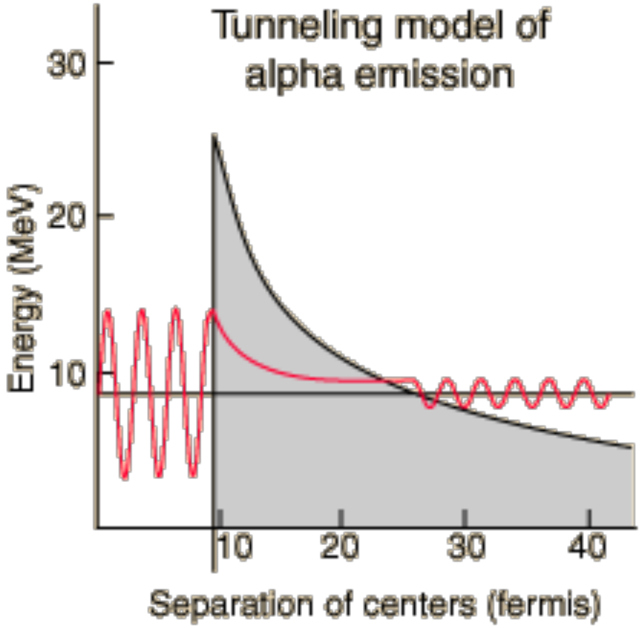
$$P = \frac{|\chi_{III}|^2}{|\chi_I|^2} \propto \exp\left[-2\int_{r_1}^{r_2} k(r)\,dr\right] \qquad T \propto \frac{1}{P}$$



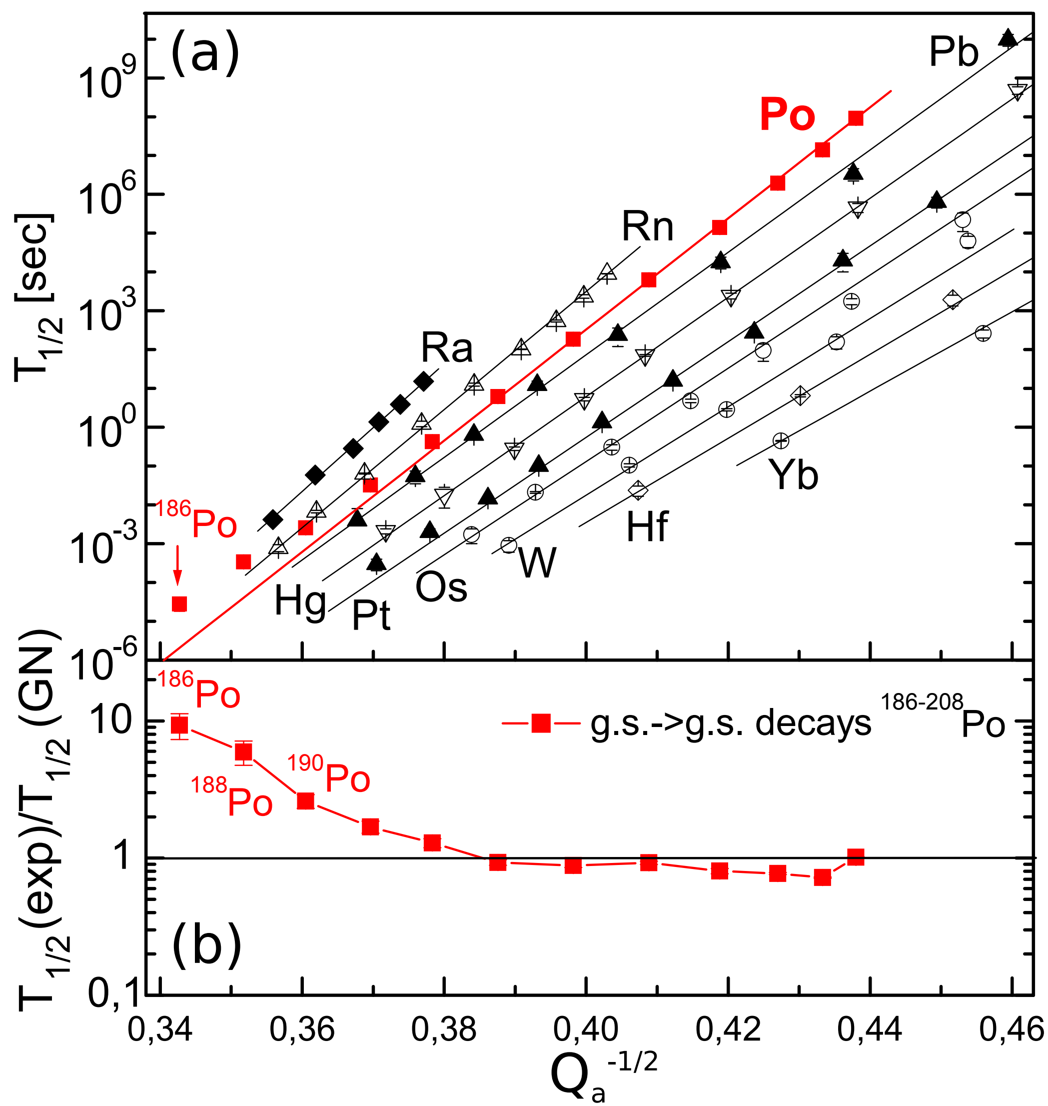
In the case of the Coulomb barrier, the above integral can be evaluated exactly.

