Advances in coupled-cluster computations of medium mass and neutron rich nuclei

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In this talk I will present recent advances in computing properties of nuclei using coupled-cluster theory. The beauty of coupled-cluster theory is that it can naturally account for: (i) effects of three nucleon forces, (ii) the presence of open decay channels and particle continuum, and (iii) many-nucleon correlations. Advances in chiral effective field theory allow for a systematic derivation of many-nucleon forces and currents, and provide us with a systematic approach to quantify uncertainties in computed observables in nuclei. Recently we optimized the nucleon-nucleon interaction from chiral effective field theory at next-to-next-to leading order (NNLO) using the mathematical optimization software POUNDerS (Practical Optimization Using No Derivatives for Squares), obtaining a $\chi^2 \approx 1$ for laboratory energies below 125MeV [1]. We demonstrated with this optimized interaction, that several key aspects of nuclei can be understood without explicitly invoking three-nucleon forces. Other recent highlights include ab-initio coupled-cluster calculation of the giant dipole resonance in ^{16}O [2], coupled-cluster calculations of oxygen and calcium isotopes, with an emphasis on the evolution of shell structure. In particular we address the question regarding shell closure in ^{54}Ca [3].

[1] "*An optimized chiral nucleon-nucleon interaction at next-to-next-to-leading order*", A. Ekström, G. Baardsen, C. Forssén, G. Hagen, M. Hjorth-Jensen, G. R. Jansen, R. Machleidt, W. Nazarewicz, T. Papenbrock, J. Sarich, S. M. Wild, arXiv:1303.4674 (2013)

[2] "*First principles description of the giant dipole resonance in ^{16}O*", Sonia Bacca, Nir Barnea, Gaute Hagen, Giuseppina Orlandini, Thomas Papenbrock,
arXiv:1303.7446 (2013)

[3] "*Evolution of shell structure in neutron-rich calcium isotopes*", G. Hagen, M. Hjorth-Jensen, G. R. Jansen, R. Machleidt, T. Papenbrock, Phys. Rev. Lett. 109, 032502 (2012).