

Q1: conceptual exploration

Write 1.5-2 pages answering the following questions in your own words, including examples.

- (a) What is a critical exponent?
- (b) What is the Coleman-Mermin-Wagner theorem?

(Try to impress me with your conceptual sophistication. For each part, don't just copy from one textbook; look up at least two different textbooks and describe the phenomenon in question in your own words.)

Q2: beta functions in Yukawa theory with a pseudoscalar

In the pseudoscalar Yukawa theory described by

$$\mathcal{L} = \frac{1}{2}(\partial\phi)^2 + \bar{\psi}(i\not{\partial})\psi - \frac{\lambda}{4!}\phi^4 - ig\bar{\psi}\gamma_5\psi\phi, \quad (1)$$

compute the Callan-Symanzik β -functions for λ and g , namely

$$\beta_\lambda(\lambda, g) \quad \text{and} \quad \beta_g(\lambda, g), \quad (2)$$

to leading order in coupling constants, assuming that λ and g^2 are of the same order. Sketch the coupling constant flows in the λ - g plane.

(Note: this is a pretty long problem involving one loop diagrams, and it is good preparation for the final exam. So please set aside plenty of time to complete it. To set about finding the beta functions at one loop, you should be computing three propagator corrections, one three-point vertex correction, and two four-point vertex corrections.)
