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Investigating Unitarity Violation With Chiral Perturbation Theory

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Partial quenching can be used to avoid isospin mixing in a theory incorporating a mass twist, but comes at the cost of introducing unitarity violation. This talk will examine pion-pion scattering in partially-quenched twisted-mass lattice QCD using chiral perturbation theory. The specific partially-quenched setup corresponds to that used in numerical lattice QCD calculations of the $I = 0$ scattering length. We study previously unquantified discretization errors proportional to a^2 , with a the lattice spacing, and newly identified errors that arise due to the use of Lüscher's two-particle quantization condition in a theory that is not unitary. The discretization errors may be as large as $\sim 100\%$ but can be systematically subtracted using a calculation of the $I = 2$ scattering amplitude in the same partially-quenched framework. The error from the violation of unitarity is $\sim 25\%$ and will be difficult to reduce in practice.

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