Defects in conformal and supersymmetric field theories

Simone Giacomelli (ICTP Trieste) and Marco Meineri (EPFL Lausanne)

Abstract

In a quantum or statistical field theory, the action of operators on the vacuum describes how a physical system is affected by a probe. Often, the probes are extended objects: the word-line of a heavy particle, a boundary or an interface, etc. We describe some general features of extended probes, in highly symmetric QFTs. We first focus on conformal field theories. We discuss properties of the Operator Product Expansion in the presence of defects and give examples of topological and non topological conformal defects. We then move to the case of supersymmetric theories, in which we can construct defects with two dimensional (or higher) support. We explain how certain kinds of extended probes are able to detect the phases of the theory. Finally, we describe the relevance of defects in constructing a large class of superconformal $\mathcal{N} = 2$ theories in four dimensions, and how one can use properties of topological defects in two-dimensions to compute the expectation value of line operators in these theories.

References

- General treatments: Chapter 7 of Cardy's book [1]; Lectures by Binder in vol. 8 and by Diehl in vol. 10 of Domb & Lebowitz, *Phase transitions and critical phenomena*; McAvity and Osborn [2]; Billò et al. [3].

- Defects in 2d conformal field theories: [4].

- Rényi entropies and conformal defects: Hung et al. [5].

- Surface defects in supersymmetric theories: section 1 of [6] and section 2 of [7].

- For class S theories see [8] or the original paper by Gaiotto [9].

- For the analysis of vev of line operators from surface defects in 6d theories see [10].

References

[1] J. L. Cardy, *Scaling and renormalization in statistical physics*,.

[2] D. McAvity and H. Osborn, *Conformal field theories near a boundary in general dimensions*, Nucl.Phys. **B455** (1995) 522–576, `arXiv:cond-mat/9505127 [cond-mat]`.

[3] M. Billò, V. Gonçalves, E. Lauria, and M. Meineri, *Defects in conformal field theory*, JHEP **04** (2016) 091, `arXiv:1601.02883 [hep-th]`.

[4] J. L. Cardy, *Conformal Invariance and Surface Critical Behavior*, Nucl.Phys. **B240** (1984) 514–532.

[5] L.-Y. Hung, R. C. Myers, and M. Smolkin, *Twist operators in higher dimensions*, JHEP **10** (2014) 178, `arXiv:1407.6429 [hep-th]`.

[6] S. Gukov, *Surface Operators,* in *New Dualities of Supersymmetric Gauge Theories*, J. Teschner, ed., pp. 223–259. 2016. `arXiv:1412.7127 [hep-th]`. `http://inspirehep.net/record/1335340/files/arXiv:1412.7127.pdf`.

[7] S. Gukov and E. Witten, *Gauge Theory, Ramification, And The Geometric Langlands Program*, `arXiv:hep-th/0612073 [hep-th]`.

[8] Y. Tachikawa, *N=2 supersymmetric dynamics for pedestrians,* in *Lecture Notes in Physics, vol. 890, 2014*, vol. 890, p. 2014. 2013. `arXiv:1312.2684 [hep-th]`. `http://inspirehep.net/record/1268680/files/arXiv:1312.2684.pdf`.

[9] D. Gaiotto, *N=2 dualities*, JHEP **08** (2012) 034, `arXiv:0904.2715 [hep-th]`.

[10] N. Drukker, J. Gomis, T. Okuda, and J. Teschner, *Gauge Theory Loop Operators and Liouville Theory*, JHEP **02** (2010) 057, `arXiv:0909.1105 [hep-th]`.