CORIOLIS INTERACTIONS IN ODD-ODD PROTON EMITTERS

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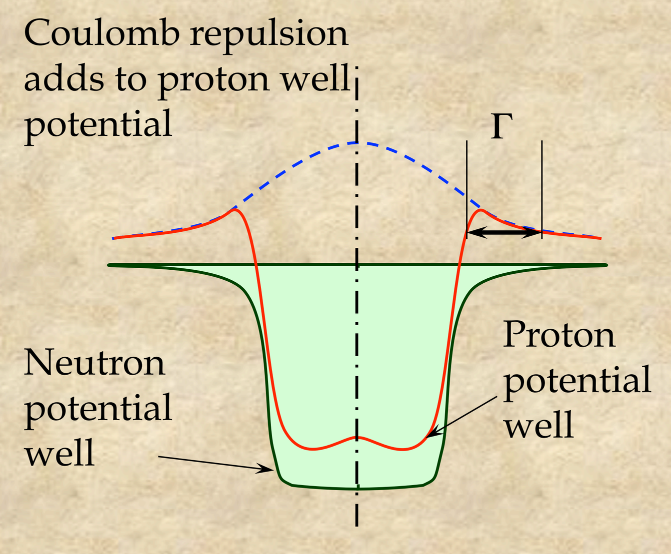
Introduction

- Proton emission is a process of nuclear decay where a proton is emitted spontaneously.
- This decay is through quantum tunneling.
- Coulomb repulsion sets the barrier for the proton to penetrate.
- Decay proceeds from a single-particle Nilsson resonance of the unbound proton with respect to the core.
- Centrifugal barrier is also important.



Motivation

- Exact calculations with nonadiabatic quasiparticle method provided a more complete and consistent description of proton emission in agreement with the experimental data for odd-A deformed nuclei.
- It will be interesting to see whether the success could be carried forward to describe odd-odd deformed proton emitters
- Non-adiabatic qp calculations for odd-odd deformed proton emitting nuclei are carried out for the first time

Theoretical framework

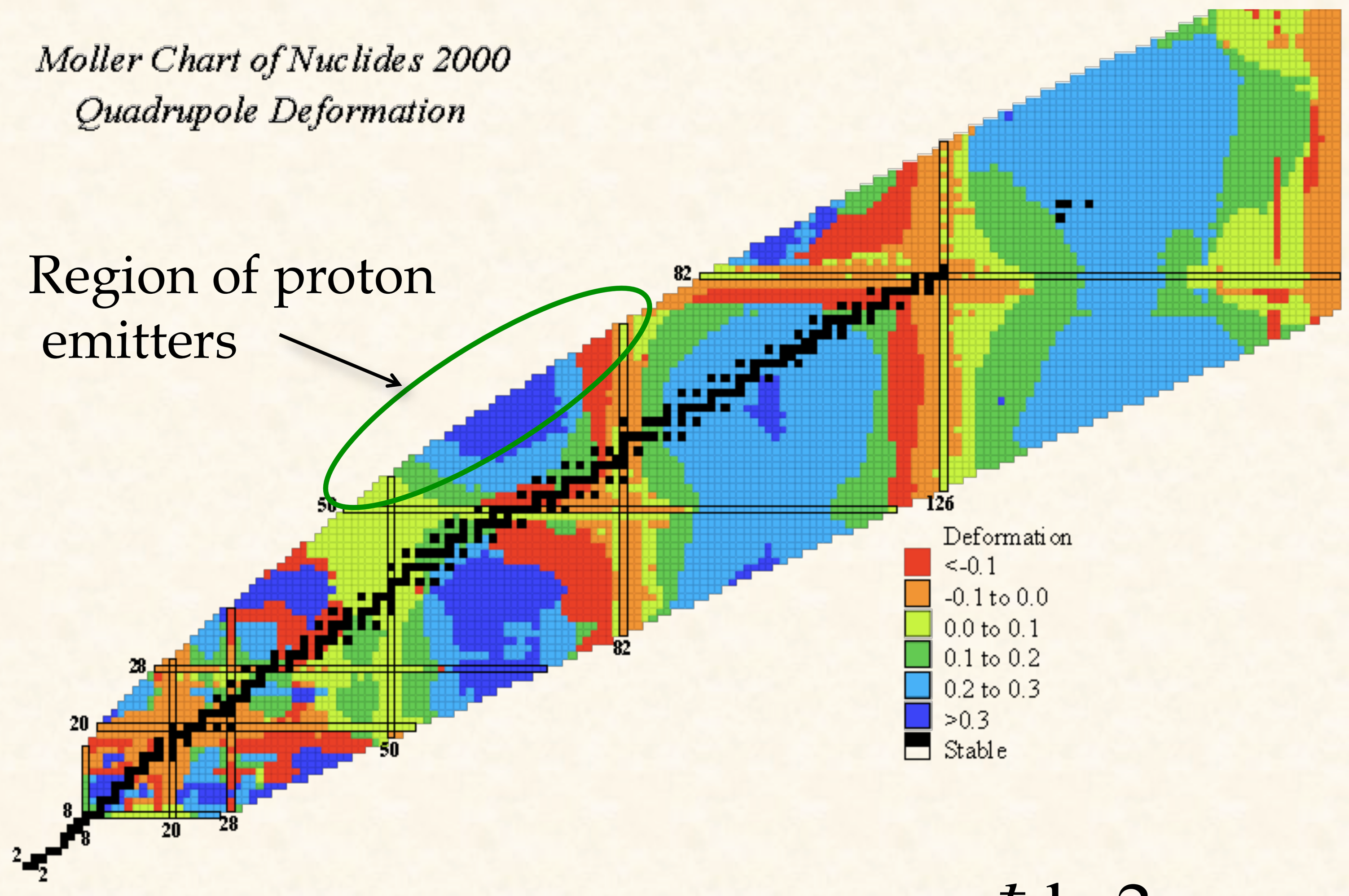
- Two quasiparticle (qp) plus rotor model based on mean field of Woods-Saxon potential (β_2,β_4) with deformed spin-orbit term is used.
- The complete Hamiltonian can be expressed as sum of intrinsic and rotational energies as shown below:

