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Unitarity for Two Nucleons with Pions[1] HARALD GRIESSHAMMER, George Washington University, MARIO SNCHEZ SNCHEZ, CNRS/IP2N3 Bordeaux, France — One can understand nuclei at the physical point by an expansion about the unitarity limit of infinite scattering length, with all other effective-range parameters zero. The NN S-wave binding energies are then zero, and there is no scale at leading order. Nuclear Physics resides in a sweet spot: bound weakly enough to be insensitive to the details of the nuclear force; but dense enough that the NN scattering lengths are perturbatively close to the unitarity limit. In this contribution, we study how new scales, namely the pion mass and decay constant change the picture in the NN system. We find that when one imposes unitarity at zero energy, phase shifts do not significantly stray from unitarity at low energies in the $^3S_1$-$^3D_1$ and in the $^1S_0$ waves. Wigner's SU(4) symmetry of combined spin and isospin transformations emerges then quite naturally. At a "magic" effective range $r_\chi \approx 1.4$ fm, the effects of these new scales are minimal in both channels. We observe that the physical values are close to it, provide further insight into unitarity with pions, and motivate a converging, perturbative expansion around the unitarity limit, with controlled corrections in the inverse scattering lengths, pion-nucleon interaction, ranges and isospin breaking.

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