

# TEP

“Category D and E” homework problems

- **At the head of your report, please write your name, student ID number and a list of problems that you worked on in a report (like “II-1, II-3, IV-2”).**
- When you start working on a category [E] problem and get stuck in the middle, I recommend that you still submit partial results as a report. Partial results are still non-zero achievements.
- This PDF file provides links to the articles referred to here.

[D-1] **Renormalization computations in a non-renormalizable theory:** Read a paper *Physica* **96A** (1979) p.327 “*Phenomenological Lagrangians*” by Steven Weinberg, and derive equation (12). Alternatively, derive eq. (19.5.26) of the textbook by Steven Weinberg vol. 2.

[D-2] **Anomaly in Fujikawa method:** Read a paper *Phys.Rev.Lett.* **42** 1195 (1979) by Kazuo Fujikawa on path-integral derivation of anomaly, and write a summary of what you have understood. (Don’t copy and paste the Wikipedia entry!)

[E-1] **Superconductivity in association with renormalization and effective theory:** Read either the “Lecture 2” in a lecture note [hep-th/9210046] “*Effective Field Theory and the Fermi Surface*,” by Joe Polchinski, or the Chapter 21.6 of Weinberg’s textbook, and submit a summary as a report.

[E-2] **How to extract parton distributions from experimental data:** With photon probe at tree level, DIS structure functions are sensitive only to a combination  $\sum_i (Q_{q_i})^2 [f_{q_i}(x) + f_{\bar{q}_i}(x)]$  of quark and anti-quark PDFs. How have we managed to extract PDFs of individual quarks from experimental data?

- Explain briefly how one can distinguish quark pdf from anti-quark pdf.
- Explain briefly how one can distinguish up quark pdf from down quark pdf.
- Explain briefly how gluon pdf can be measured.

References:

- a textbook “*Deep Inelastic Scattering*,” by R.Devenish and A. Cooper-Sarkar, (Oxford U. Press)
- slides of a review talk at JPS meeting by Dr. K. Nagano

[E-3] **BFKL equation (derivation):** Read a paper *Nucl.Phys.***B415** (1994) p.373 “*Soft gluons in the infinite-momentum wave function and the BFKL pomeron*,” by A. Mueller and submit a summary (or any kinds of record of reading it) as a report.

- [E-4] **1-loop results by unitarity:** Read such papers as hep-ph/9409265 by Z. Bern et.al., and learn how to combine tree-level correlation functions under the unitarity principle to construct 1-loop correlation functions. Then write a summary of what you have understood about the notion of cut constructibility. If you have further curiosity, you might also be interested in looking at such papers as hep-ph/0609191 by C. Anastasiou et.al. on the  $D$ -dimensional unitarity method.
- [E-5] **duality between DGLAP and BFKL** Read a lecture note hep-ph/0001157 by G. Altarelli et.al. and write a summary of what you have understood.
- [E-6] **Soft Collinear Effective Theory** Read the following papers hep-ph/0005275 and hep-ph/0011336 by C. Bauer et.al. and write a summary of what you have understood.