$$H = H_{in} + H_{rot}$$

$$H_{rot} = \frac{\hbar}{2\Im}(I^2 - I_3^2) + H_{cor} + H_{ppc} + H_{irrot} \qquad H_{ppc} = \frac{\hbar}{2\Im}(j_p^+ j_n^- + j_p^- j_n^+)$$

$$H_{cor} = \frac{\hbar}{2\Im}(I^+ j^- + I^- j^+) \qquad H_{irrot} = \frac{\hbar}{2\Im}[(j_p^2 - j_{pz}^2) + (j_n^2 - j_{nz}^2)]$$

- Residual pairing interaction are dealt within constant BCS approach.
- Coriolis mixed wavefunction of parent and daughter nuclei are considered.
- Decay width is obtained from the overlap of the parent wavefunction with tensorial product of daughter and emitted proton.

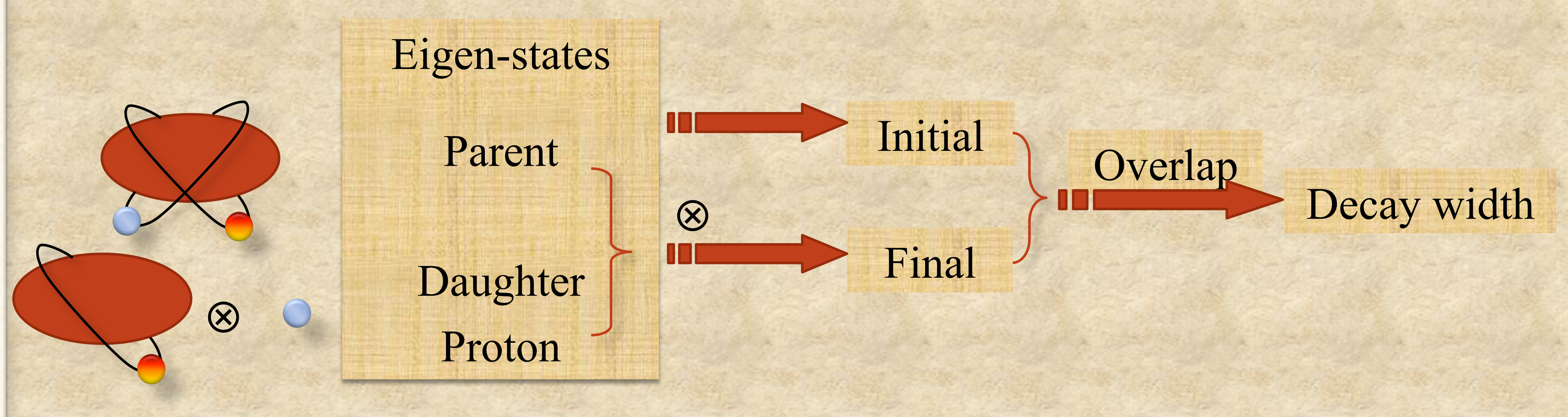


Half-lives → $T_{1/2} = \dfrac{\hbar \ln 2}{\Gamma}$

The calculated half-live values for ^{112}Cs from the probable ground state spin $I^\pi = 3^+$.

Theory	β_2 = 0.20		β_2 = 0.22	
	β_4 = 0	β_4=0.067	β_4= 0	β_4= 0.067
Adiabatic	0.46	0.53	0.47	0.54
Nonadiabatic				
ρ = 0.5	0.62	0.69	0.62	0.91
ρ = 0.6	0.84	0.70	0.72	0.92
Experiment				0.5(1) ms

Decay width



$$\Gamma_{l_p, j_p}^{I, I_d}(r) = \frac{\hbar k}{\mu} \left| \sum_{K_n, K_p, K_T = K_n \pm K_p} a_{K_T, K_n, K_p}^{I,M} a_{K_n}^{I_d, M_d} \times \sqrt{\frac{(2I_d+1)}{(2I+1)}} \langle I_d, K_n, j_p, K_p | I, K_T \rangle u_{k_p} \frac{\phi_{j_p, K_p}^p(r)}{G_{l_p} + iF_{l_p}} \right|^2$$

Results

- Half-lives of ^{112}Cs are considerably affected by Coriolis mixed wavefunctions of parent and daughter nuclei.
- Good agreement with experimental value can be seen from the table at predicted deformation by Moller and Nix
- In conclusion, we have extended the nonadiabatic approach for the calculation of half-lives of odd-odd proton emitters.

References

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