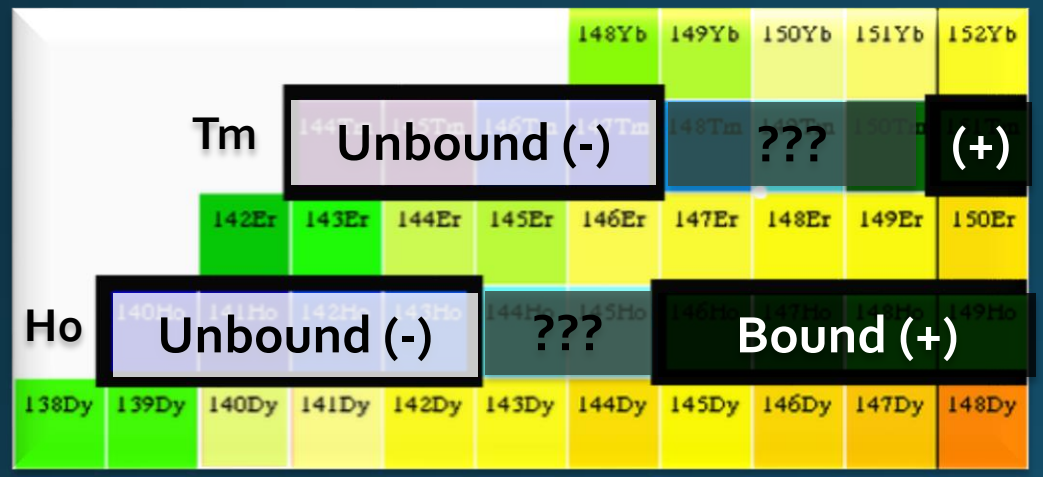
Penning Trap Mass Measurements Beyond the Proton Drip Line



nndc.bnl.gov

What are the limits of nuclear binding?
$S_p > 0$ proton bound
$S_p < 0$ proton unbound

So just look for proton emission, right? Not always good enough!

- Coulomb barrier delays proton emission
- β decay can dominate

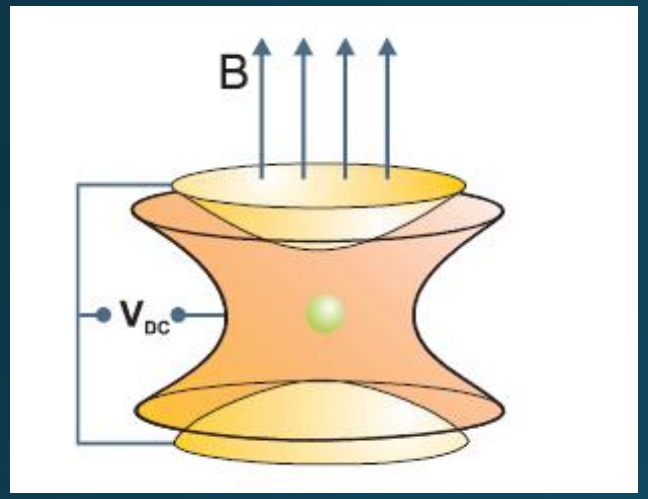
Can use mass differences instead!

$$S_p = B(Z,N) - B(Z-1,N)$$
$$= -M(Z,N) + M(Z-1,N) + M_H$$

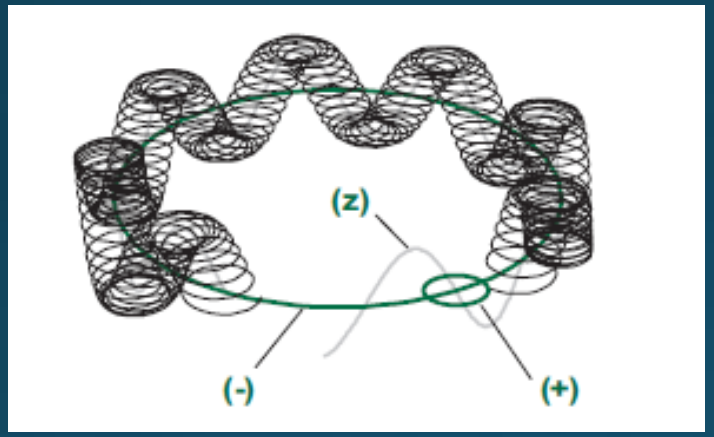
C. Rauth et al., PRL **100**, 012501 (2008)

