My Study Notes 2024 / QFT

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In specific circumstances, quantum corrections can destroy symmetries of the classical equations of motion.

4.1 Intuitive Example: The Axial Current in Two Dimensions

A Some notes

A.1 Normalization of Maxwell Lagrangian

The Maxwell lagrangian is the form

$$\mathcal{L} = NF^{\mu\nu}F_{\mu\nu} \tag{A.1}$$

where $F^{\mu\nu} = \partial^\mu A^\nu - \partial^\nu A^\mu$ is a field strength. We will determine the constant N to lagrangian contains the term

$$\mathcal{L} = \frac{1}{2}\dot{A}_1^2 + \frac{1}{2}\dot{A}_2^2 + \frac{1}{2}\dot{A}_3^2 + \cdots \ . \tag{A.2}$$

Now expanding the term $F^{\mu\nu}F_{\mu\nu}$ carefully, we obtain

$$\begin{aligned} F^{\mu\nu}F_{\mu\nu} &= (\partial^\mu A^\nu - \partial^\nu A^\mu)(\partial_\mu A_\nu - \partial_\nu A_\mu) \\ &= 2((\partial^\mu A^\nu)(\partial_\mu A_\nu) - (\partial_\mu A^\nu)(\partial_\nu A_\mu)) \\ &= -2(\dot{A}_1^2 + \dot{A}_2^2 + \dot{A}_3^2) + \cdots \end{aligned} \tag{A.3}$$

and thus, the constant N satisfies the condition $-2N = 1/2$ and $N = -1/4$. That's why we get Maxwell Lagrangian as[*1]

$$\mathcal{L} = -\frac{1}{4}F^{\mu\nu}F_{\mu\nu} \ . \tag{A.4}$$

[*1] aaa