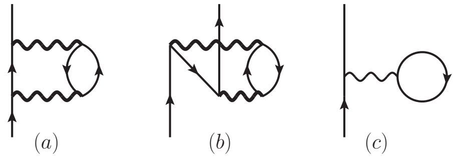
Microscopic Optical Potential from Chiral Effective Field Theory

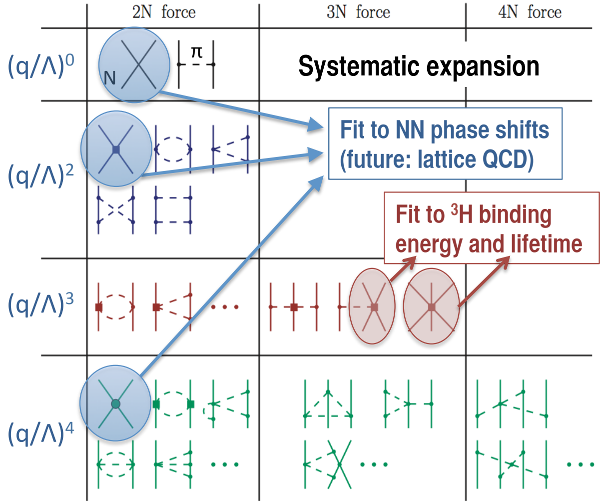
T. R. Whitehead, Y. Lim, and J. W. Holt

Introduction: Microscopic OMPs can be used in regions of the nuclear chart where phenomenological optical potentials are not well constrained, since they do not rely on experimental data for tuning. In the present work, we calculate the real and imaginary terms of the optical potential from chiral two and three nucleon interactions. Proton-nucleus scattering cross sections are calculated for the microscopic optical potential and compared to those of phenomenological models and experimental data.

Methods: We compute the optical potential from the nucleon self energy in infinite nuclear matter with varying density and isospin asymmetry [1]. The real and imaginary parts are obtained from the following self energy diagrams:

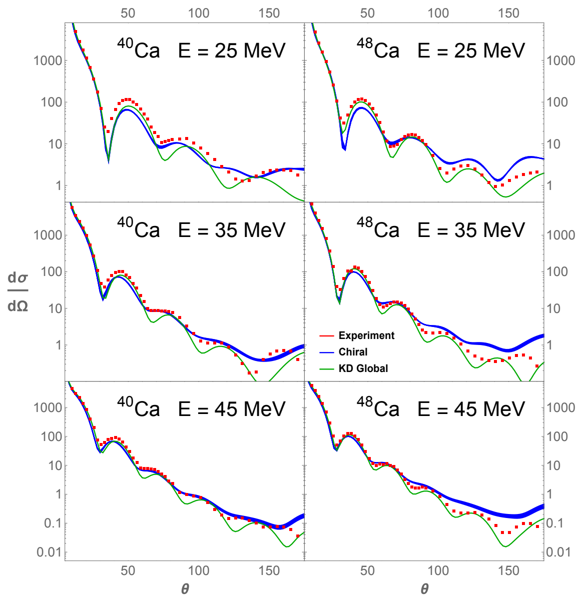


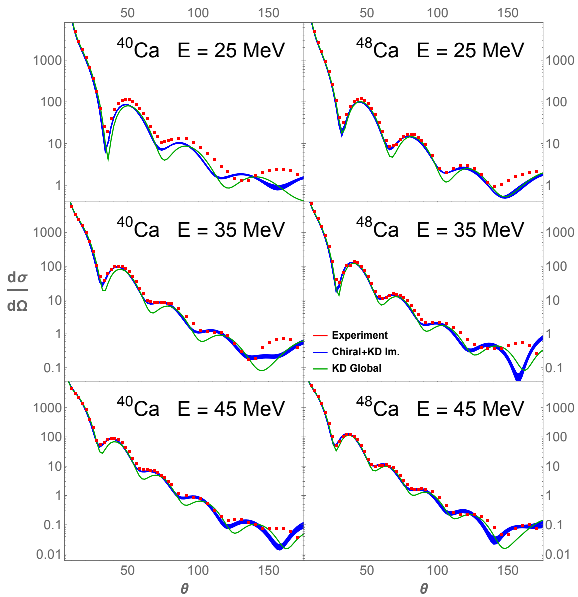
The spin-orbit term, on the other hand, is derived from a microscopic nuclear energy density functional [2]. For all terms, we calculate 2N forces up to N3LO and 3N forces at N2LO.



The density-dependent Chiral OMP is then folded with the nuclear density to obtain a finite nucleus optical potential. The density distribution is calculated using mean field theory with Skyrme interactions that are constrained by Ch-EFT. The improved local density approximation is utilized to account for the finite range of the nuclear force [3].

Results: The left plots show differential cross sections for the microscopic OMP compared to the global Koning-Delaroche (KD) model [4] and experiment. The right plots show the KD phenomenological imaginary term substituted into the Chiral OMP. Future work will investigate the role of higher-order perturbative contributions to the imaginary part of the optical potential.





References: [1] J. W. Holt, N. Kaiser, G. A. Miller, and W. Weise, Phys. Rev C 88, 024614 (213).
[2] J. W. Holt, N. Kaiser, W. Weise, Eur. Phys. J. A 47, 128 (2011) .
[3] J. P. Jeukenne, A. Lejeune, and C. Mahaux, Phys. Rev. C 16, 80 (1977).
[4] A. J. Koning and J.P. Delaroche, Nucl. Phys. A 713, 231 (2003).