# Effective Field Theory for Halo Nuclei: Lecture 2

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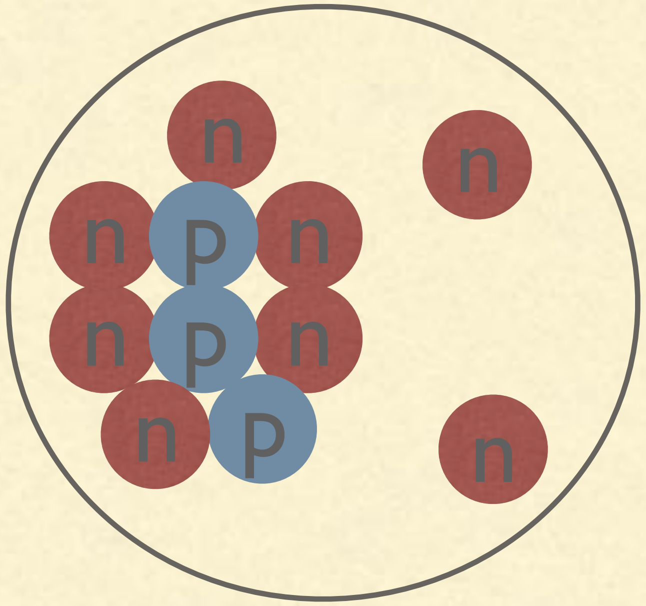
# Halo EFT



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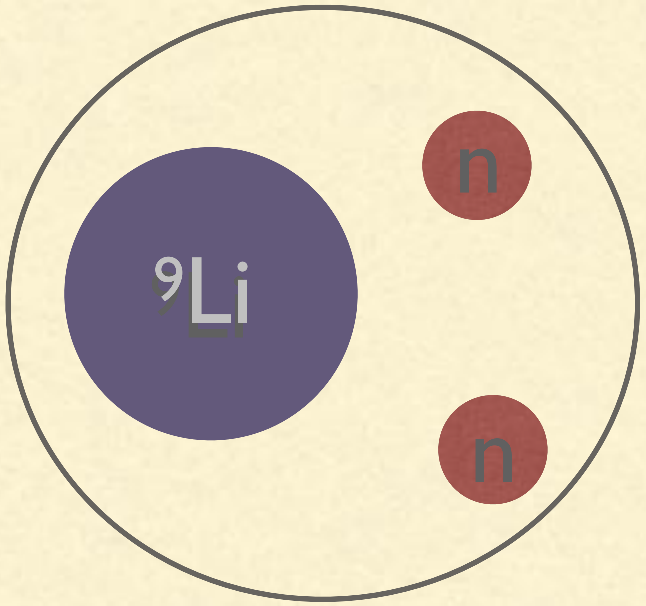

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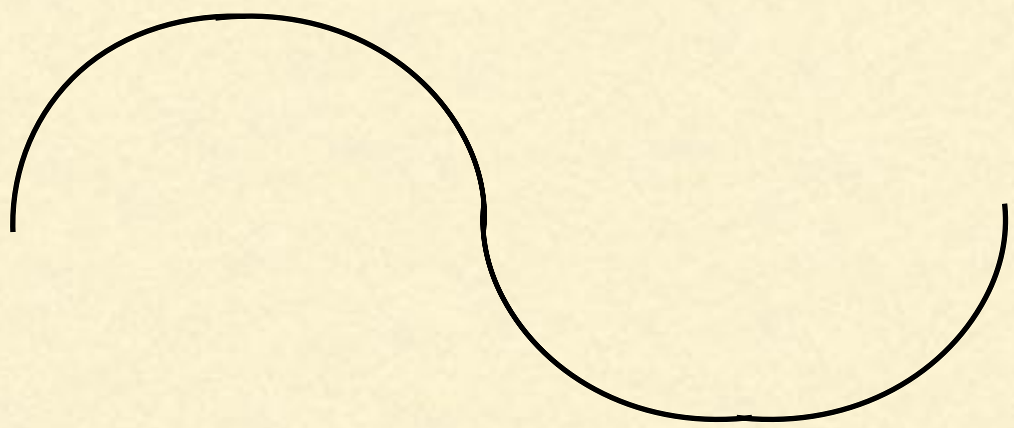