$$\log T = a + \frac{b}{\sqrt{Q_\alpha}}$$

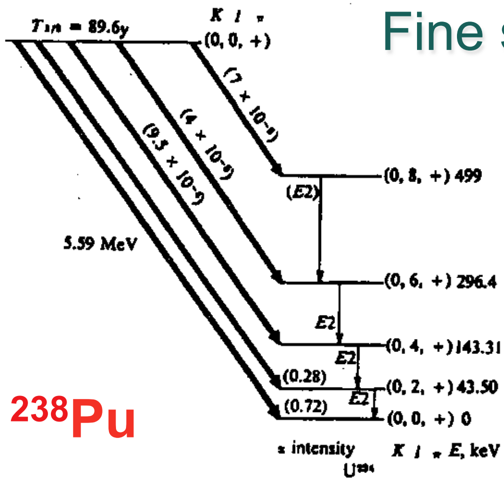
Geiger-Nuttall law of alpha decay 1911

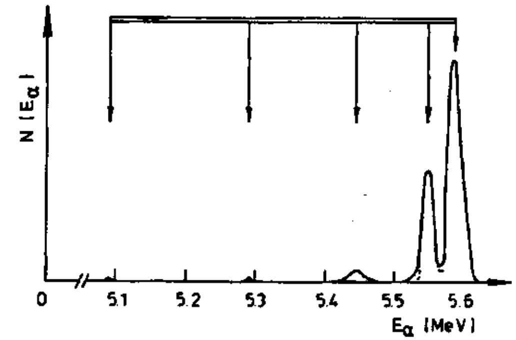
EC10: For the Coulomb barrier above, derive the Geiger-Nuttall law. Assume that the energy of an alpha particle is $E=Q_\alpha$, and that the outer turning point is much greater than the potential radius.

Phys. Lett. B 734 203 (2014)



