Panel Discussion

Hadronic physics and heavy quarks on the lattice
Hamilton Mathematics Institute, TCD
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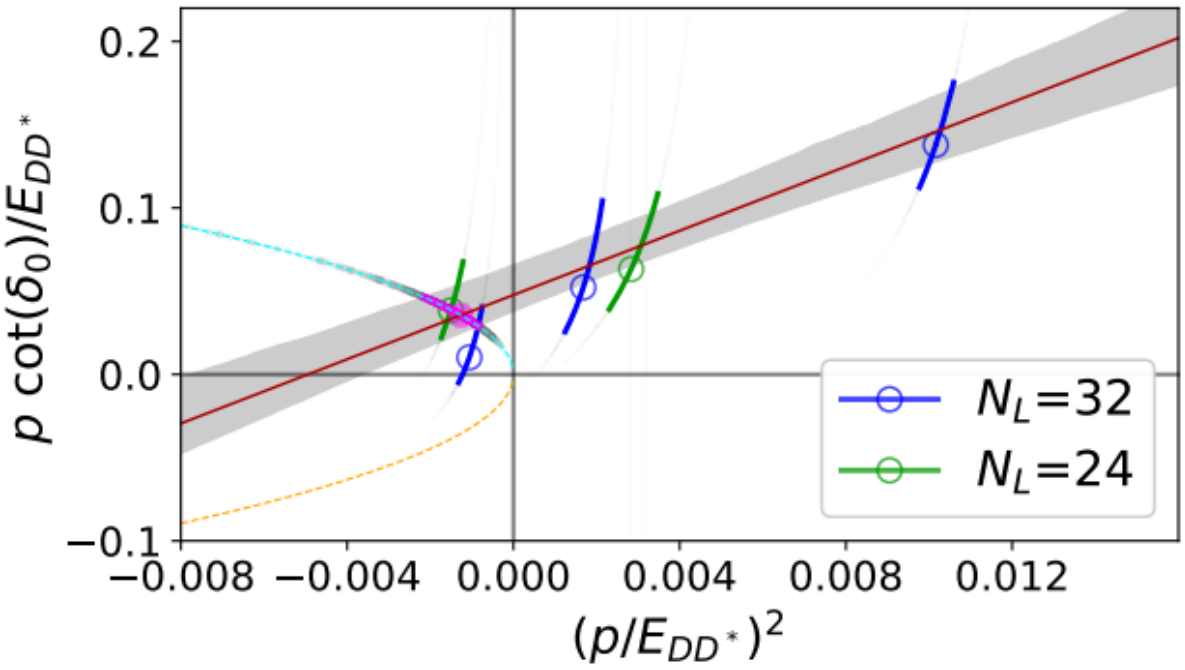
Trinity College Dublin
Coláiste na Tríonóide, Baile Átha Cliath
The University of Dublin

HAMILTON MATHEMATICS INSTITUTE

SIMONS FOUNDATION

The T_{cc} on the lattice

- The first study of the T_{cc} on the lattice using the Lüscher formalism done by Padmanath and Prelovsek 2202.10110



- Subsequently pointed out in Du et. al. 2303.09441 that this ignores the contribution of the left-hand cut due to one pion exchange

