Integrability and stringy WZW models

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Different perspectives for strings on $AdS_3 \times S^3 \times T^4$

Integrability on the string worldsheet

1. Strings in **lightcone gauge** give 2D integrable QFTs
   [Arutyunov, Frolov, Staudacher '04; Ambjorn, Janik, Kristjansen '05; Arutyunov, Frolov, Zamaklar '06]

2. Spectrum follows from **Bethe equations** and **dispersion relation**

$$e^{ip_i J} \prod_{j \neq i} S(p_i, p_j) = 1 \qquad H_{\text{tot}} = \sum_i H(p_i)$$

3. Finite size effects encoded in **Thermodynamic Bethe Ansatz**
   [Yang, Yang '69; Zamolodchikov '90; . . .]

2D CFT on the worldsheet

For pure-NSNS flux, the **WZW model** provides

- ▶ **CFT** description of superstrings on $\text{AdS}_3 \times \text{S}^3 \times \text{T}^4$

- ▶ Exact solution and **closed formula** for the **entire spectrum**

- ▶ Short-string **worldsheet energy** [Maldacena, Ooguri, Son '00-'01; ...]

$$H = \sqrt{J^2 + 4k\,N} - J + \hat{\mu}$$

16:00 - 16:30	J. De Boer
16:30 - 17:00	L. Eberhardt
17:00 - 17:30	M. Guica

A simple S-matrix and...

The **pure-NSNS S-matrix** was **not derived** at all loops in α' but...

...Baggio and Sfondrini '18 proposed a **very simple form**

$$S(p_i, p_j) = e^{i\Phi(p_i, p_j)}\, \mathbb{I},$$

T$\overline{\text{T}}$ CDD factor [Dubovsky, Flauger, Gorbenko '12]

$$\Phi(p_i, p_j) = \begin{cases} -\frac{k}{2\pi} p_i p_j & \xrightarrow{p_i} \quad \xleftarrow{p_j} \\ +\frac{k}{2\pi} p_i p_j & \xrightarrow{p_j} \quad \xleftarrow{p_i} \\ 0 & \xrightarrow{p_i} \xrightarrow{p_j}, \quad \xleftarrow{p_i} \xleftarrow{p_j} \end{cases}$$

It passes perturbative checks [Hoare, Tseytlin '13; Baggio, Sfondrini '18; AD, Sfondrini '18]

...its drastic consequences

Energy levels admit a **closed form**

▶ We reproduce WZW short-string energy levels

▶ ... including fermions & spectrally flowed representations

[Baggio, Sfondrini '18; AD, Sfondrini '18]

Uniquely **simple TBA structure**

▶ Wrapping corrections can be resummed

▶ Seems generic for NSNS strings ($\mathbf{AdS_3 \times S^3 \times S^3 \times S^1}$)

▶ Hints of an underlying spin chain structure

[AD, Sfondrini '18]

Future directions

▶ Full spectrum, including **degeneracies** and **long strings**

▶ Go beyond the spectrum: **three-** and **higher-** point functions
[Basso, Komatsu, Vieira '15; Eden, Sfondrini '15; Fleury, Komatsu '16; Yunfeng, Komatsu, Vescovi '19]

▶ Understand the microscopic structure of the **spin chain**
[Pakman, Rastelli, Razamat '09]