Fine structure in alpha decay

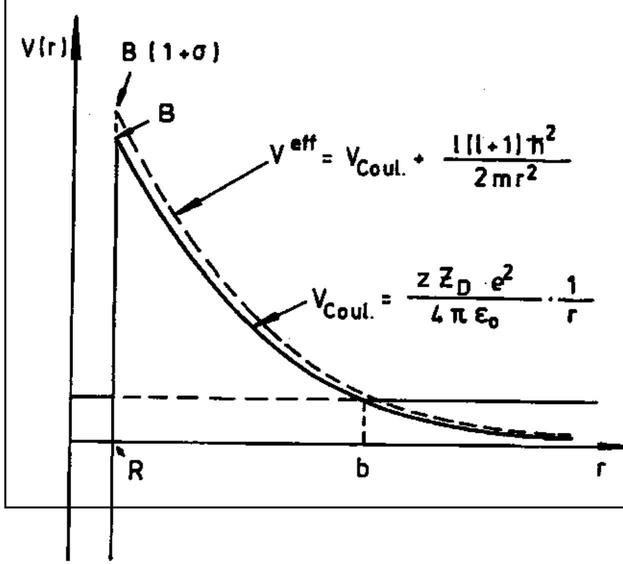




centrifugal barrier effect

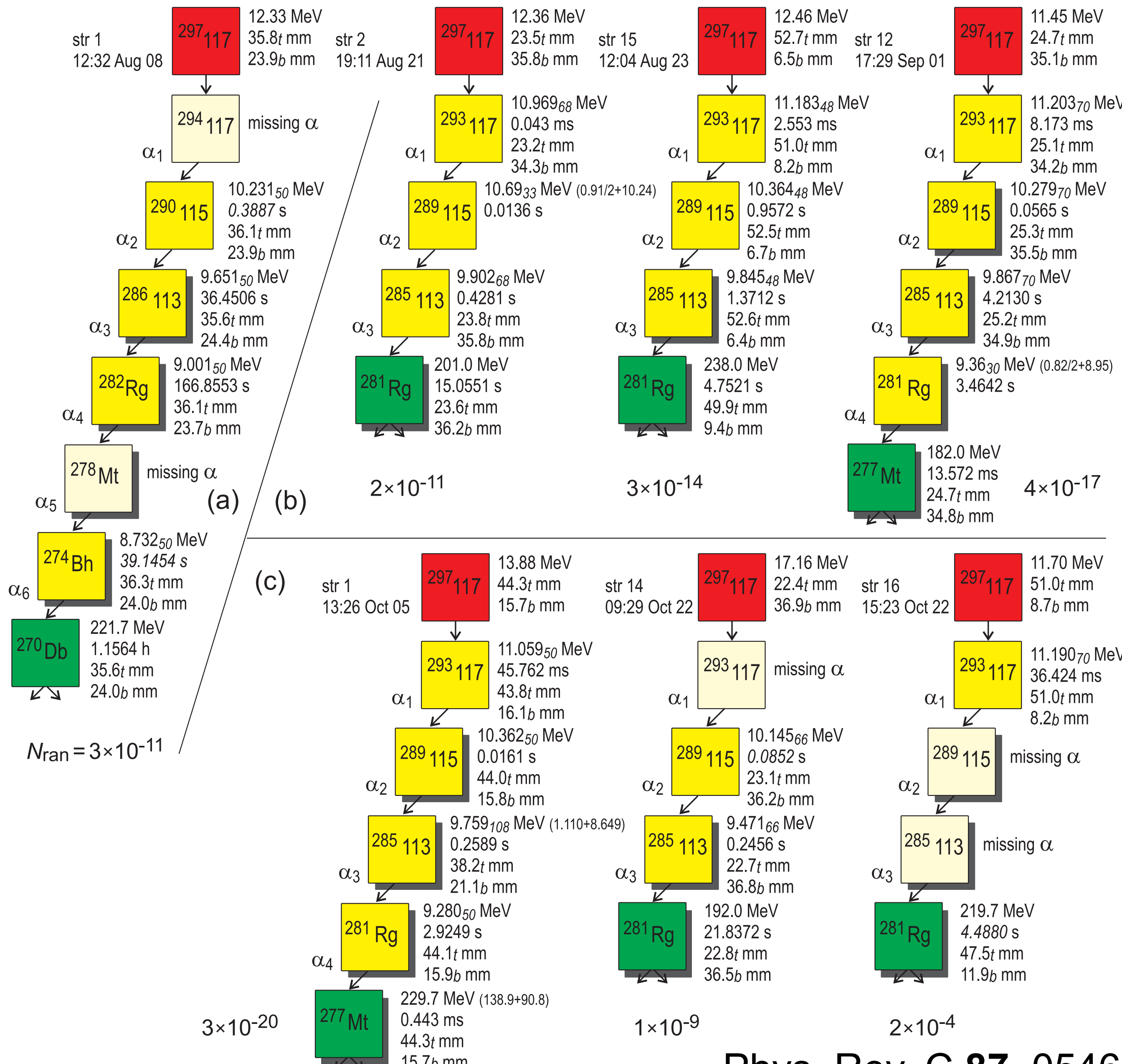
One still has to consider:

- alpha-particle formation