Left-hand cut physics

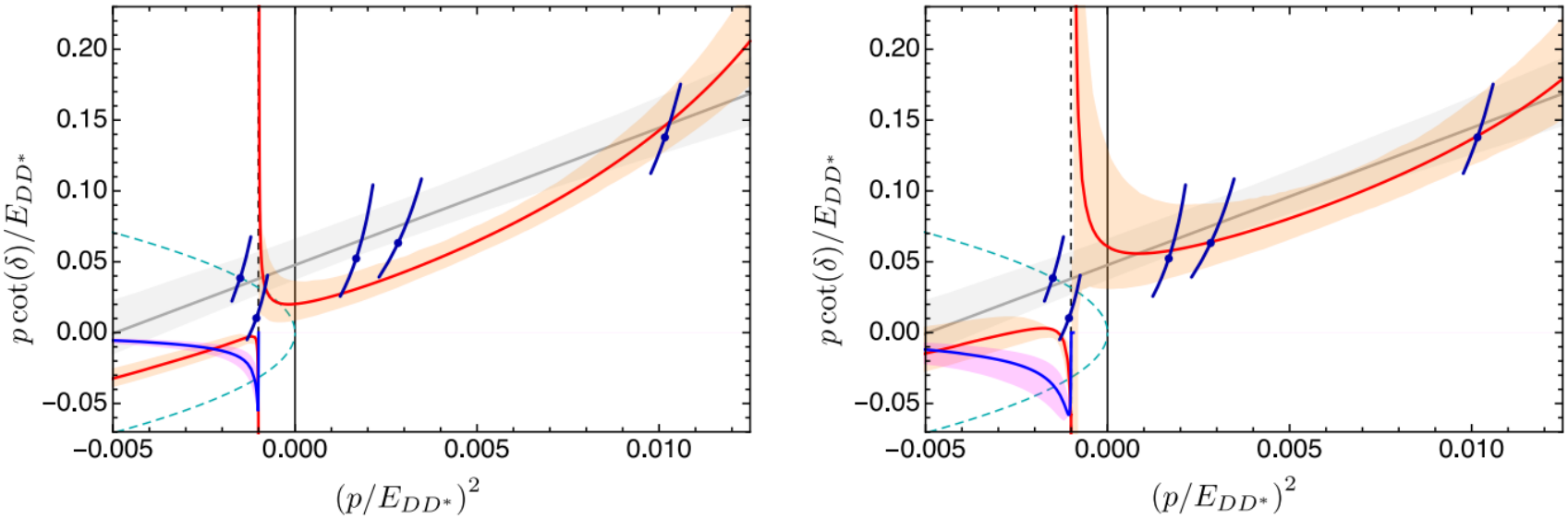
- The Lüscher formalism for two particle scattering unable to account for left hand cuts in the u-channel

Hansen, Romero-Lopez, Sharpe 2401.06609

- One pion exchange creates a left hand cut in the u-channel, invalidating the assumption of analyticity in the energy region near s_{lhc}
- Relevant to $BB\pi$, $KK\pi$, NN and **many** other systems

