

Sine-Gordon Integrability of Classical String Solutions on $AdS_5 \times S^5$

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Gauge/gravity correspondence gives us important ideas to study various aspects of gauge, gravity and string theories. A famous example is the one between maximally supersymmetric Yang-Mills theory in 4 dimensions and superstring theory on the $AdS_5 \times S^5$ spacetime background, which is called (but not yet proven) AdS/CFT correspondence.

Among the nontrivial tests for the AdS/CFT correspondence, comparison of the integrability of the both sides has recently been well investigated. For instance, there is correspondence between ‘long’ gauge-invariant, single-trace operators in gauge theory side and classical string solutions with a large angular momentum in S^5 in string theory side.

To be more precise: one calculates the anomalous dimension matrix of SYM operators, which we expect to be diagonalizable by Bethe Ansatz. And one compares it with (Energy) - (the total angular momentum in S^5) of the solutions of classical string sigma model, which is again an integrable system. Then both quantities will agree if the conjectured AdS/CFT correspondence is true.

In this work, we construct quasi-periodic closed string solutions on $R \times S^3$ that interpolate various string solutions whose SYM counterparts have already been known.

They also have two interesting features from an integrability point of view: (1) In certain limit, our solution is identical to spinning string solutions found by Frolov and Tseytlin, which has interpretation as finite-gap solutions of genus 1. So one can expect that our solutions have similar interpretation as finite-gap solutions. (2) Our construction is based on Pohlmeyer-Lund-Regge reduction, which relates string theory on $R \times S^3$ with Complex sine-Gordon system. So eventually we will be able to construct explicitly a map between the finite-gap solutions of string sigma model on $R \times S^3$ and those of Complex sine-Gordon system.

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