- angular momentum of alpha particle (centrifugal barrier effect)



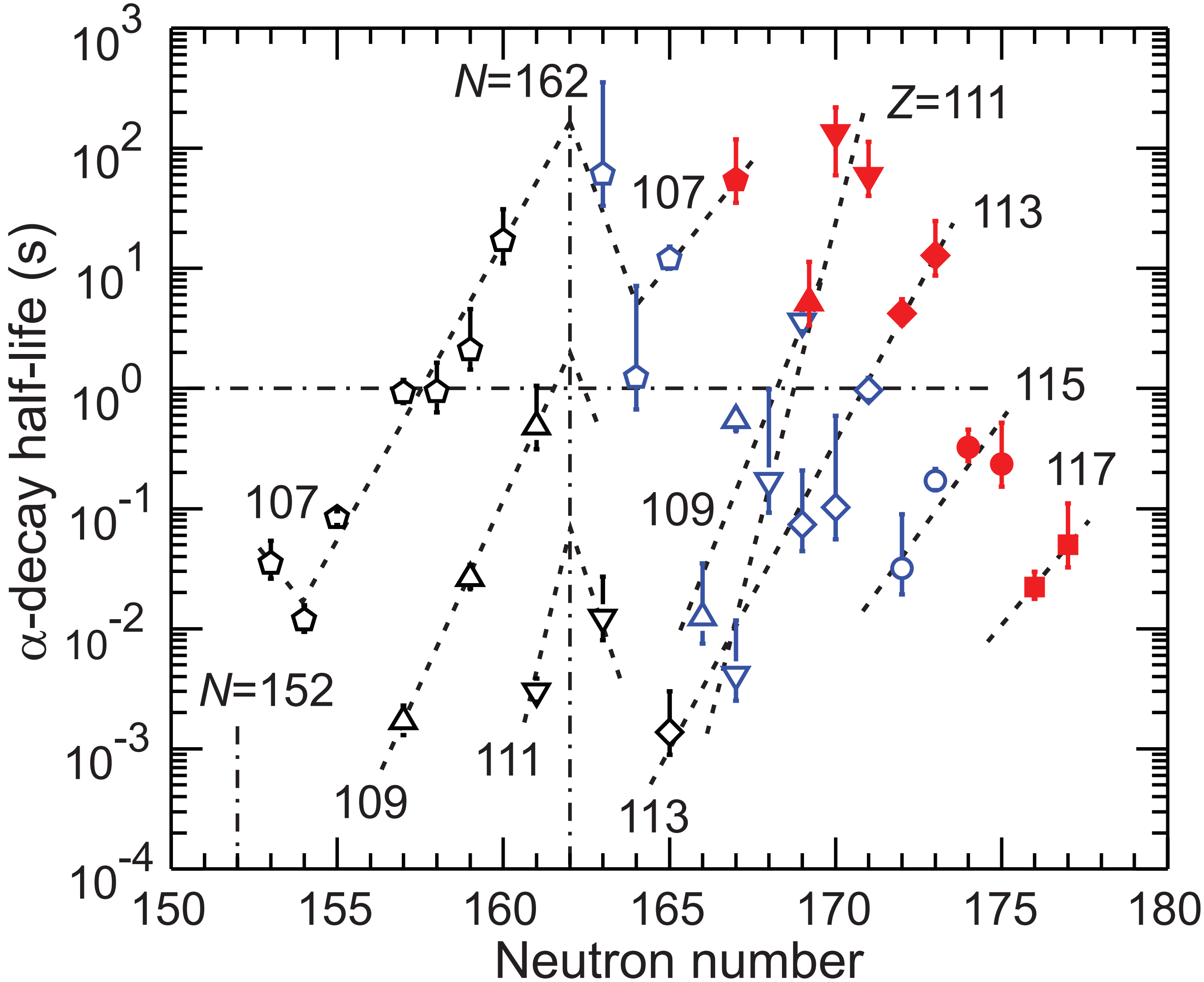
ℓ	$\frac{\lambda_\alpha(\ell)}{\lambda_\alpha(\ell=0)}$
0	1
1	0.7
2	0.37
3	0.137
4	0.037
5	7.1×10^{-3}
6	1.1×10^{-3}

