

# Large charge aux Diablerets



## Report of Contributions

Contribution ID: 22

Type: **not specified**

## Large charge in perturbation theory: Past and future

*Monday 4 July 2022 14:00 (1 hour)*

I will review the applications of the fixed-charge semiclassical method to various models concentrating mostly on the perturbative aspects of the calculation.

I will elucidate the identification of the lowest-lying operator, analytic structure of the large charge expansion and application to various proposed dualities at the critical point. I will conclude with several open problems.

**Presenter:** ANTIPIN, Oleg (Institut Rudjer Boskovic)

Contribution ID: 23

Type: **not specified**

## Identifying Large Charge Operators

*Friday 8 July 2022 11:00 (30 minutes)*

The Large Charge sector of Conformal Field Theory can generically be described through a semiclassical expansion around a superfluid background. Focussing on  $U(1)$  invariant Wilson-Fisher fixed points, I will discuss the spectrum of spinning large charge operators. For sufficiently low spin these correspond to the phonon excitations of the superfluid state. I will describe the organization of these states into conformal multiplets and the form of the corresponding composite operators in the free field theory limit. The latter entails a mapping, built order-by-order in the inverse charge  $n^{-1/2}$ , between the Fock space of vacuum fluctuations and the Fock space of fluctuations around the superfluid state. I will comment on the limitations of the semiclassical method, in particular the fact that the phonon description breaks down for spins of order  $n^{1/2}$  while the computation of observables seems valid up to spins of order  $n$ . Finally, I will show that this knowledge of the operator spectrum is useful to analyze the conformal block decomposition of some 4-point functions. Based on a work in progress with A. Monin and R. Rattazzi.

**Presenter:** BADEL, Gil (EPFL)

Contribution ID: 24

Type: **not specified**

## The large-charge expansion for multiple charges

*Tuesday 5 July 2022 11:00 (30 minutes)*

I will discuss the large-charge expansion in cases where more than one charge is taken to be large. As an illustration, I will consider the first known example of a Standard Model-like theory featuring asymptotic safety in four dimensions. In particular, I will present the contribution to the scaling dimension of charged operators stemming from quartic, Yukawa, and gauge interactions, and comment on the effect of the charge configuration on the large-charge expansion.

**Presenter:** BERSINI, Jahmall (Rudjer Boskovic Institute)

Contribution ID: 26

Type: **not specified**

## Large-order behaviours in CFTs and Resurgence

*Monday 4 July 2022 11:00 (30 minutes)*

The conformal data of CFTs involving heavy charged operators can be organised as a series in inverse powers of the global charges involved. When extrapolating these expansions to light low-charge sectors, it is relevant to ask whether these series are divergent and Borel-summable. In this talk, I will show that, generically, one would expect large-charge expansions to be divergent faster than factorial. Moreover, In scalar large-N CFTs one finds series which are not Borel-summable with non-perturbative ambiguities cured by Worldline instantons. These are discussed using Resurgence methods and shown to have an exact semi-classical expansion. The talk is based on arXiv:2102.12488.

**Presenter:** DONDI, Nicola Andrea (University of Bern)

Contribution ID: 27

Type: **not specified**

## Flux Correlators and Semiclassics

*Friday 8 July 2022 11:30 (30 minutes)*

I will talk about charge and energy flux correlators in a Lorentzian CFT in the presence of a large  $U(1)$  charge  $n$  produced by an external excitation. This type of object is particularly interesting as it is very close to observables used in collider physics. Even considering a weakly coupled theory, the standard perturbative expansion breaks down at large  $\lambda n$ , with  $\lambda$  the theory's coupling. In this situation, correlators can still be computed in a semiclassical expansion around a non-trivial saddle point. Applying this formalism developed in Euclidean CFT to the computation of correlators of non-local operators in a Lorentzian context raises specific challenges.

**Presenter:** FIRAT, Eren (EPFL)

Contribution ID: 28

Type: **not specified**

## Long Range Model at Large Charge and Large N

*Thursday 7 July 2022 15:30 (30 minutes)*

We study operators with large charge  $j$  in the  $d$ -dimensional  $O(N)$  model with long range interactions that decrease with the distance as  $1/r^{d+s}$ , where  $s$  is a continuous parameter. We consider the double scaling limit of large  $N$ , large  $j$  with  $j/N = \hat{j}$  fixed, and identify the semiclassical saddle point that captures the two-point function of the large charge operators in this limit. The solution is given in terms of certain ladder conformal integrals that have recently appeared in the literature on fishnet models. We find that the scaling dimensions for general  $s$  interpolate between  $\Delta_j \sim \frac{(d-s)}{2}j$  at small  $\hat{j}$  and  $\Delta_j \sim \frac{(d+s)}{2}j$  at large  $\hat{j}$ , which is a qualitatively different behavior from the one found in the short range version of the  $O(N)$  model. We also derive results for the structure constants and 4-point functions with two large charge and one or two finite charge operators. Using a description of the long range models as defects in a higher dimensional local free field theory, we also obtain the scaling dimensions in a complementary way, by mapping the problem to a cylinder in the presence of a chemical potential for the conserved charge. Based on arXiv:2205.00500 with S. Giombi and H. Khanchandani.

