Spin Chain Techniques for Scattering Amplitudes in Quantum Field Theory

Jan Plefka and Matthias Staudacher (both IRIS Adlershof) applied the mathematical technique termed "integrability", which is borrowed from the exact solution of spin chain models in condensed matter theory, to the calculation of scattering amplitudes in four-dimensional quantum Yang-Mills theory. The latter are a class of models used at particle physics colliders such as the LHC in Geneva to study matter at very small scales and high energies.

In a joint work with Humboldt University postdoctoral researchers Livia Ferro and Tomasz Łukowski, as well as former student Carlo Meneghelli, the idea of introducing a so-called spectral parameter into the amplitude problem was born. The existence of this parameter is a hallmark of quantum integrability, as it appears in certain spin chain models and special Yang-Mills theories. The authors supplied initial evidence that the spectral parameter might find its use as a novel symmetry-respecting regulator for the vexing infrared divergences of the amplitudes. Its physical meaning is a local deformation of particle helicity, a fact that might be useful for a much larger class of non-integrable, realistic four-dimensional field theories.

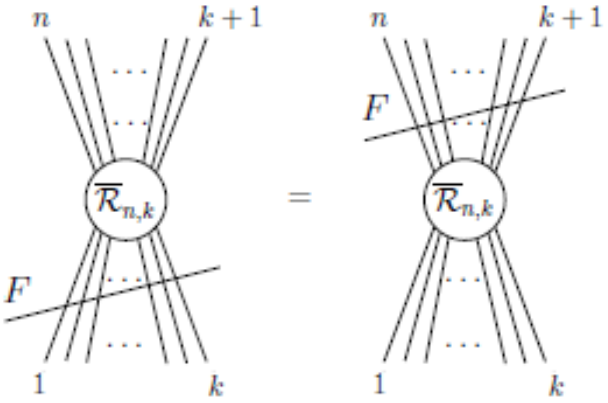

Figure:
A scattering amplitude of a gauge theory probed by a fictitious "test particle". The resulting equation is a generalization of the so-called Yang-Baxter equation appearing in the mathematical description of certain spin chains of condensed matter theory, as well as in some four-dimensional quantum field theories.

Harmonic R Matrices for Scattering Amplitudes and Spectral Regularization

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