Superheavy element alpha decays



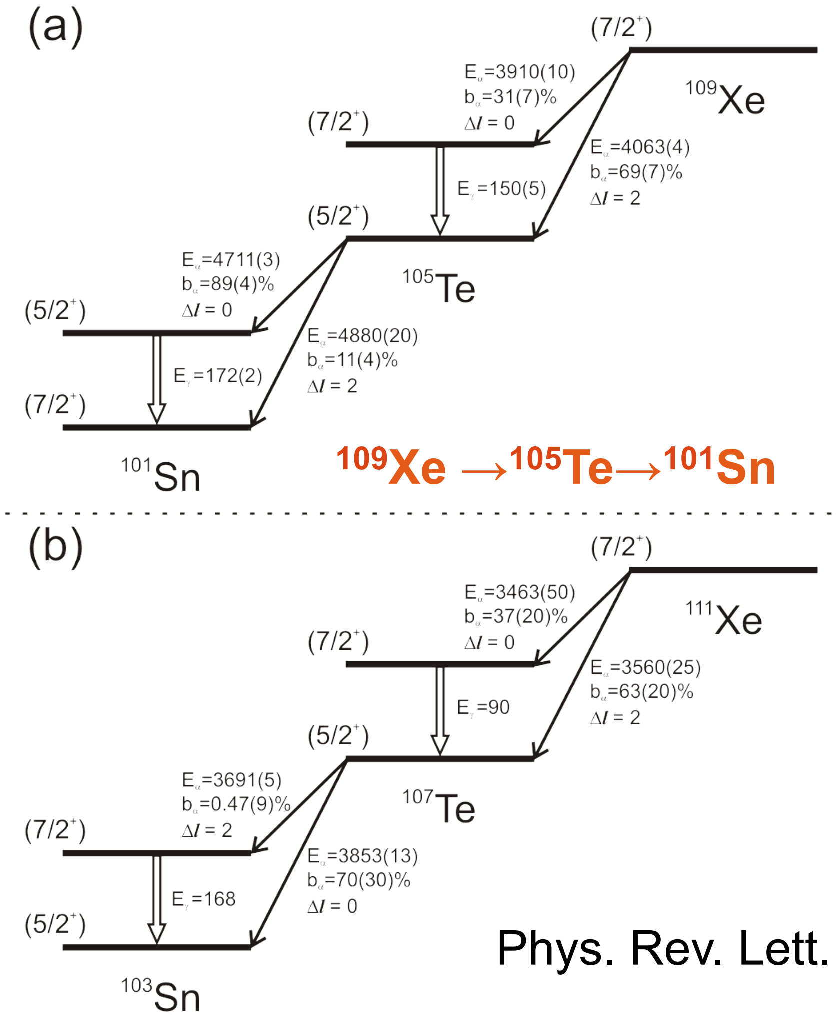
Phys. Rev. C **87**, 054621 (2013)

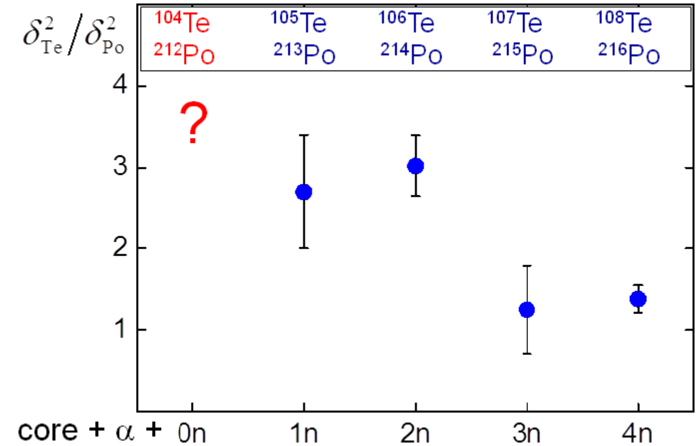
Superheavy element alpha decays



Phys. Rev. C **87**, 054621 (2013)