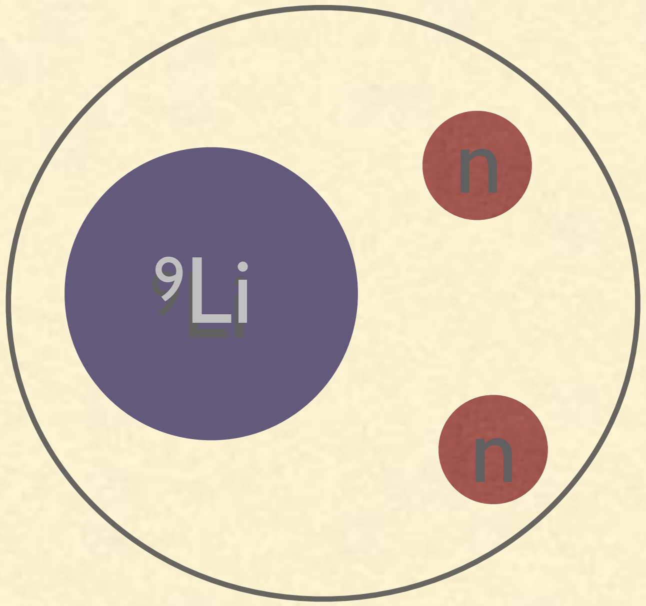

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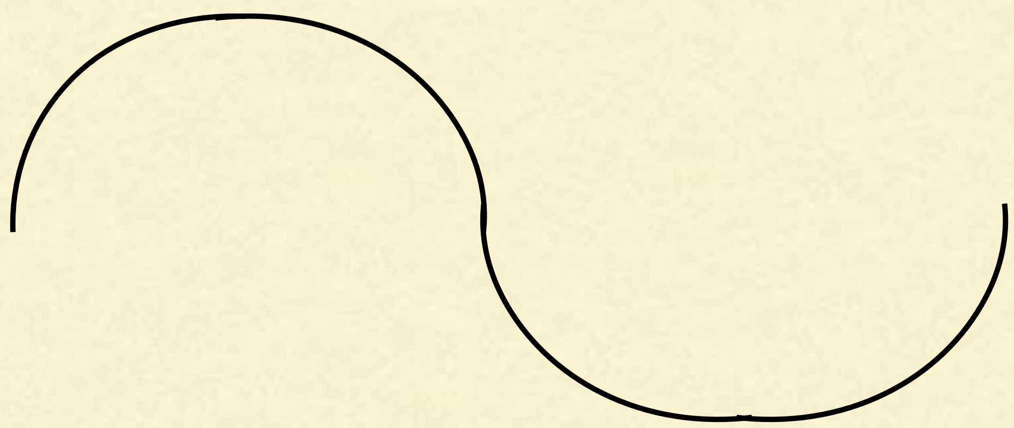

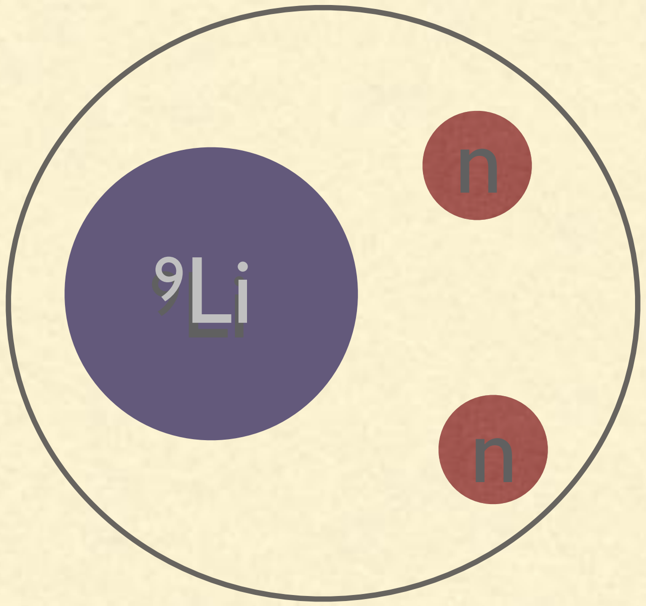


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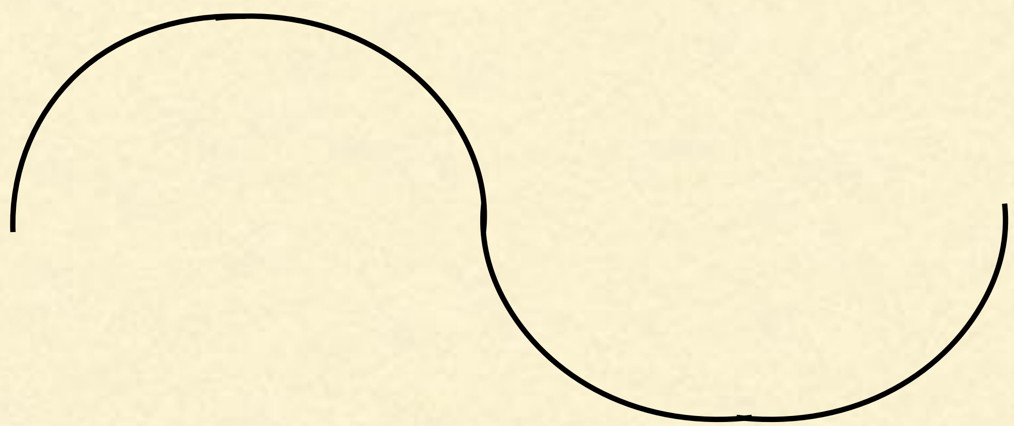

