

## Quantum Field Theory C (215C) Spring 2013

### End-of-Term Project

**Deadlines:** Topic choices are due May 16, 2013.

Papers are due on the day of the last lecture (Thursday, 13 June, 2013).

The end of term project for 215C will be a *short* paper explaining a nugget of truthy goodness about the physics of quantum fields.

Your goal in deciding what to say should be to try to save the rest of us from having to read the papers. Give some context, say what the crucial point is, say what the implications are.

The paper should be approximately 2 pages in a TeX format for which I'll provide a template. You may include arbitrarily many figures, which need not count toward the page limit. The page limit is not sharp, but keep in mind that I will post all the papers to the course webpage and everyone should read everyone else's paper.

I would prefer a level of detail and technical sophistication comparable to that of my lecture notes. Anything we've covered may be assumed known (though a reference to a specific section of the notes might be helpful). Your paper may contain as much detail as you like, but complicated technical details must be put in a box and labelled, so that the reader may read only the label on the box without losing the narrative thread. Examples of boxes into which you may put details are footnotes, appendices and actual boxes.

Please tell me (by email or in person) what topic you plan to study as soon as possible. Below are some topic suggestions, involving wildly varying levels of difficulty. The list is certainly not in any sense exhaustive. Creative topics are encouraged.

### Submission instructions:

Please give me a paper copy of your paper, and email me a pdf copy. It would help me if you name the file in the following format:

2013S-215C-YourLastName-YourFirstName.pdf

### Some topic suggestions:

Anything in blue below is a link to the literature.

Lists of and links to references below are intended as entry points to the literature, and not as complete citations of all good work on the subject. For each paper you should of course always also read all papers which cite it<sup>12</sup>, as well as all of the papers to which it refers. The order below is not meaningful, though I've tried to group related topics together. I will keep adding to this file.

1. Entanglement entropy in quantum field theory [[Cardy-Calabrese](#)]. (claimed by [Paul Rozdeba](#))
2. Nielsen-Ninomiya no-go theorem for regularization of chiral fermions. [See [these papers](#) by Nielsen and Ninomiya, and [0912.2560](#) and [Friedan's paper](#).] (claimed by [Nirag Kadakia](#))
3. Fermion zero-modes on solitons. This is really several topic suggestions: [[codimension 2: Jackiw-Rossi](#), [codimension 3: Jackiw-Rebbi](#), recent related developments: [Fu-Kane](#), [Teo-Kane](#), [McGreevy-Swingle](#)]
4. Skyrme model of baryons. [[Here](#) or [here](#) are places to start.]
5. WZW models of 2d current algebra CFT, non-abelian bosonization [[Witten, 1983](#)]
6. Realization of anomalies in the sigma model (Wess-Zumino terms) [[Witten, 1983](#)]
7. Monopole catalysis of baryon decay ([Callan-Rubakov effect](#)) [[see also this paper](#)]
8. The Witten SU(2) anomaly [[Witten, 1982](#)]
9. 3d Parity anomaly [[Redlich, 1984](#)].
10. Emergence of gauge theory and fermions from local bosonic lattice models [[Levin-Wen](#), [Kitaev](#), [Kitaev](#)] (claimed by [Minyoung You](#))
11. The  $c$ -theorem in 2d QFT [[Zamolodchikov](#), [Friedan-Cappelli-Latorre](#)]
12. The Kondo model (one of the first applications of the RG) [[Affleck](#) and [Affleck](#)]
13. Fermi edge singularity in X-ray absorption from 2d CFT [[Affleck](#), [Ludwig](#)]
14. Mossbauer effect: recoil-free scattering from a solid is made possible by the quantum nature of phonons [[here](#)].
15. BCFW recursion relations for tree amplitudes [[0801.2385](#)]
16. Conformal bootstrap [[an old idea on which there has been recent progress](#)]

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<sup>1</sup>Am I exaggerating?

<sup>2</sup>For many of the papers listed below, a relatively complete citation list can be found using [Spire's: http://www.slac.stanford.edu/spires/hep/](http://www.slac.stanford.edu/spires/hep/).

17. Theta vacua of Yang-Mills theory [see the section of Coleman's book called *Uses of Instantons*.]
18. Confinement of  $U(1)$  gauge theory in  $D = 2+1$  [Polyakov]; bonus topic: the role of this fact in the study of quantum spin liquids [see Wen's textbook]. (claimed by Shauna Kravec)
19. Magnetic bions are responsible for confinement in some gauge theories on  $\mathbb{R}^3 \times S^1$  [Unsal – this fascinating 'scientific memoir' has a bibliography]
20. Perturbation theory is only asymptotic [Dyson]; attempts to improve upon it by Borel resummation [Zinn-Justin's textbook]; renormalons [1204.1661]. (claimed by Justin Bond)
21. Deconfined quantum criticality and dangerously irrelevant operators [Senthil, Balents, Sachdev, Vishwanath, Fisher] (silently claimed by Alex Kuczala)
22. Kosterlitz-Thouless transition (claimed by Dan Arovas for the SPT Fridays meeting)
23. Casimir effect (claimed by David Leon)
24. Topology of the configuration space and particle statistics [J. M. Leinaas and J. Myrheim, *Nuovo Cim.* B37, 1 (1977)] (claimed by Daniel Walsh)
25. Interactions between neutrinos and photons in medium (claimed by Amol Patwardhan)
26. BPHZ theorem (claimed by Wang Yang)
27. Schwinger effect (pair creation of charged particles in an electric field) [Itzykson-Zuber, p. 193] (claimed by Miles Albert)
28. anything else we don't get to in lecture that's on the syllabus.