Superallowed alpha decays

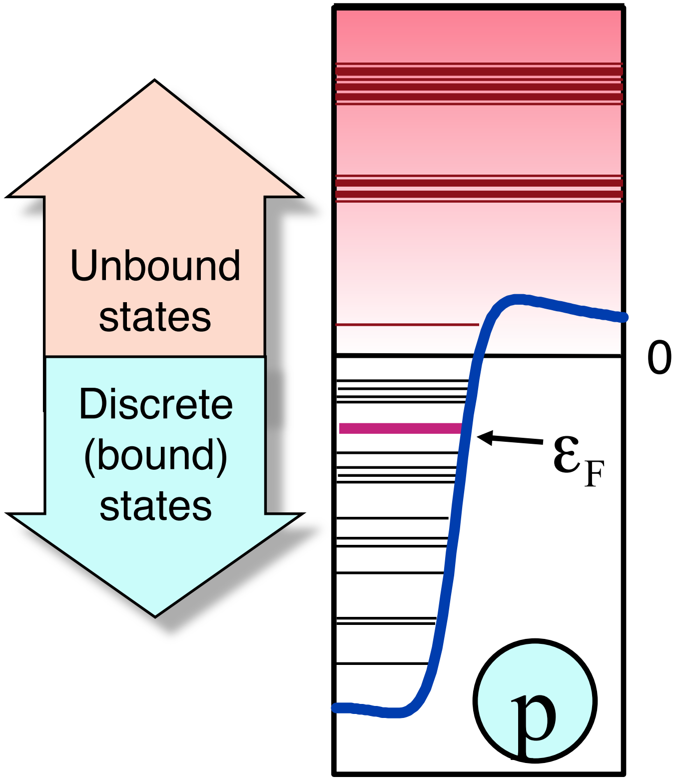


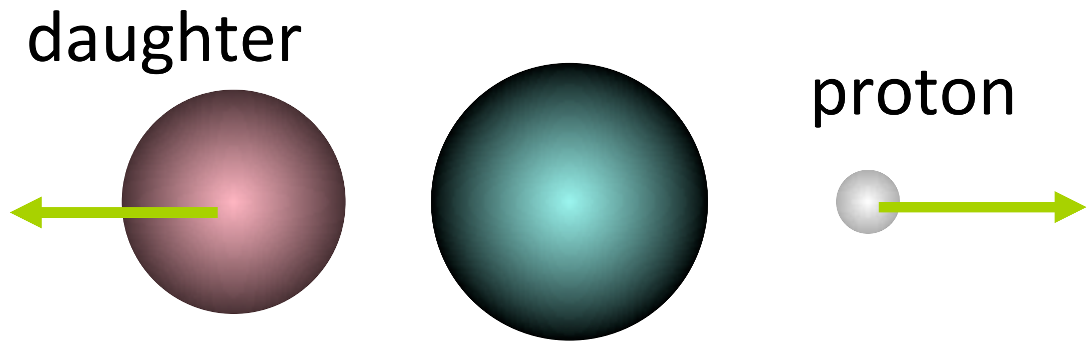


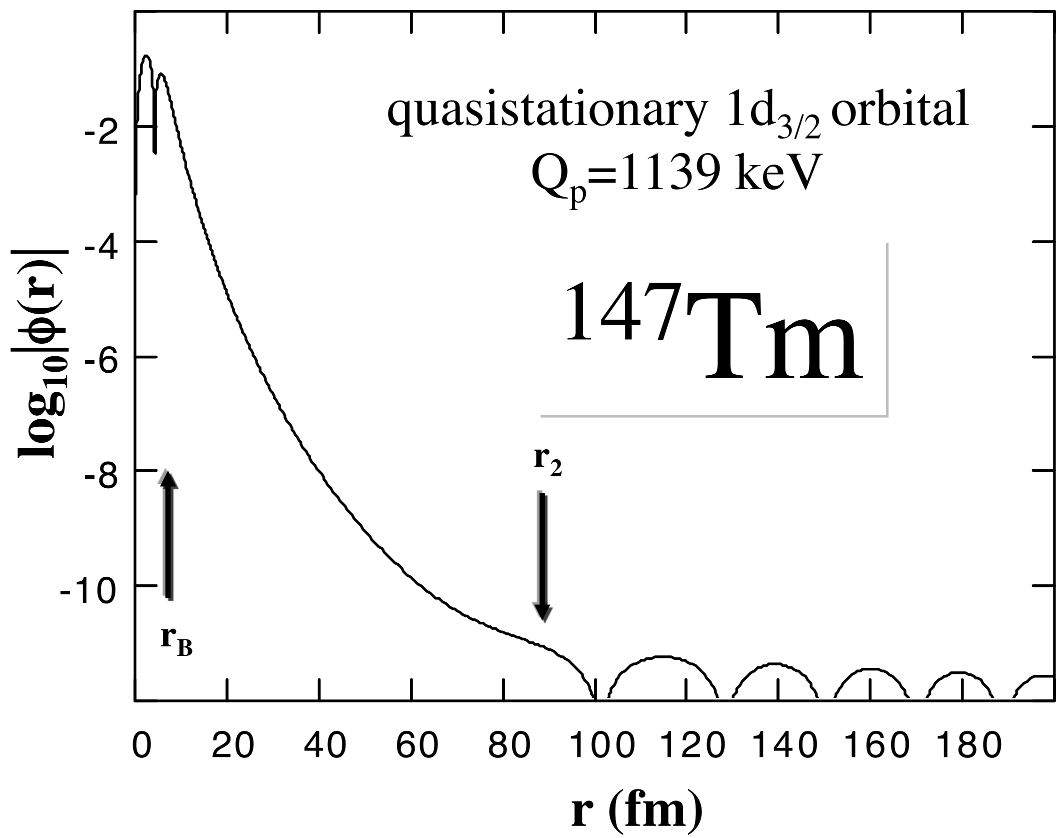
The inversion of the ground-state spins between ^{103}Sn and ^{101}Sn is due to the strong pairing interaction between $g_{7/2}$ valence neutrons.

