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## **Causality constraint on bound states and scattering with zero-range force, or do perturbative pions deserve another chance?**

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The present treatment of the nucleon-nucleon and few-nucleon forces in chiral effective theory is semi-relativistic. One of the immediate difficulties of this description is that, in accordance with Wigner's causality bound, the leading-order (zero-range) interaction yields zero effective range. This leads to the necessity of "promoting" the subleading three-body force to leading order, in the pionless theory. It eventually becomes the major reason for "non-perturbative pions". I argue that these difficulties are absent in relativistically causal theory. On a simple field-theoretic example [1,2], I demonstrate relativistic zero-range potential scattering surpasses Wigner's causality bound without violating causality [3]. The relativistic theory exhibits a K-matrix pole necessarily accompanying the bound-state solution. Possible implications of these results for the effective-field theory of nuclear forces will be discussed, time permitting.

### References

1. V. Pascalutsa and M. Vanderhaeghen, "Sum rules for light-by-light scattering", Phys. Rev. Lett. 105 (2010) 201603 [arXiv:1008.1088 [hep-ph]].
2. V. Pauk, V. Pascalutsa and M. Vanderhaeghen, "Analytic structure of  $\phi^4$  theory using light-by-light sum rules," Phys. Lett. B 725 (2013) 504.
3. V. Pascalutsa, "Surpassing Wigner's causality bound in relativistic scattering with zero-range interaction," arXiv:1402.4973 [nucl-th].

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