QCD), the fundamental theory of the strong interaction, is chiral effective field theory (EFT). Instead of working directly with quarks and gluons it is more efficient to formulate an effective field theory of QCD with pions and nucleons as explicit degrees of freedom. The relevant symmetries of QCD are by construction implemented in chiral EFT and equip one with a small expansion parameter in the low energy sector. Nuclear forces and currents can then be determined via perturbation theory. The increase of precision is achieved by going to higher orders in this expansion.
In my talk I will review the current status of the construction and implementation of chiral nuclear forces: I will show that in order to get chiral three-nucleon forces at next-to-next-to-next-to-leading order (N3LO) one has to use symmetry-preserving cut-off regulator, otherwise one violates chiral symmetry at N3LO. I will present powerful techniques like symmetry-preserving gradient-flow regularization and novel path-integral approach for construction of nuclear forces and will present the current status of their application.

Primary author: KREBS, Hermann (Ruhr-Universität Bochum)

Presenter: KREBS, Hermann (Ruhr-Universität Bochum)

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