Phys. Rev. Lett. 105, 162502 (2010)

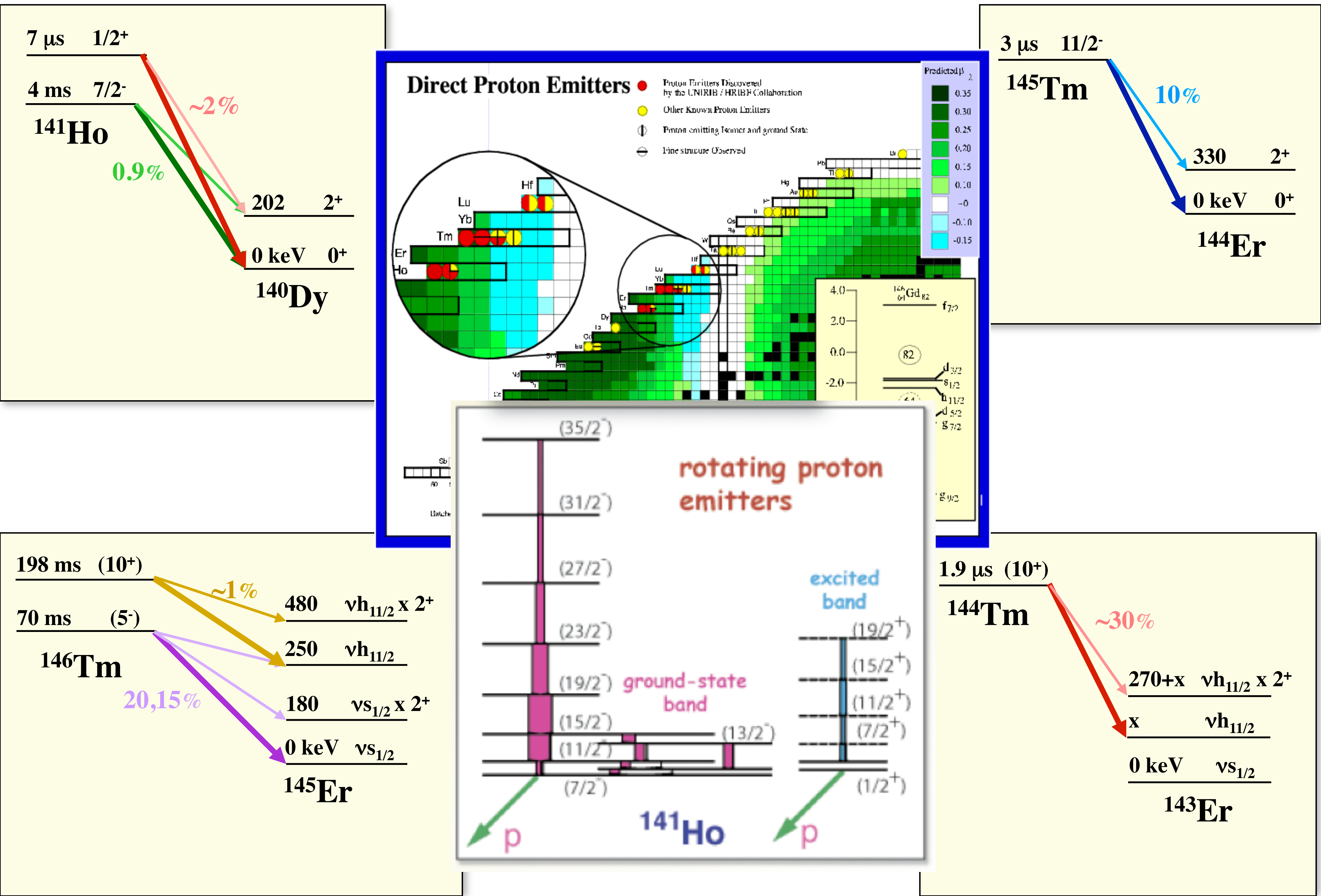
Proton emitters







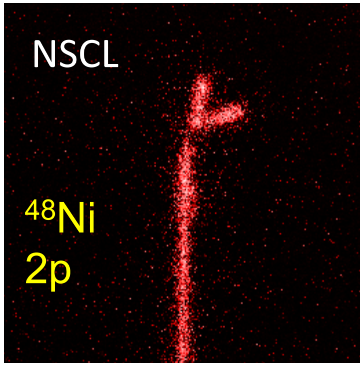
Proton emission

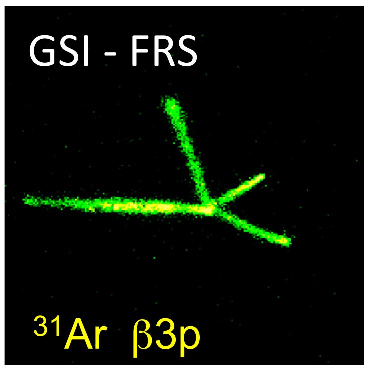


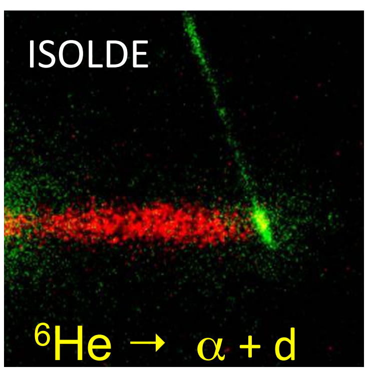
The landscape of two-proton radioactivity

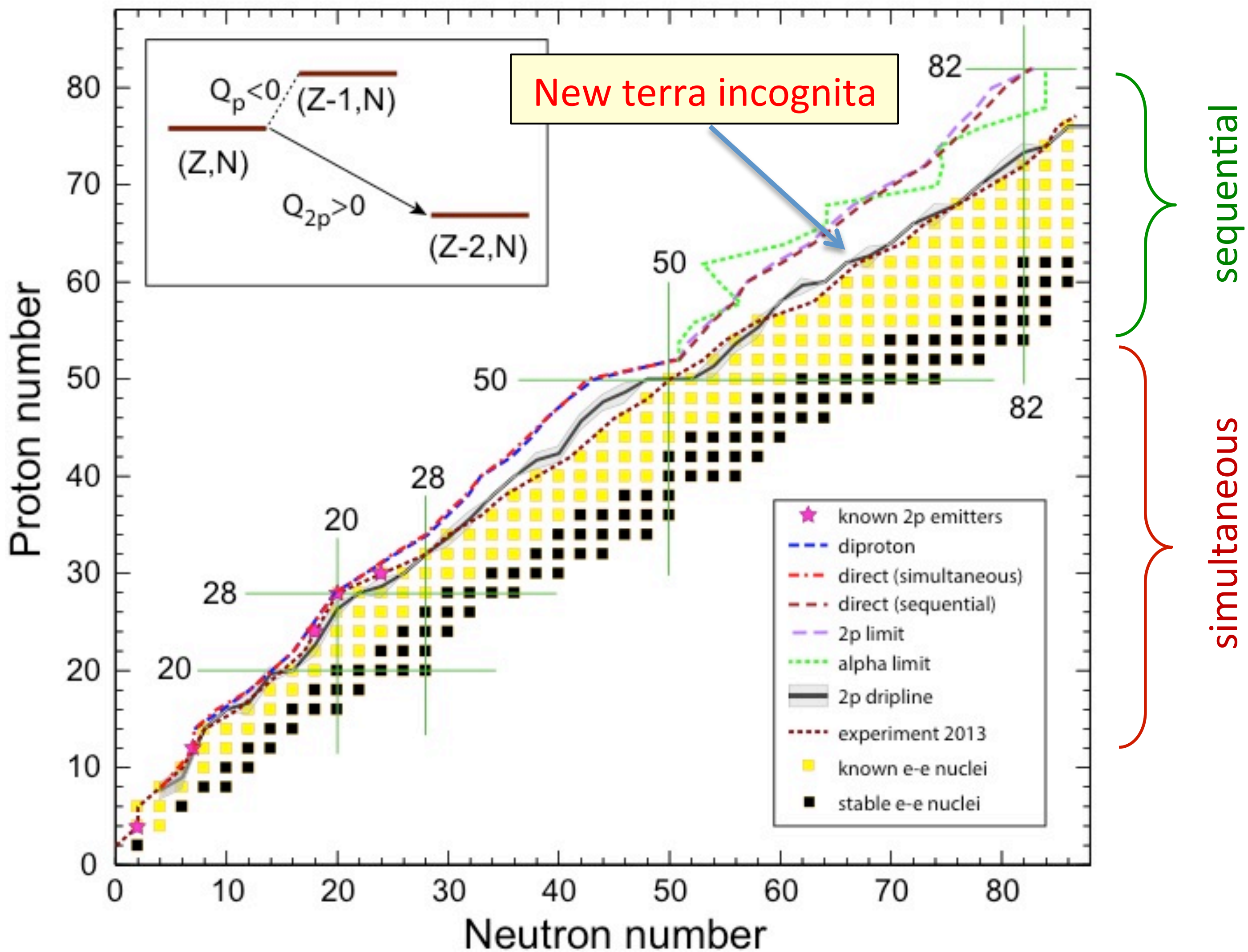
E. Olsen et al,

PRL 111, 139903 (2013); E: PRL 111, 139903 (2013)