**Presenter:** HELFENBERGER, Elizabeth (Princeton University)

Contribution ID: 29

Type: **not specified**

## Reviewing spinning correlators in CFTs in a sector of large global charge

*Monday 4 July 2022 11:30 (30 minutes)*

In this talk I systematically study spinning correlators of a generic non-parity violating CFT, with an  $O(2)$  internal symmetry at sectors of large charge. At the beginning I will show the equivalence between canonical and path integral quantization to the leading order result, and subsequently I will use the former to compute three- and four-point functions with conserved current insertions sandwiched between spinful phonon states

**Presenter:** KALOGERAKIS, Ioannis (University of Bern)



Contribution ID: 30

Type: **not specified**

## Large Charge 't Hooft Limit

*Tuesday 5 July 2022 09:30 (1 hour)*

$N=4$  super Yang-Mills (SYM) in four dimensions is integrable in the planar limit, allowing exact computations of a variety of observables. In this talk, I will provide evidence that the large charge sector of  $N=4$  SYM with the  $SU(2)$  gauge group provides another interesting solvable corner, which is far from the planar limit but nevertheless exhibits similar structures. Specifically, we consider non-BPS operators obtained by small deformations of half-BPS operators with large charge  $J$ , and analyze their spectrum in the double-scaling limit where  $J$  is sent to infinity with  $\lambda_J \equiv g_{\text{YM}}^2 J$  fixed. We find that the spectrum in this limit is governed by the centrally-extended  $SU(2|2)^2$  symmetry—the symmetry that played a crucial role in integrability in the planar limit. At the leading order in the  $1/J$  expansion, it is fully fixed by the symmetry, and is given by the celebrated magnon dispersion relation. At the next leading order, the symmetry constrains the spectrum up to a few overall constants, most of which can be determined by a simple semi-classical analysis around a BPS background. I also present the result for the structure constant of two large charge operators and a Konishi operator up to order  $1/J$ , but exact in  $\lambda_J$ . The result exhibits a rich structure that interpolates between the perturbation series at weak coupling and the worldline instantons at strong coupling. I will also briefly mention the relation to the physics on the Coulomb branch and discuss potential generalizations, such as the higher-rank gauge groups, the large spin 't Hooft limit, the combination of large  $N$  and large  $J$  limits, and application to operators dual to black holes.

**Presenter:** KOMATSU, Shota (CERN)

Contribution ID: 32

Type: **not specified**

## Demystifying the State-Operator correspondence in NRCFT

*Monday 4 July 2022 09:30 (1 hour)*

The usual state-operator correspondence in Non Relativistic CFT maps the positively charged operators to the states in a harmonic trap. We point out that there exists a notion of state-operator correspondence which leverages the  $SL(2,R)$  subgroup of Schrodinger group and can be used to extend the state-operator map to the sector with zero charge. We can rederive the unitarity bounds using this map. We further show that the usual NRCFT state-operator map is in fact related to the N-S quantization of relativistic CFT and  $SL(2,R)$  subgroup plays a crucial role tying the NRCFT with CFT. The talk will be amalgamation of my unpublished thoughts and arXiv: <https://arxiv.org/abs/1802.02262> .

**Presenter:** PAL, Sridip (Institute for Advanced Study, Princeton)

Contribution ID: 33

Type: **not specified**

## **Convexity of Charged Operators in CFTs and the Weak Gravity Conjecture**

*Wednesday 6 July 2022 09:30 (1 hour)*

**Presenter:** PALT, Eran (Ben-Gurion University)

Contribution ID: 34

Type: **not specified**

## Gauge invariant interactions and Large Charge

*Tuesday 5 July 2022 14:30 (30 minutes)*

Using large charge methods we evaluate the contributions from gauge invariant interactions to the scalar field anomalous dimensions in various models between 2 and 4 dimensions. Examples contain scalar QED, Nambu-Jona-Lasinio and Gross-Neveu-Yukawa models. In some of these, superconformal field theories emerge at the fixed points, exhibiting a rich structure and relation between actions in various dimensions. (Work in progress with Oleg Antipin and Jahmall Bersini)

**Presenter:** PANOPOULOS, Pantelis (Rudjer Boskovic Institute, Croatia)

Contribution ID: 35

Type: **not specified**

## Nonrelativistic CFTs at large charge

*Tuesday 5 July 2022 11:30 (30 minutes)*

I will discuss the large-charge expansion of the conformal dimension  $\Delta(Q)$  of the lowest operator of charge  $Q$  in nonrelativistic CFTs using the state-operator correspondence. The latter requires coupling the theory to an external harmonic trap that confines the particles to a spherical cloud, at the edge of which the effective theory breaks down and leads to divergences. I will show how to build the appropriate counterterms living at the edge of the cloud and discuss the resulting expansion for  $\Delta(Q)$ , which is significantly richer than its relativistic counterpart. In particular, there is a rich structure of  $\log(Q)$  terms emerging from this analysis. On the other side of the correspondence, this also provides new corrections to the Thomas-Fermi approximation of the unitary Fermi gas, and I will comment on their relevance for ultracold atom physics.