M. Thoennessen, Rep. Prog. Phys. **67**, 1187 (2004)

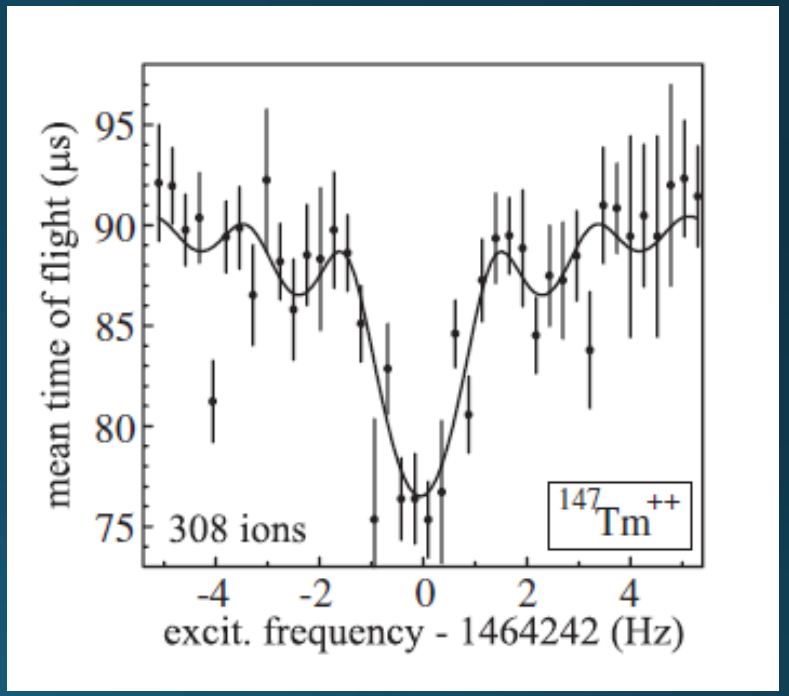
Penning Traps



- Uniform magnetic field (7T)
- Quadrupolar electrostatic field



resulting ion motion



Resonance!

$$\text{Cyclotron Frequency } \omega_c = \omega_+ + \omega_- = \frac{qB}{m}$$

G. Bollen, LNP **651** (2004) 169

Conclusion: More Certain Knowledge of Proton Drip Line!

Nuclide	$T_{1/2}$	r	M_{exp} (keV)	M_{AME} (keV)	$M_{exp} - M_{AME}$ (keV)	S_p (keV)			
						This work	AME	FRDM	HFB-9
^{144}Ho	700 ms	0.847 655 803(54)	−44 609.5(90)	−45 200(300)#	590(300)	−271(16)	160(360)	260	−510
^{145}Ho	2.4 s	0.853 515 790(47)	−49 120.1(80)	−49 180(300)#	60(300)	−161(10)	−110(300)	260	30
^{146}Ho	3.6 s	1.098 111 737(78)	−51 238.2(70)	−51 570(200)#	330(200)	285(11)	570(200)	790	−130
		0.859 390 963(61)							
^{147}Ho	5.8 s	1.105 599 461(59)	−55 757.1(50)	−55 837(28)	80(28)	492(10)	570(40)	840	800
		0.865 250 860(44)							
^{147}Tm	580 ms	0.865 375 925(63)	−35 969.8(10)	−36 370(300)#	400(300)	−1066(13)	−1058(3)	−560	−780
^{148}Tm	700 ms	1.113 260 920(84)	−38 765(10)	−39 270(400)#	500(400)	−560(40)	−490(500)	10	−560

Uncertainties now small enough to definitely say whether positive or negative!

Previous evaluation: large uncertainties

Future studies???