

# Direct DM Detection in SU(2) Chiral Perturbation Theory

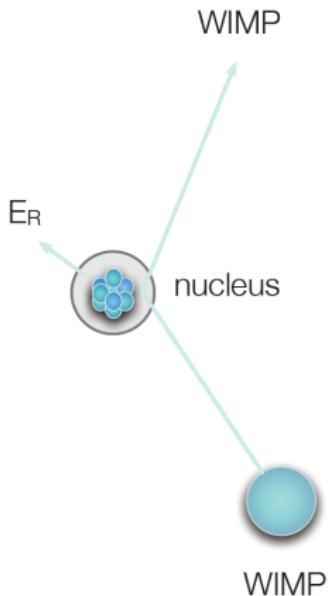
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# Direct DM Detection

- DM-Nucleus scattering
- Momentum transfer:  $p \lesssim 200 \text{ MeV}$
- Aim: diff. cross section  $\frac{d\sigma}{dE_R}$
- How?  $\rightarrow$  Effective Field Theory
- $\mathcal{L} \supset \frac{c_{1,q}^{(6)}}{\Lambda^2} (\bar{\chi} \gamma^\mu \chi) (\bar{q} \gamma_\mu q) + \dots$



# Chiral Perturbation Theory

- Introduce external fields  $s_G, v_\mu, a_\mu, \dots$  in  $\mathcal{L}_{\text{QCD}}$ :

$$\mathcal{L}_{\text{QCD}} \supset \mathcal{L}_{\text{QCD}}^0 + s_G(x) \frac{\alpha_s}{12\pi} G_{\mu\nu}^a G^{a\mu\nu} + \bar{q} \gamma^\mu [v_\mu(x) + \gamma_5 a_\mu(x)] q + \dots$$

- Symmetries: Lorentz invariance,  $SU(2)_L \times SU(2)_R$ ,  $C, P, T$

$$\mathcal{L}_{\text{ChPT}}^{(2)} = \frac{f^2}{4} \text{Tr} [(D_\mu U)^\dagger D^\mu U] + \frac{B_0 f^2}{2} \text{Tr} [(s - ip) U + (s + ip) U^\dagger]$$

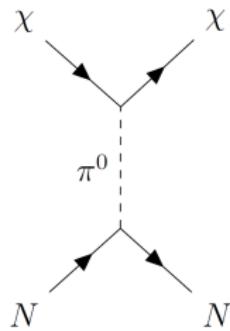
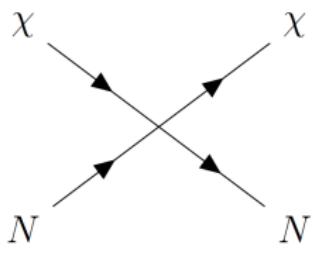
$$U = \exp(i\pi/f) \text{ with } \pi = \begin{pmatrix} \pi^0 & \sqrt{2}\pi^+ \\ \sqrt{2}\pi^- & -\pi^0 \end{pmatrix}$$

# Power Counting

How to determine the leading contributions?

- Power counting:  $M \sim (p/\Lambda_{\text{ChPT}})^\nu$

$$\nu = 4 - A - 2C + 2L + \sum_i V_i \left( d_i + \frac{n_i}{2} - 2 \right)$$



**Thank you for your attention!**

Questions?

- Sources:

- ▶ Laura Baudis: „Principles of direct WIMP detection“
- ▶ Joshua Ellis. „TikZ-Feynman: Feynman diagrams with TikZ“
- ▶ S. Scherer, M. Schindler: „A Chiral Perturbation Theory Primer“