Resolving the left-hand cut problem - EFT

Du et. al. 2303.09441

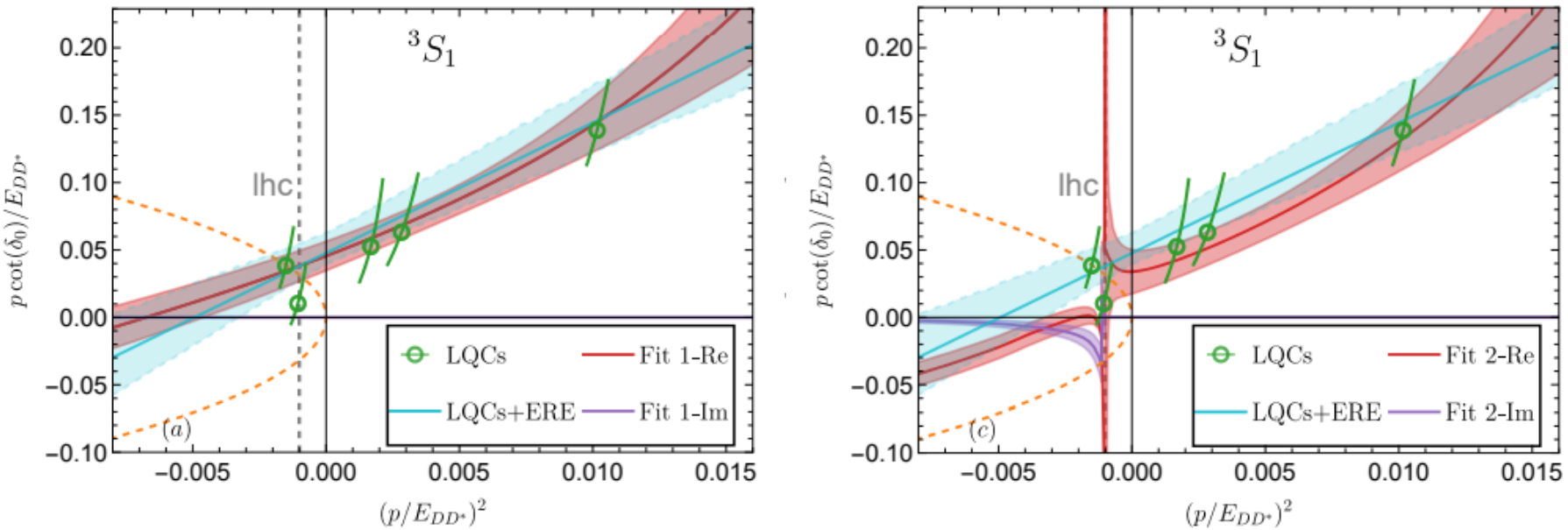


$$p\cot\delta(p^2) = \frac{-2\pi}{\mu} T^{-1}(E) + ip \tag{1}$$

- Fits of $p\cot(p^2)$ from the lattice and $p\cot(p^2)$ from Lippman-Schwinger equations $\rightarrow$ $T(E)$ contains the one pion exchange potential

