Physics 253c Final Project Topics

You are asked to choose one of the following topics, with a few other students in the class as a team. Treat it as a problem set in which you will formulate your own problem and come up with its solution, guided by the suggested references. You should write up your findings in the form of an expository term paper, and give a 40 minute presentation (per person) on it. The presentation can be done collaboratively, whereas the term paper should be written individually.

The suggested references should serve as a starting point for your exploration of the subject. You should by no means limit yourself to the suggested reference, nor feel obligated to understand/present everything in the reference. The goal of your term paper should be to explain one single nontrivial result on the topic of your choice in a self-contained manner. The presentation should be done in blackboard style (use slides only if you need to show numerical plots and/or computer codes), and you should be prepared to reproduce the derivation of key steps and claims, if asked. Avoid giving broad overviews or merely paraphrasing results without your own derivation/arguments. For the numerical projects (which I highly recommend), you should write your own code that (re-)produces the claimed numerical results.

The final presentations will be scheduled between Dec 6 and 15 (precise schedule TBD). The term paper will be due at the end of the exam period.

1. Numerical bootstrap of the 3D Ising CFT (using mixed correlators and SDPB).

S. El-Showk, M. F. Paulos, D. Poland, S. Rychkov, D. Simmons-Duffin and A. Vichi, "Solving the 3D Ising Model with the Conformal Bootstrap," PhysRevD.86.025022 [arXiv:1203.6064 [hep-th]]. F. Kos, D. Poland and D. Simmons-Duffin, "Bootstrapping Mixed Correlators in the 3D Ising Model," JHEP11(2014)109 [arXiv:1406.4858 [hep-th]]. D. Simmons-Duffin, "A Semidefinite Program Solver for the Conformal Bootstrap," JHEP06 (2015), 174 [arXiv:1502.02033 [hep-th]].

2. The $SU(2)$ WZW model as a solvable CFT.

E. Witten, "Nonabelian Bosonization in Two-Dimensions," Commun. Math. Phys. 92 (1984), 455-472. D. Gepner and E. Witten, "String Theory on Group Manifolds," Nucl. Phys. B278 (1986), 493-549.

3. 2D Liouville field theory.

A. B. Zamolodchikov and A. B. Zamolodchikov, "Structure constants and conformal

bootstrap in Liouville field theory," Nucl. Phys. B477 (1996), 577-605 [arXiv:hep-th/9506136 [hep-th]]. J. Teschner, "Liouville theory revisited," Class. Quant. Grav. 18 (2001), R153-R222 [arXiv:hep-th/0104158 [hep-th]].

4. 2D superconformal nonlinear sigma models.

L. Alvarez-Gaume and D. Z. Freedman, "Geometrical Structure and Ultraviolet Finiteness in the Supersymmetric Sigma Model," Commun. Math. Phys. 80 (1981), 443. E. Witten, "Phases of N=2 theories in two-dimensions," Nucl. Phys. B403 (1993), 159-222 [arXiv:hep-th/9301042 [hep-th]].

5. Chern-Simons-matter theories

O. Aharony, G. Gur-Ari and R. Yacoby, "d=3 Bosonic Vector Models Coupled to Chern-Simons Gauge Theories," JHEP03 (2012), 037 [arXiv:1110.4382 [hep-th]]. O. Aharony, O. Bergman, D. L. Jafferis and J. Maldacena, "N=6 superconformal Chern-Simons-matter theories, M2-branes and their gravity duals," JHEP10 (2008), 091 [arXiv:0806.1218 [hep-th]].

6. 4D Seiberg-Witten gauge theories and related CFTs

N. Seiberg and E. Witten, "Electric - magnetic duality, monopole condensation, and confinement in N=2 supersymmetric Yang-Mills theory," Nucl. Phys. B426 (1994), 19-52 [erratum: Nucl. Phys. B **430** (1994), 485-486] [arXiv:hep-th/9407087 [hep-th]]. N. Seiberg and E. Witten, "Monopoles, duality and chiral symmetry breaking in N=2 supersymmetric QCD," Nucl. Phys. B431 (1994), 484-550 [arXiv:hep-th/9408099 [hep-th]]. P. C. Argyres and M. R. Douglas, "New phenomena in SU(3) supersymmetric gauge theory," Nucl. Phys. B448 (1995), 93-126 [arXiv:hep-th/9505062 [hep-th]].

7. 6D $(2,0)$ superconformal theories

C. Beem, M. Lemos, L. Rastelli and B. C. van Rees, "The (2, 0) superconformal bootstrap," Phys. Rev. D93 (2016) no.2, 025016 [arXiv:1507.05637 [hep-th]].

8. Truncated conformal space approach to massive QFTs

V. P. Yurov and A. B. Zamolodchikov, "TRUNCATED CONFORMAL SPACE APPROACH TO SCALING LEE-YANG MODEL," Int. J. Mod. Phys. A5 (1990), 3221-3246. P. Fonseca and A. Zamolodchikov, "Ising field theory in a magnetic field: Analytic properties of the free energy," [arXiv:hep-th/0112167 [hep-th]].