

Exact results for superconformal field theories

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One of the most widely used approaches to study interacting quantum field theories is perturbation theory, where physical quantities are expressed as a series expansion in some small parameter. Despite its many successes, the perturbative approach cannot be used to study important physical phenomena like confinement and chiral symmetry breaking in QCD for which non-perturbative and strong-coupling effects play a key role. While these are still largely open problems, in the last few years the field has witnessed tremendous progress in understanding the non-perturbative and strongly coupled behaviors of many interesting quantum field theories, especially in the supersymmetric context where we can now compute several observables of interest, such as partition functions and correlation functions, exactly in the coupling constant.

In these lectures we will present some of these recent developments, focusing in particular on four dimensional $\mathcal{N} = 2$ supersymmetric field theories. After introducing the theories of interest, we will discuss how these are related to integrable systems and how this correspondence can be used to compute their partition function around a generic strong-coupling point. In the case where these theories also enjoy conformal symmetry, the partition function encodes detailed information about correlation functions of chiral operators. We will describe how the 3-point functions of chiral primaries can be computed exactly using techniques from localization and the tt^* equations.

References

- [1] O. Gamayun, N. Iorgov and O. Lisovyy, *Conformal field theory of Painlevé VI*, *JHEP* **10** (2012) 038, [1207.0787].
- [2] O. Gamayun, N. Iorgov and O. Lisovyy, *How instanton combinatorics solves Painlevé VI, V and IIIs*, *J. Phys.* **A46** (2013) 335203, [1302.1832].
- [3] A. Its, O. Lisovyy and Y. Tykhyy, *Connection problem for the sine-Gordon/Painlevé III tau function and irregular conformal blocks*, 1403.1235.

- [4] G. Bonelli, O. Lisovyy, K. Maruyoshi, A. Sciarappa and A. Tanzini, *On Painlevé / gauge theory correspondence: the four-dimensional case*, to appear.
- [5] E. Gerchkovitz, J. Gomis and Z. Komargodski, *Sphere Partition Functions and the Zamolodchikov Metric*, *JHEP* **11** (2014) 001, [1405.7271].
- [6] M. Baggio, V. Niarchos and K. Papadodimas, *Exact correlation functions in $SU(2)\mathcal{N} = 2$ superconformal QCD*, *Phys. Rev. Lett.* **113** (2014) 251601, [1409.4217].
- [7] M. Baggio, V. Niarchos and K. Papadodimas, *tt^* equations, localization and exact chiral rings in $4d \mathcal{N} = 2$ SCFTs*, *JHEP* **02** (2015) 122, [1409.4212].
- [8] E. Gerchkovitz, J. Gomis, N. Ishtiaque, A. Karasik, Z. Komargodski and S. S. Pufu, *Correlation Functions of Coulomb Branch Operators*, 1602.05971.