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Reconstruction of spectra and an algorithm based on the theorem of Darboux

Assuming only a known dispersion relation of single mode in the spectrum of a two-point function in some quantum field theory, we investigate when and how a reconstruction of the complete spectrum of physical excitations is possible. In particular, we develop a constructive algorithm based on the theorem of Darboux that allows for such a reconstruction when the associated spectral curve is non-factorised and all modes can be connected by level-crossings. For concreteness, we focus on theories in which the known mode is the gapless excitation described by the hydrodynamic gradient expansion. We numerically apply the algorithm to a few simple examples of reconstructions and then to the example of transverse momentum excitations in the holographic theory describing a stack of M2 branes, which includes momentum diffusion as its gapless excitation.

Authors: GROZDANOV, Saso;   LEMUT, Timotej

Presenter: LEMUT, Timotej

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