PANEL on EFTs, Lattice and ML

Chair: N. Brambilla (TUM)

Members : W. Detmold (MIT), A. Mazeliauskas (Heidelberg), M. Marinkovic (ETHZ), P. Shahanan (MIT)

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Q1: what can EFTs do for ML4LATTICE ?

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Q1: what can EFTs do for ML4LATTICE ?

i.e. can one take advantage of EFT methods and scale separation to pursue better ML applications?

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Q2: what ML4LATTICE can do for EFT?

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Q2: what ML4LATTICE can do for EFT? threefold question: 1

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Q2: what ML4LATTICE can do for EFT?

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Q21. An example from your favoured EFT: what is special when
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Q2: what ML4LATTICE can do for EFT?

threefold question: 1

Q21. An example from your favoured EFT: what is special when applying ML4Lattice to an EFT?

Bayesian Analysis of χEFT at Leading Order in a Modified Weinberg Power Counting

Oliver Thim,* Eleanor May, Andreas Ekström, and Christian Forssén
Department of Physics, Chalmers University of Technology, SE-412 96, Göteborg, Sweden

(Dated: February 27, 2023)

We present a Bayesian analysis of renormalization-group invariant nucleon-nucleon interactions at leading order in chiral effective field theory (χEFT) with momentum cutoffs in the range 400–4000 MeV. We use history matching to identify relevant regions in the parameter space of low-energy constants (LECs) and subsequently infer the posterior probability density of their values using Markov chain Monte Carlo. All posteriors are conditioned on experimental data for neutron-proton scattering observables and we estimate the χEFT truncation error in an uncorrelated limit. We do not detect any significant cutoff dependence in the posterior predictive distributions for two-nucleon observables. For all cutoff values we find a multimodal LEC posterior with an insignificant mode harboring a bound $^1S_0$ state. The $^3P_0$ and $^3P_2$ phase shifts emerging from the Bayesian analysis are less constrained and typically more repulsive compared to the results of a phase shift optimization. We expect that our inference will impact predictions for nuclei. This work demonstrates how to perform inference in the presence of limit cycles and spurious bound states, and lays the foundation for a Bayesian analysis of renormalization-group invariant χEFT interactions beyond leading order.

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Q2: what ML4LATTICE can do for EFT? threefold question 2

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Q2: what ML4LATTICE can do for EFT?

threefold question 2

Take the example of NREFTs where a factorization between high energy and low energy is realised. The high energy part can be calculated in perturbation theory in DR in MSbar, the low energy part is carried in gauge invariant correlators depending only on the glue, no longer flavour dependent and carrying only one scale. These correlators are nonlocal in time or in time and space and contain Wilson lines: something similar to what happens for PDFs and TMDs using LAMET and SCET

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Q2: what ML4LATTICE can do for EFT? threefold question 2

