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Pion production in nucleon-nucleon collisions near threshold: complete NNLO calculation in chiral EFT

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Study of pion production near threshold is interesting for several reasons: it tests applicability of chiral EFT at intermediate energies, probes nucleon-nucleon dynamics at relatively large transferred momenta, and gives possibility to study isospin violation in few-body processes. The neutral pion production in $pp \rightarrow pp\pi^0$ channel has been known to be the most puzzling process for a long time. The data for near-threshold cross section in this channel is suppressed by more than an order of magnitude compared to charged pion-production channels. This suppression agrees with conclusions made using chiral EFT, namely that there is almost no leading order contribution to $pp \rightarrow pp\pi^0$ and the higher order effects are expected to be important for quantitative understanding of neutral pion production. We present the results for the full pion production operator near threshold calculated up-to-and-including next-to-next-to-leading order (NNLO) in chiral effective field theory [2, 3], which includes pions, nucleons and delta degrees of freedom. Our analysis of chiral loops at NNLO reveals new mechanisms which are important, but haven't been considered in phenomenological studies so far. The obtained production operator, being convolved with nucleon-nucleon wave functions derived recently based on chiral EFT [4] is used to compute the pion production amplitudes. First results for the observables in $NN \rightarrow NN\pi$ are going to be presented.

References

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Primary author: FILIN, Arseniy (Ruhr University, Bochum)

Co-authors: Dr HANHART, Christoph (IKP-TH, Forschungszentrum Juelich); Prof. EPELBAUM, Evgeny (Institut für Theoretische Physik II, Ruhr-Universität Bochum, D-44780 Bochum, Germany); Prof. MYHRER, Fred (Department of Physics and Astronomy, University of South Carolina, Columbia, SC 29208, USA); Dr KREBS, Hermann (Institut für Theoretische Physik II, Ruhr-Universität Bochum, D-44780 Bochum, Germany); Dr BARU, Vadim (Bochum University)

Presenter: FILIN, Arseniy (Ruhr University, Bochum)

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