

Effective Field Theory Parameters

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In these notes I define the parameters used to make known the effective field theory interaction used in `dmfortfactor`. As a shorthand, "the code" will refer to the `dmfortfactor` program.

The code uses the EFT coefficients in explicit proton-neutron couplings, i.e. the interaction is defined by:

$$\sum_{x=p,n} \sum_{i=1,15} c_i^x \mathcal{O}_i \tag{1}$$

and the 15 momentum dependent operators are:

$$\mathcal{O}_1 = 1_\chi 1_N \quad (2)$$

$$\mathcal{O}_2 = (v^\perp)^2 \quad (3)$$

$$\mathcal{O}_3 = i\vec{S}_N \cdot \left(\frac{\vec{q}}{m_N} \times \vec{v}^\perp \right) \quad (4)$$

$$\mathcal{O}_4 = \vec{S}_\chi \cdot \vec{S}_N \quad (5)$$

$$\mathcal{O}_5 = i\vec{S}_\chi \cdot \left(\frac{\vec{q}}{m_N} \times \vec{v}^\perp \right) \quad (6)$$

$$\mathcal{O}_6 = \left(\vec{S}_\chi \cdot \frac{\vec{q}}{m_N} \right) \left(\vec{S}_N \cdot \frac{\vec{q}}{m_N} \right) \quad (7)$$

$$\mathcal{O}_7 = \vec{S}_N \cdot \vec{v}^\perp \quad (8)$$

$$\mathcal{O}_8 = \vec{S}_\chi \cdot \vec{v}^\perp \quad (9)$$

$$\mathcal{O}_9 = i\vec{S}_\chi \cdot \left(\vec{S}_N \times \frac{\vec{q}}{m_N} \right) \quad (10)$$

$$\mathcal{O}_{10} = i\vec{S}_N \cdot \frac{\vec{q}}{m_N} \quad (11)$$

$$\mathcal{O}_{11} = i\vec{S}_\chi \cdot \frac{\vec{q}}{m_N} \quad (12)$$

$$\mathcal{O}_{12} = \vec{S}_\chi \cdot \left(\vec{S}_N \times \vec{v}^\perp \right) \quad (13)$$

$$\mathcal{O}_{13} = i \left(\vec{S}_\chi \cdot \vec{v}^\perp \right) \left(\vec{S}_N \cdot \frac{\vec{q}}{m_N} \right) \quad (14)$$

$$\mathcal{O}_{14} = i \left(\vec{S}_\chi \cdot \frac{\vec{q}}{m_N} \right) \left(\vec{S}_N \cdot \vec{v}^\perp \right) \quad (15)$$

$$\mathcal{O}_{15} = - \left(\vec{S}_\chi \cdot \frac{\vec{q}}{m_N} \right) \left(\left(\vec{S}_N \times \vec{v}^\perp \right) \cdot \frac{\vec{q}}{m_N} \right) \quad (16)$$

Each of these operators as written has one of several different sets of dimensions. To match, each operator coefficient must therefore have a conjugate set of dimensions to bring $c_x^i \mathcal{O}_i$ to the proper di-

dimensionality. The code reads the 15 coefficients c_x^i as dimensionless parameters which here we will label a_x^i . The appropriate scaling factors are then added by a combination of the WIMP-mass m_χ , the target-nucleus-mass m_N , and a standard-model weak interaction mass scale $m_v = 246.2$ GeV.

The 5 parameters with dimension 1 are (1, 4, 7, 8, 12):

$$c_{1,4,7,8,12}^x = \frac{4m_N m_\chi}{m_v^2} a_{1,4,7,8,12}^x \quad (17)$$

$$(18)$$

The 2 parameters with dimension $1/\text{GeV}$ are (6, 15):

$$c_{6,15}^x = \frac{4m_\chi}{m_v^2} a_{6,15}^x \quad (19)$$

$$(20)$$

The 7 parameters with dimension $1/\text{GeV}^2$ are (3, 5, 9, 10, 11, 13, 14):

$$c_{3,5,9,10,11,13,14}^x = \frac{4m_\chi}{m_N m_v^2} a_{3,5,9,10,11,13,14}^x \quad (21)$$

$$(22)$$