April the 1st 2026 **Quiz number 5**

Phenomenology of Physics Beyond the Standard Model

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1. SUSY breaking

- Discuss how supersymmetric actions can be built with the superspace and superfields formalism.
- Comment on Figure 1, and explain in which case only gauge symmetry is broken and in which one supersymmetry is broken. Which are the conditions to break supersymmetry ? Which are the conditions to break gauge symmetry and how can supersymmetry explain it ?
- What are the main problems with F-breaking and D-breaking of supersymmetry ?
- In which way can supersymmetry be broken without adding new quadratic divergences ? How can the supersymmetry breaking terms be transferred to the visible sector ?

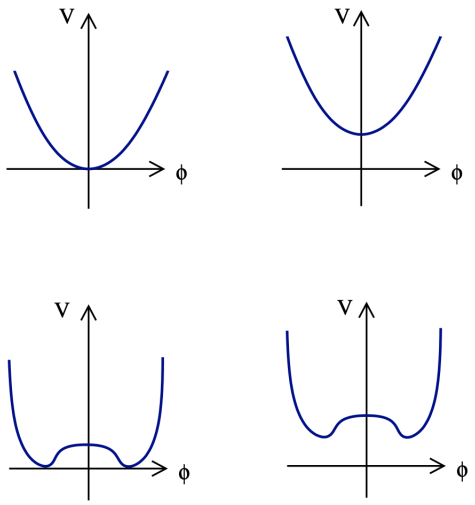


Figure 1: Possible patterns of spontaneous symmetry breaking

2. Vector superfields

Consider a general vector superfield $V(x, \theta, \bar{\theta})$.

- How many off-shell fermionic and bosonic degrees of freedom does $V(x, \theta, \bar{\theta})$ contain ?
- How many on-shell degrees of freedom are necessary for $V(x, \theta, \bar{\theta})$ in order to represent the vector super-multiplet ? What are the requirements needed to reduce the number of degrees of freedom of $V(x, \theta, \bar{\theta})$ only to on-shell ones ?
- In which way can you promote the term $\Phi^\dagger \Phi$ in order to incorporate the vector field $V(x, \theta, \bar{\theta})$ and describe matter-radiation interactions?
- Which are the new interaction terms you get ?