

# QFT II/QFT

## homework IV

- submission via the U Tokyo LMS. We request that the file name includes the problem number(s), such as II-1\*\*\*.pdf or \*\*\*-IV-2-IX-1.jpeg. The LMS will show who had submitted the file (student ID and name), so the file name will not have to contain your name or ID number.
- course credit guaranteed by working on  $1\#[A] + 1.5\#[B] + 2\#[C] + 4\#[D] + 8\#[E] \geq 9$  problems.
- A sample solution is available as a pdf file for problems with the mark  $\star$ .

### 1. Feynman rule of external lines [B]

In the classroom, we did not take enough time to explain what the Feynman rule is supposed to be for external states. What are they supposed to be in the momentum space version? and why? It will be a good exercise—if this is the first time to learn the Feynman rule—to think about that in the case of relativistic Weyl fermion, Dirac fermion (both particle and its anti-particle).

If you have spent your time to do so before (e.g., during the summer semester QFT I course), on the other hand, I would not recommend you to do the same thing again. There are many other things to do.

### 2. Time ordered perturbation theory [C]

(a) When we learn quantum mechanics for the first time, we learn that for a state with energy  $E_*$ , states with energy level  $E_n$  contribute to the perturbative correction to  $E_*$  by  $\Delta E_* = \sum_n |V_{n*}|^2 / (E_* - E_n)$ , where  $V_{n*} := \langle n | H | * \rangle$  is the perturbation term in the Hamiltonian. This is just one example of general phenomenon that quantum processes give rise to corrections inverse proportional to the virtuality  $(E_* - E_n)$ . How can computations using Feynman diagrams in quantum field theory be consistent with the general principle of quantum mechanics? Discuss in any way you like.

- i. It is OK to read related sections of some QFT textbooks, follow computations and fill gaps between the lines; you can take a photo-copy of your computation notes of that process and submit it as a report. For example, an explanation is found in pp.71–72 of a lecture note by G. Sterman, available in the following

URL.

<http://arxiv.org/abs/hep-ph/9606312>