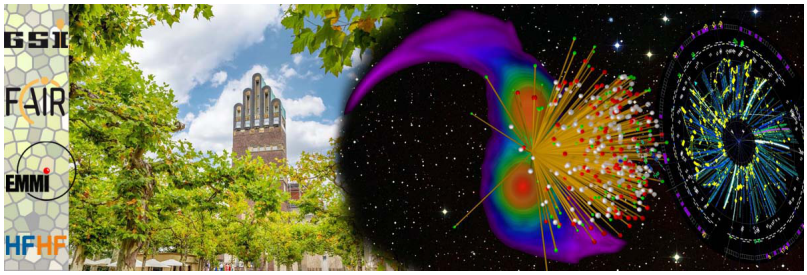

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What are true ab initio calculations of neutron-rich matter?

Wednesday, 20 September 2023 08:30 (30 minutes)

Microscopic nuclear theory is based on the tenet that atomic nuclei and nucleonic matter can be accurately described as collections of point-like nucleons interacting via two- and many-body forces obeying nonrelativistic quantum mechanics—and the concept of the ab initio approach is to calculate nuclear systems accordingly. The forces are fixed in free-space scattering and must be accurate. I will critically review the history of this approach from the early beginnings until today. The main focus of this contribution will then be on current microscopic predictions of neutron-rich matter and the symmetry energy—as relevant to this symposium. A critical analysis reveals that many calculations presented as ab initio do not pass muster. Moreover, most contemporary calculations apply nuclear forces of a rather low order of chiral effective field theory. The ultimate goal are high-precision ab initio predictions which, as it turns out, may be possible only at the fifths order of the chiral expansion. Calculations of this kind, which must also include all many-body forces at that order, are very challenging, and the current status of ab initio calculations is far from meeting that goal.

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