

Massless scattering amplitudes in 2d field theory

Nat Levine

based on work in progress with
Arkady Tseytlin and Ben Hoare

Motivation

- Want to... classify integrability of sigma models on (1+1)d Minkowski space

$$\mathcal{L} = \partial_\mu X^i \partial_\nu X^j \eta^{\mu\nu} G_{ij}(X) + \partial_\mu X^i \partial_\nu X^j \epsilon^{\mu\nu} B_{ij}(X)$$

- Integrability = Lax connection \implies solvable EOM
- Very difficult!

Factorized scattering

Theorem:

The S-matrix of a relativistic **massive** integrable model has:

- No particle production
- Factorized scattering [Parke, 80]

- What about massless models?! S-matrix **not well defined**
- Want to design formal 'S-matrix-type' object that satisfies the theorem. (Tree-level only!)
- Recent interest:
 - [Dubovsky, Flauger, Gorbenko, 12]
 - [Cooper, Dubovsky, Gorbenko, Mohsen, Storace, 15]
 - [Wulff, 18]
 - [Gabai, Mazac, Shieber, Vieira, 18]

Integrable Examples:

S^n sigma model

$$\mathcal{L} = \frac{\partial y^i \partial y^j}{(1 + \frac{\lambda^2}{4} y^j y^j)^2} \quad (i, j = 1, \dots, n)$$

Symmetric coset space: $S^n = SO(n+1)/SO(n) \rightarrow$ integrable

Nappi model

$$\mathcal{L} = (\partial A)^2 + (\partial B)^2 + (\partial C)^2 + g \epsilon^{\mu\nu} A \partial_\mu B \partial_\nu C$$

Classically equivalent to $S^3 \cong SU(2)$ sigma model!

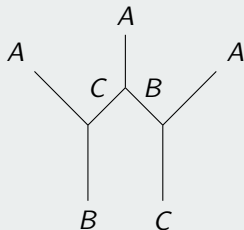
Lax connection constructed \rightarrow integrable

[Zakharov, Mikhailov, 78]

It was claimed to have particle production

[Nappi, 80]

Goes against integrability intuition



Prescription ideas

Naive prescription

LSZ with:

1. external legs \rightarrow on-shell
2. $i\epsilon \rightarrow 0$

Result:



Particle production in:

- Nappi model – agrees with [Nappi, 80]
- S^n sigma model

These limits do not commute!

'Off-shell' prescription

LSZ with swapped order of limits:

1. $i\epsilon \rightarrow 0$
2. external legs \rightarrow on-shell

Result:



Watch this space!

Final comments

- Off-shell prescription requires choices: how to take on-shell limit?
- Hope to find a universal choice that manifests integrability.
- We also expect T-duality to be manifest.
- **In the future:** hope to use this S-matrix to discover new constraints imposed by integrability.