Advanced Topics in the Theory of Fundamental Interactions

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Relevant, Marginal, Irrelevant operators of a relativistic QFT in d dimensions

1. Consider the mass operator for scalar φ, Dirac fermion ψ and vector boson A_μ in d dimensions:

$$m^2\varphi^2 \quad , \qquad m\bar{\psi}\psi \quad , \qquad m^2 A_\mu A^\mu \quad . \tag{1}$$

Can the operators be marginal in some dimension d?

2. Find d such that $(\bar{\psi}\psi)^2$ is marginal.

3. Find d such that $(\varphi)^6$ is marginal.

4. Classify the operator $(\varphi \,\Box\varphi^2)$ for integer d.