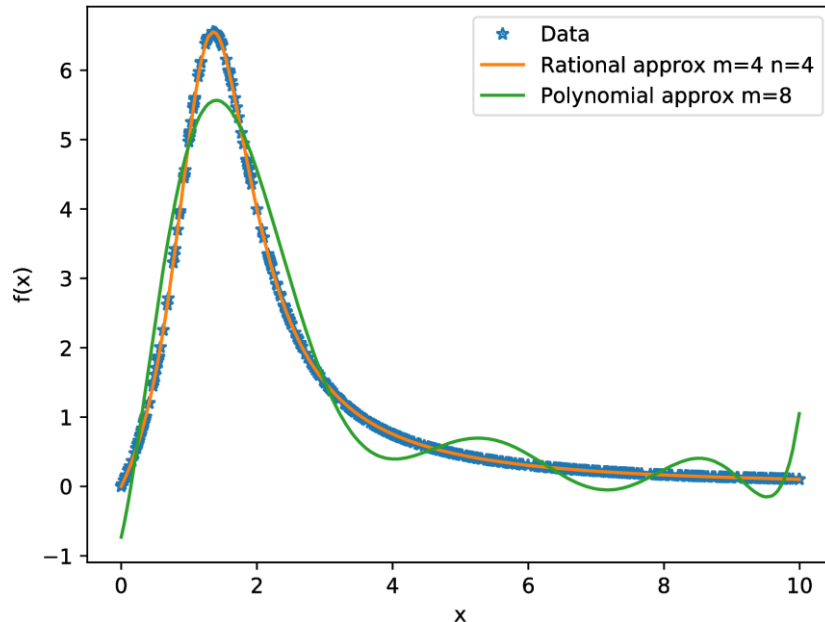# Rational approximations for physics signal modeling

Scientific Achievement

We developed an algorithm that reliably calculates multivariate rational approximations.

Demonstration of the superiority of the rational approximation algorithm. We compare the input data (blue) with the predictions from a rational approximation (orange) and a polynomial approximation (green) with similar information content. The oscillatory behaviour as well as the unsatisfactory predictions at the edges of the interpolation domain so far restricted the usage of surrogates for applications in BSM studies where rational functions are frequently observed.
(Image Credit: Holger Schulz, U Cincinnati)

Significance and Impact

The predictive power of polynomial approximations is limited if the data exhibits traits of rational functions. Our algorithm solves this problem and allows the application of surrogate models in HEP to wider areas.

Research Details

– Simultaneous multivariate construction of denominator (order m) and numerator (order n) polynomials by means of singular value decomposition (SVD).

– Numerical stability promoted through SVD and orthonormal bases.

– Automatic detection and rejection of solutions that have poles in the interpolation domain.

– Enables new high-fidelity beyond the standard model applications, such as signal modeling for dark matter direct detection simulations.