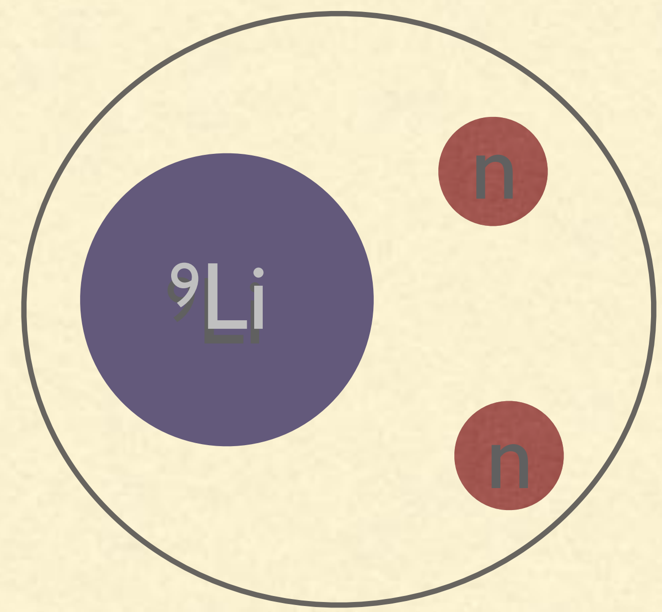


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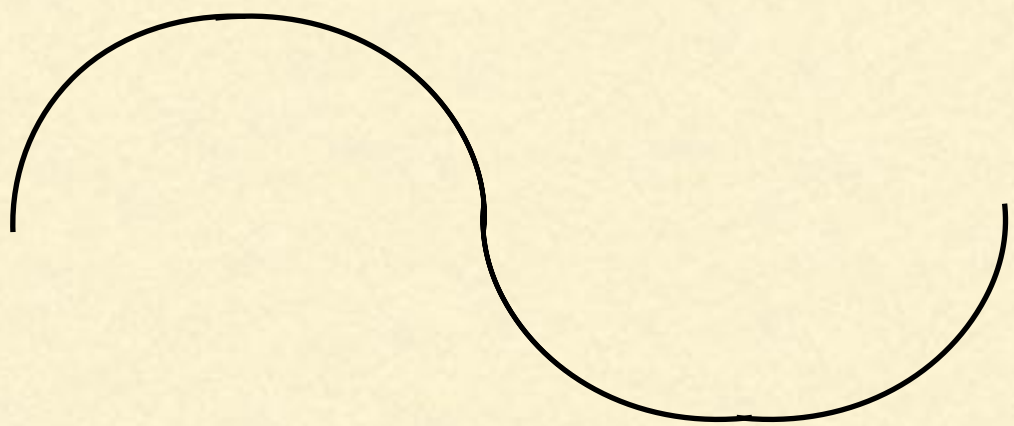