Resolving the left-hand cut problem - EFT

Meng et. al. 2312.01930

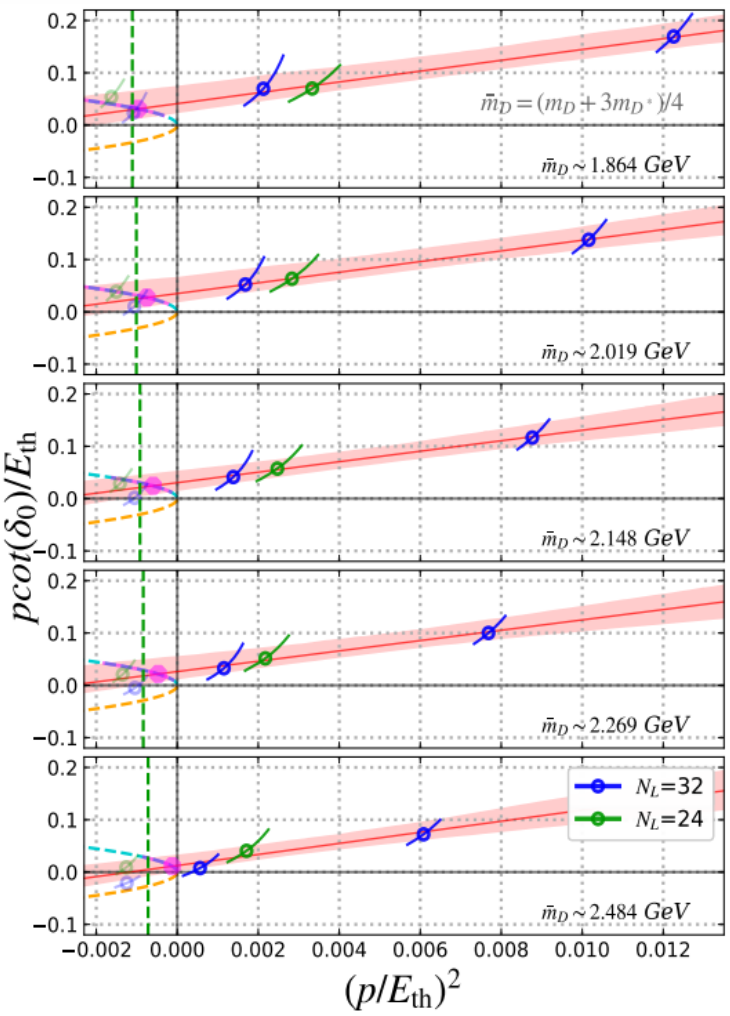


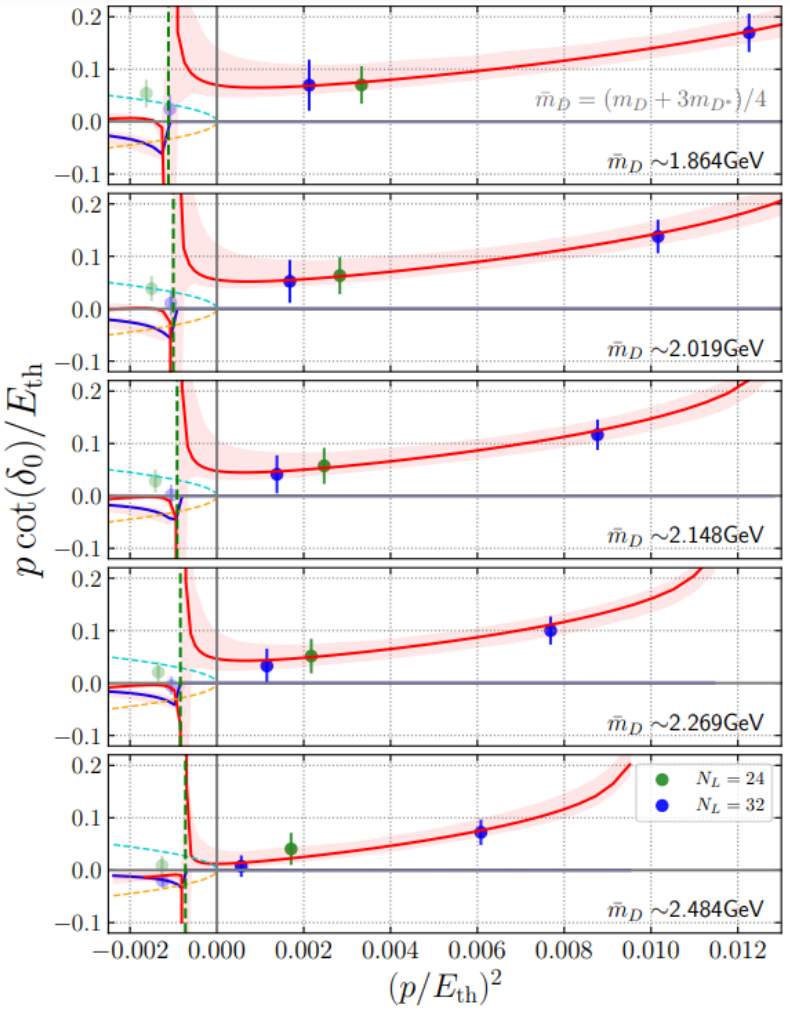
$$\det[G^{-1}(E) - V(E)] = 0 \tag{2}$$

- $V(E)$ contains the one pion exchange potential. Finite volume energy levels obtained from an appropriate parameterization of LEC's

Resolving the left-hand cut problem - EFT

Collins, Nefediev, Padmanath, Prelovsek 2402.14715





Resolving the left-hand cut problem - Three Body Scattering

Hansen, Romero-Lopez, Sharpe 2401.06609

- Connects the three particle quantization condition

$$\det[1 + \hat{K}_{df,3}\hat{F}_3] = 0 \tag{3}$$

  to $DD\pi$ scattering amplitude by solving integral equations

- Analytically continue the $DD\pi$ scattering below the DD^* threshold to obtain the DD^* scattering amplitude, which accounts for one pion exchange

- Many spectra needed, only applicable below the D^*D^* threshold and away from left-hand cut due to two pion exchange

Outlook

1. The presence of the left-hand cut has a significant role in the nature of poles found close to them
2. Can the Lippmann-Schwinger Equations be applied to coupled-channel calculations? This has not been looked at yet!
3. Is there a way to directly approach this problem through a parameterization of the scattering t-matrix while using the two particle Lüscher determinant?
4. Is there a modification to the two particle quantization condition that could allow for the effects of the left-hand cut?