

In this article the author studies quantum integrability of string theory on $\text{AdS}_3 \times S^3 \times S^3 \times S^1$. The integrability is widely considered as a key concept behind the AdS/CFT correspondence. The integrability of the typical type IIB superstrings on $\text{AdS}_5 \times S^5$ is known to be related to an integrable spin chain system, see, *e.g.*, [1]. Regarding type IIB superstrings on $\text{AdS}_3 \times S^3 \times T^4$ and $\text{AdS}_3 \times S^3 \times S^3 \times S^1$, the relevant string theories with 16 supercharges are known to be *classically* integrable [2].

In [3] the type IIB superstrings on $\text{AdS}_3 \times S^3 \times S^3 \times S^1$ with mixed Ramond-Ramond (RR) and Neveu-Schwarz-Neveu-Schwarz (NSNS) fluxes are investigated and, under some assumption of quantum integrability, a worldsheet S-matrix of the type IIB string theories is constructed. The article under review utilizes this S-matrix expression to investigate Yangian symmetries of the string theories on $\text{AdS}_3 \times S^3 \times S^3 \times S^1$ with mixed fluxes. The Yangian symmetries typically arise in integrable quantum field theories such as $\mathcal{N} = 4$ super Yang-Mills theory and its AdS/CFT dual, *i.e.*, type IIB superstrings on $\text{AdS}_5 \times S^5$. It is thus expected that the study of Yangian symmetry in superstrings on $\text{AdS}_3 \times S^3 \times S^3 \times S^1$ with mixed fluxes would deepen our understanding of the integrability in superstring theory in general.

The author reports that the Yangian symmetry can algebraically be extracted from the S-matrix found in [3]. The analysis uses the so-called ternary (or RTT) relation, an algebraic technique developed long time ago (see, *e.g.*, [4, 5, 6]) so as to solve the quantum Yang-Baxter equation. The author concludes that the worldsheet S-matrix of interest preserves the Yangian symmetry where a corresponding Yangian evaluation representation depends on the quantized coefficient of the Wess-Zumino terms (induced by the mixed fluxes). The author further indicates that, in a large effective string-tension limit, the Yangian (algebra) becomes a deformation of a unitary loop algebra and obtains its universal classical r-matrix, relating it to the classical limit of an R-matrix by means of the evaluation representation.

References

- [1] G. Arutyunov, S. Frolov, J. Russo and A. A. Tseytlin, “Spinning strings in $\text{AdS}(5) \times S^{**}5$ and integrable systems,” Nucl. Phys. B **671**, 3 (2003) doi:10.1016/j.nuclphysb.2003.08.036 [hep-th/0307191].

- [2] A. Babichenko, B. Stefanski, Jr. and K. Zarembo, “Integrability and the AdS(3)/CFT(2) correspondence,” *JHEP* **1003**, 058 (2010) doi:10.1007/JHEP03(2010)058 [arXiv:0912.1723 [hep-th]].
- [3] R. Borsato, O. Ohlsson Sax, A. Sfondrini and B. Stefanski, “The AdS₃ × S³ × S³ × S¹ worldsheet S matrix,” *J. Phys. A* **48**, no. 41, 415401 (2015) doi:10.1088/1751-8113/48/41/415401 [arXiv:1506.00218 [hep-th]].
- [4] L. D. Faddeev, N. Y. Reshetikhin and L. A. Takhtajan, “Quantization of Lie Groups and Lie Algebras,” *Leningrad Math. J.* **1**, 193 (1990) [*Alg. Anal.* **1**, no. 1, 178 (1989)].
- [5] P. P. Kulish and E. K. Sklyanin, “On the solution of the Yang-Baxter equation,” *J. Sov. Math.* **19**, 1596 (1982) [*Zap. Nauchn. Semin.* **95**, 129 (1980)]. doi:10.1007/BF01091463
- [6] A. Molev, M. Nazarov and G. Olshansky, “Yangians and classical Lie algebras,” *Russ. Math. Surveys* **51**, 205 (1996) doi:10.1070/RM1996v051n02ABEH002772 [hep-th/9409025].