**Presenter:** PELLIZZANI, Vito (University of Bern)

Contribution ID: 36

Type: **not specified**

## **The Quantum Mechanics of a 2D perfect fluid**

*Friday 8 July 2022 09:30 (1 hour)*

**Presenter:** RATTAZZI, Riccardo (EPFL)

Contribution ID: 37

Type: **not specified**

## Double scaling limits for field theory defects

*Thursday 7 July 2022 14:00 (1 hour)*

Defect operators in field theory are very interesting for a number of reasons. Drawing inspiration from techniques which have been very recently applied to uncover interesting properties of sectors of operators with large charge under a global symmetry, we will study simple defects in the Wilson-Fisher fixed point near  $d=4,6$  dimensions. Combining with localization, we will also introduce a novel double-scaling limit for certain Wilson loops in  $N=2$  supersymmetric theories in 4d which allows to make exact statements at finite  $N$ .

**Presenter:** RODRIGUEZ-GOMEZ, Diego (U. of Oviedo)

Contribution ID: 38

Type: **not specified**

## The Effective theory of Quantum Black holes

*Wednesday 6 July 2022 11:00 (1 hour)*

We explore the quantum nature of black holes by introducing an effective frame- work that takes into account deviations from the classical results. The approach is based on introducing quantum corrections to the classical Schwarzschild geometry in a way that is consistent with the physical scales of the black hole and its classical symmetries. This is achieved by organizing the quantum corrections in inverse powers of a physical distance. By solving the system in a self-consistent way we show that the derived physical quantities, such as event horizons, temperature and entropy can be expressed in a well defined expansion in the inverse powers of the black hole mass. The approach captures the general form of the quantum corrections to black hole physics without requiring to commit to a specific model of quantum gravity.

**Presenter:** SANNINO, Francesco (Federico II, CP3-Origins, Danish-IAS, CERN, Scuola Superiore Meridionale)



Contribution ID: 39

Type: **not specified**

## Computing OPE coefficients for strongly coupled SCFTs

*Thursday 7 July 2022 09:30 (1 hour)*

There are special classes of  $N=2$  superconformal field theories in four dimensions, such as those of the “Argyres-Douglas” type, that feature an intrinsically strong dynamics. Due to the lack of a Lagrangian description, determining their properties quantitatively is a challenge. In this talk, I will present a general formula, which, inspired by the techniques of localization in gauge theory, computes the OPE coefficients between the Coulomb-Branch operators of such SCFTs. The formula only depends on data of the theory that can all be extracted from its classical Seiberg-Witten geometry, and it gives results in surprising agreement with the bootstrap bounds.

**Presenter:** SAVELLI, Raffaele (University of Rome “Tor Vergata”)

Contribution ID: 40

Type: **not specified**

## The analytic structure of the large charge expansion

*Monday 4 July 2022 15:30 (30 minutes)*

In this talk, I will focus on two different methods that allow us to go beyond standard perturbation theory: the large charge expansion and resurgence. In particular, I will talk about the scaling dimension associated to charged operators in the  $O(N)$  model near  $d=4$  and  $d=3$  and monopoles operators in QED3. I will present their analytic structure for large and small values of the charge and discuss the non-perturbative corrections to these objects using resurgence techniques.

**Presenter:** TORRES SANDOVAL, Matías (Università Napoli Federico ii)

Contribution ID: 41

Type: **not specified**

## Stability analysis of a non-Unitary CFT

*Thursday 7 July 2022 11:00 (1 hour)*

I will argue for the instability of the  $O(N)$  Wilson-Fisher fixed point above four dimensions, using the epsilon expansion.

By computing the lowest operator dimension in the rank- $Q$  symmetric rep in the double-scaling limit where  $\epsilon Q$  fixed, I will show that its imaginary part never vanishes for any  $\epsilon Q$ .

The mechanism for the imaginary part is different for small and large  $\epsilon Q$ , which I will explain.

Since this type of phenomena is widely seen in matrix models and its large- $N$  phase transitions, I will conclude by pointing out possible (qualitative) connections between large charge sectors of CFTs and matrix models.

**Presenter:** WATANABE, Masataka (Weizmann Institute of Science)