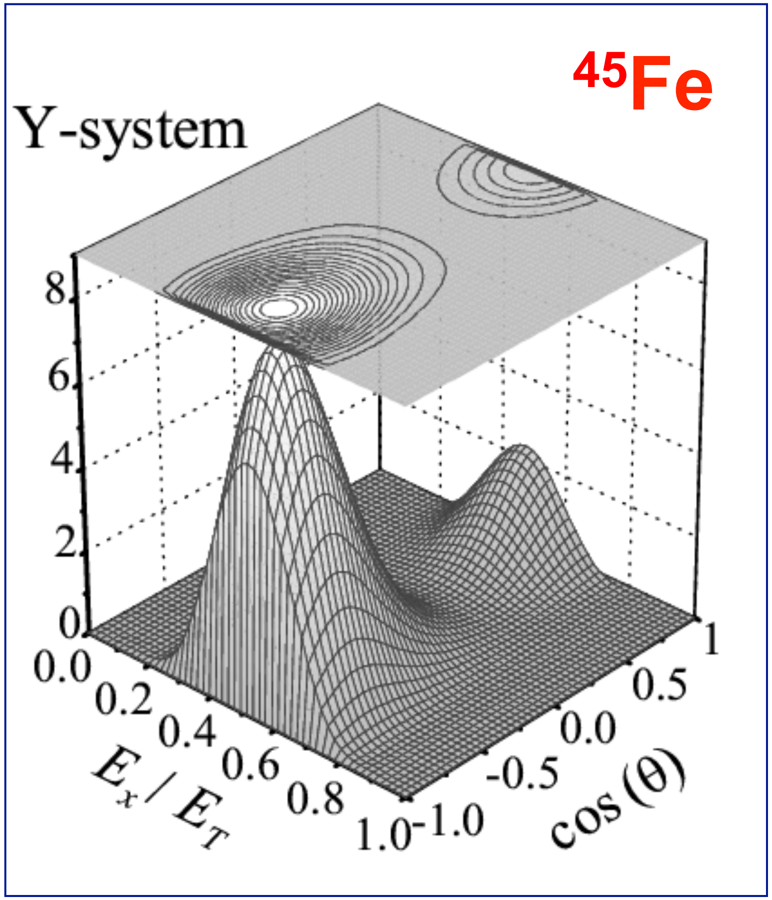


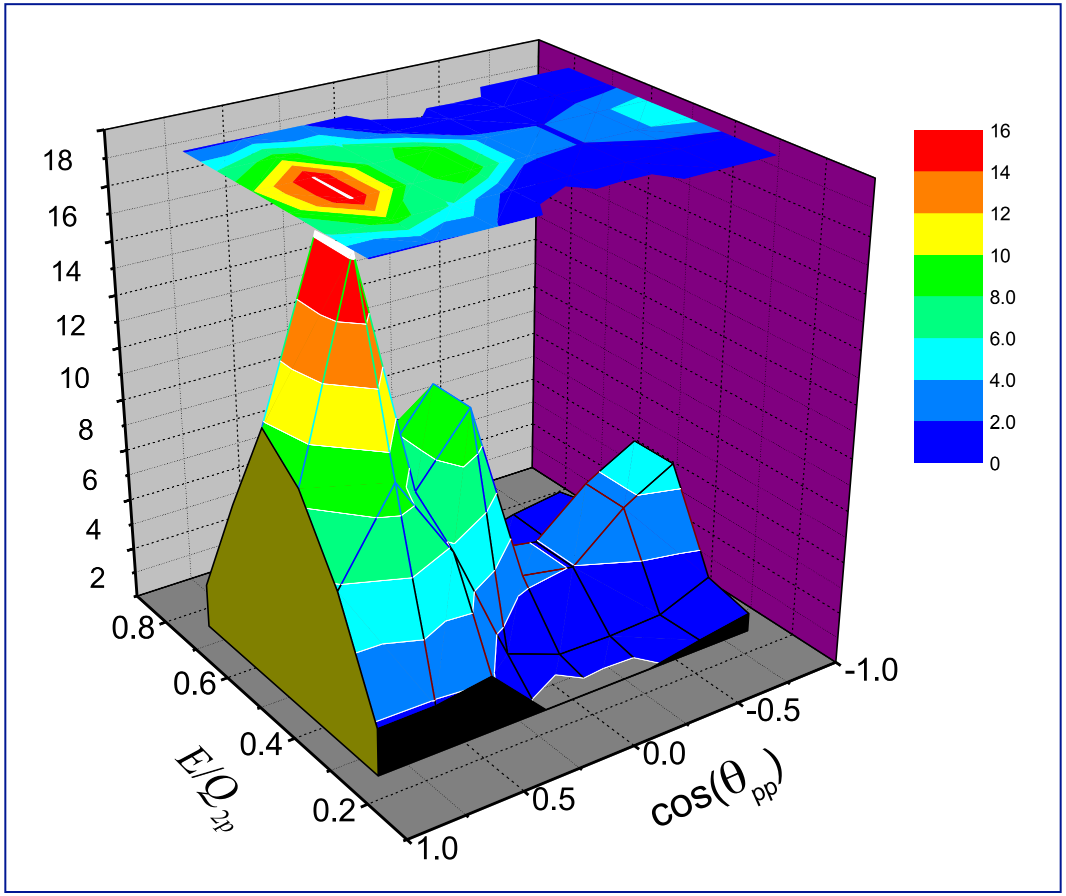






Energy - angle 2D correlation





3-body model prediction

Experiment