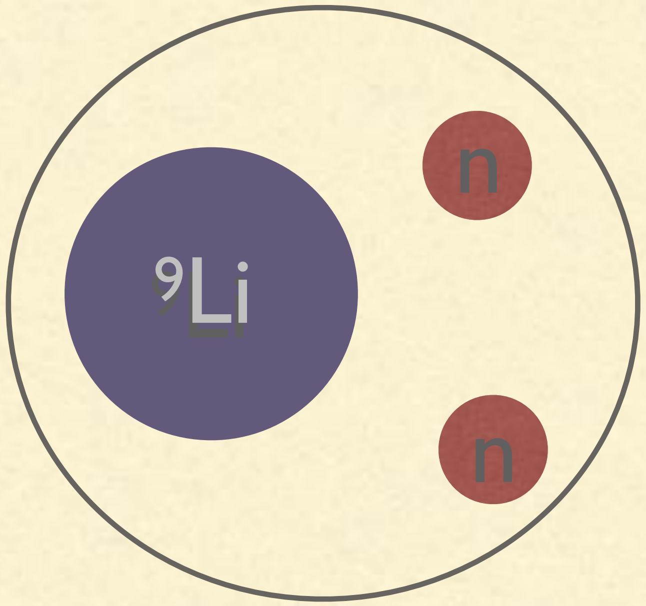


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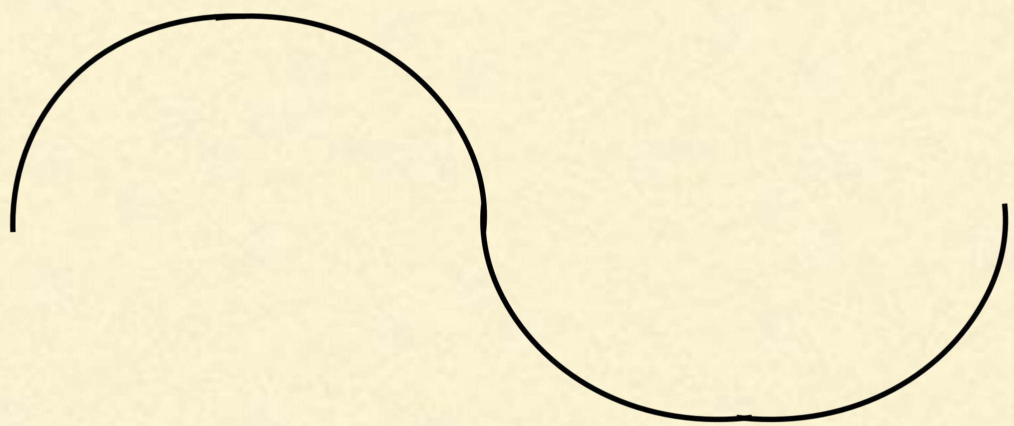

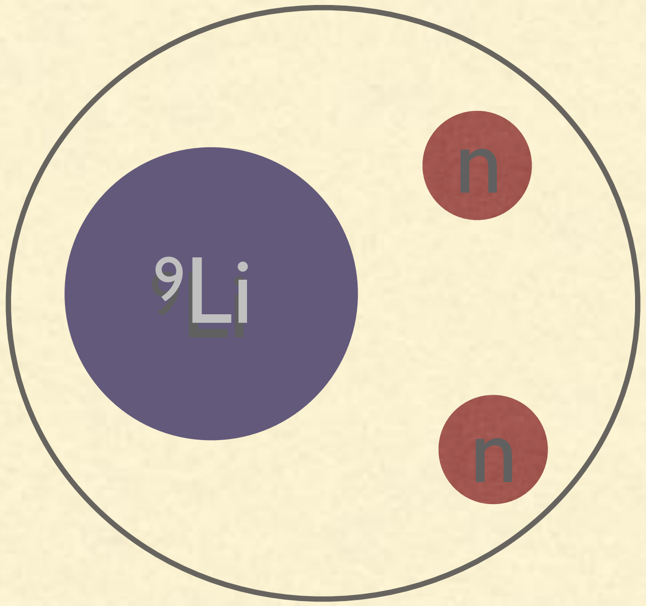


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- $^{22}C$, $^{11}Li$, $^{12}Be$, $^{62}Ca$ (hypothesized), and $^{3}H$: all s-wave 2n halos

# EFT for shallow S-wave states

$$\mathscr{L} = c^\dagger\left(iD_t + \frac{D^2}{2M_c}\right)c + n^\dagger\left(iD_t + \frac{D^2}{2M_n}\right)n$$
$$+d^\dagger\left[\eta\left(iD_t + \frac{D^2}{2M_{nc}}\right) + \Delta\right] - g(\sigma^\dagger nc + n^\dagger c^\dagger \sigma)$$

- c, n: "core", "neutron" fields. c: spin-0 boson, n: spin-1/2 fermion.
- d: S-wave "dimer" field

$$t_0^{LO}(E) = \frac{2\pi a_0}{m_R}\frac{1}{1 + ia_0 k}$$

$$k^2 = 2m_R E$$

$$t_0^{NLO}(E) = -\frac{2\pi}{m_R}\frac{1}{-\frac{1}{a_0} + \frac{1}{2}r_0 k^2 - ik}$$

# Questions for discussion

1. Is this t a number or an operator? What is its momentum space representation?
2. Does this t-matrix have poles? How many? What do they represent?
3. You computed Z for the t-matrix. What is $Z_d$ for the dimer propagator?
4. How is t related to the Green's function $G(E) = \dfrac{1}{E - H}$?
5. Can you extract the (momentum-space) wave function from your answer for G?
6. What co-ordinate space wave function does that correspond to?

**See Prof. Hammer's Exercise 10 for full solution**