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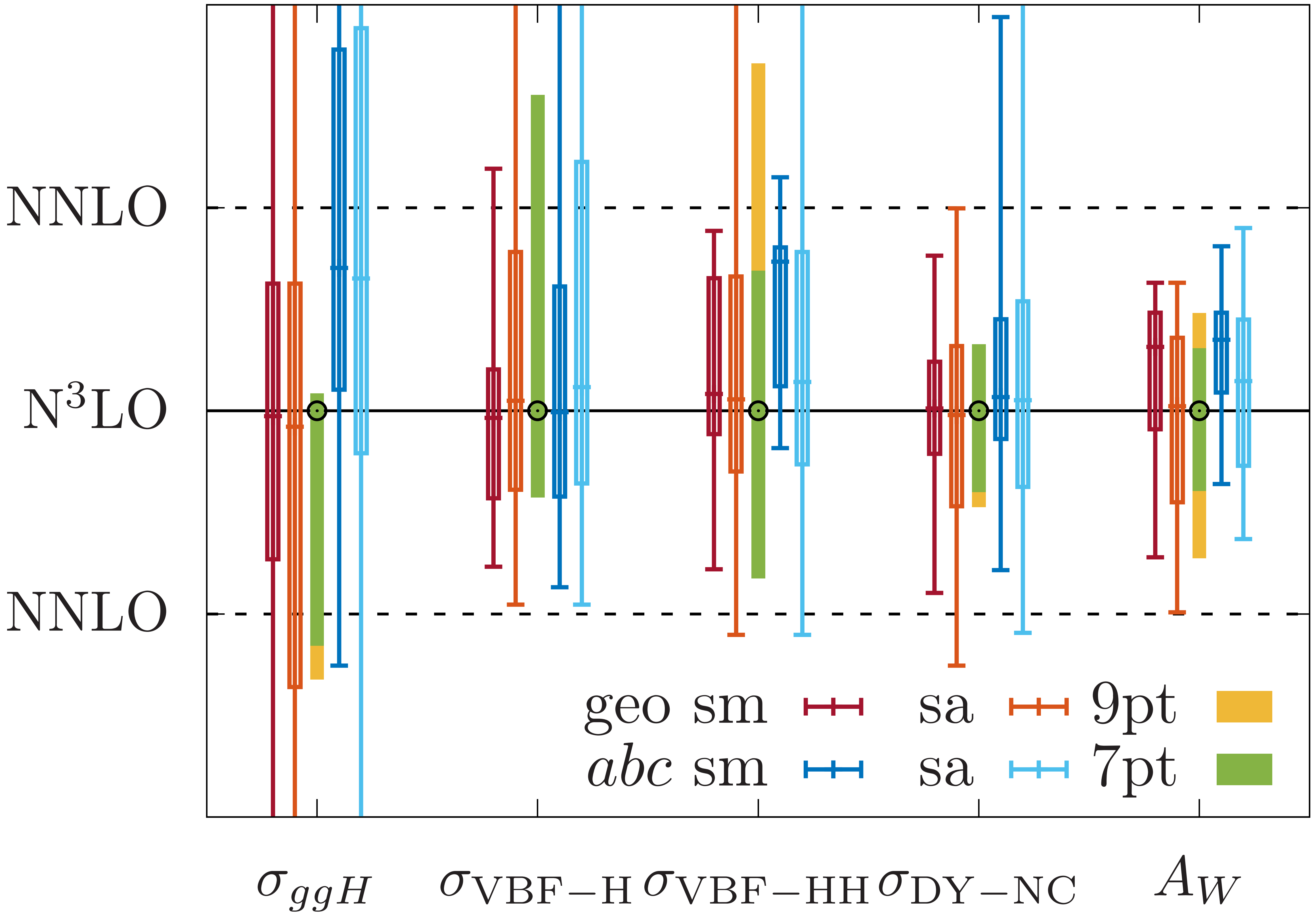
Q2.2: Could ML help us in going to higher orders of the perturbative calculations (or quantify its error) in the high energy part?

Global summary of MHO CIs given up to and including N^{3}LO results

Could ML help in going to higher orders or quantify its error?



- With limited input it is impossible to predict genuine higher order corrections.
- ML can improve upon traditional error estimates (statistical interpretation, convergence information).

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Q2: what ML4LATTICE can do for EFT? threefold question 3

Take the example of NREFTs where a factorization between high energy and low energy is realised. The high energy part can be calculated in perturbation theory in DR in MSbar, the low energy part is carried in gauge invariant correlators depending only on the glue, no longer flavour dependent and carrying only one scale. These correlators are nonlocal in time or in time and space and contain Wilson lines: something similar to what happens for PDFs and TMDs using LAMET and SCET

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Q2: what ML4LATTICE can do for EFT? threefold question 3

Take the example of NREFTs where a factorization between high energy and low energy is realised. The high energy part can be calculated in perturbation theory in DR in MSbar, the low energy part is carried in gauge invariant correlators depending only on the glue, no longer flavour dependent and carrying only one scale. These correlators are nonlocal in time or in time and space and contain Wilson lines: something similar to what happens for PDFs and TMDs using LAMET and SCET

Q2.2: Could ML work better in calculation of lattice correlators at low energy i.e. with typically only one scale?

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Q3 (Phiala) : For what types of questions does it makes sense to consider using ML and for what questions does it not?