Mass Parabolas and Stability

$$M(A,Z) = \alpha + \beta Z + \gamma Z^2$$

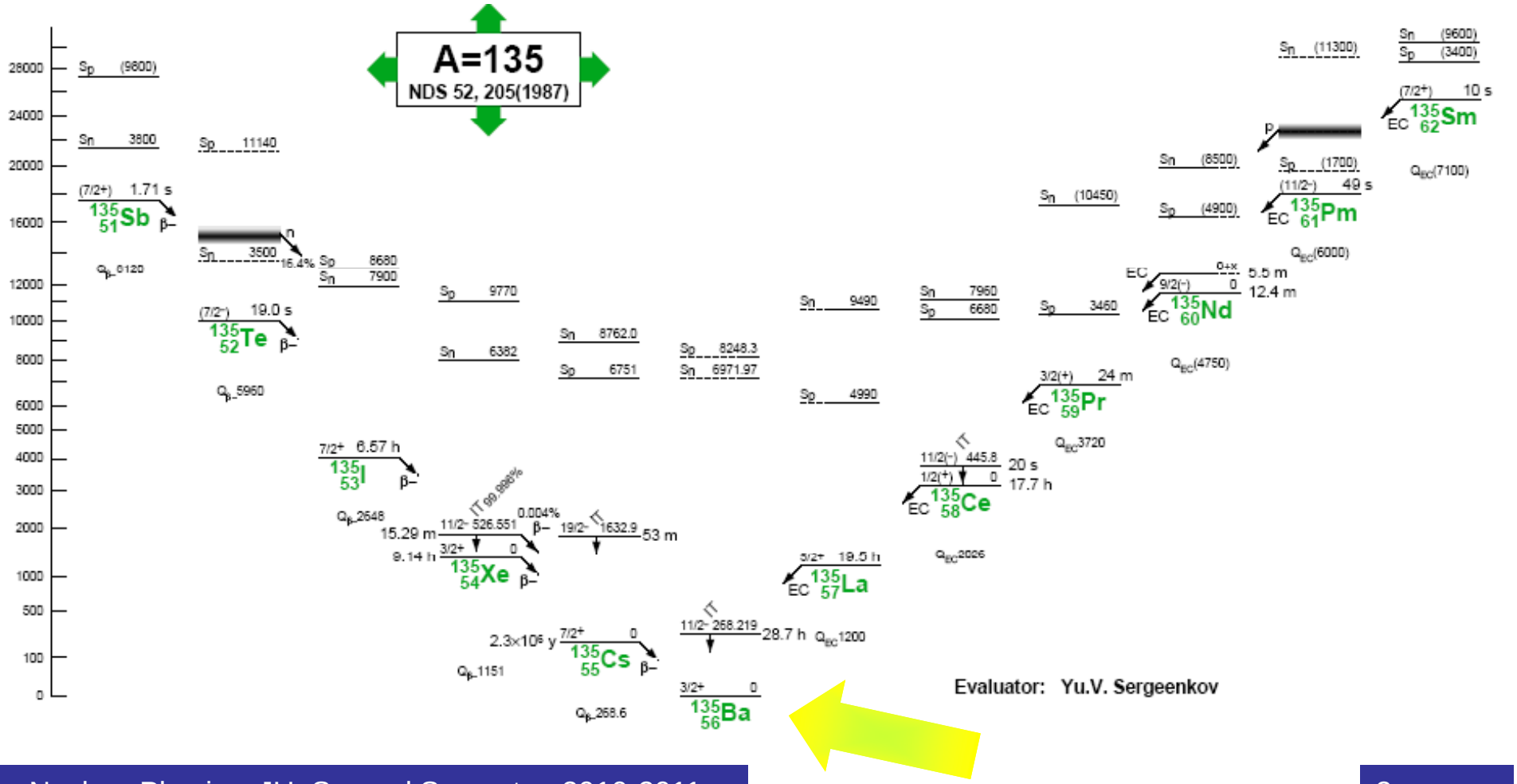
$$\alpha = AM_n - a_V A + a_S A^{2/3} + a_a A - \delta - \eta$$

$$\beta = -(M_n - M_H) - a_C A^{-1/3} - 4a_a$$

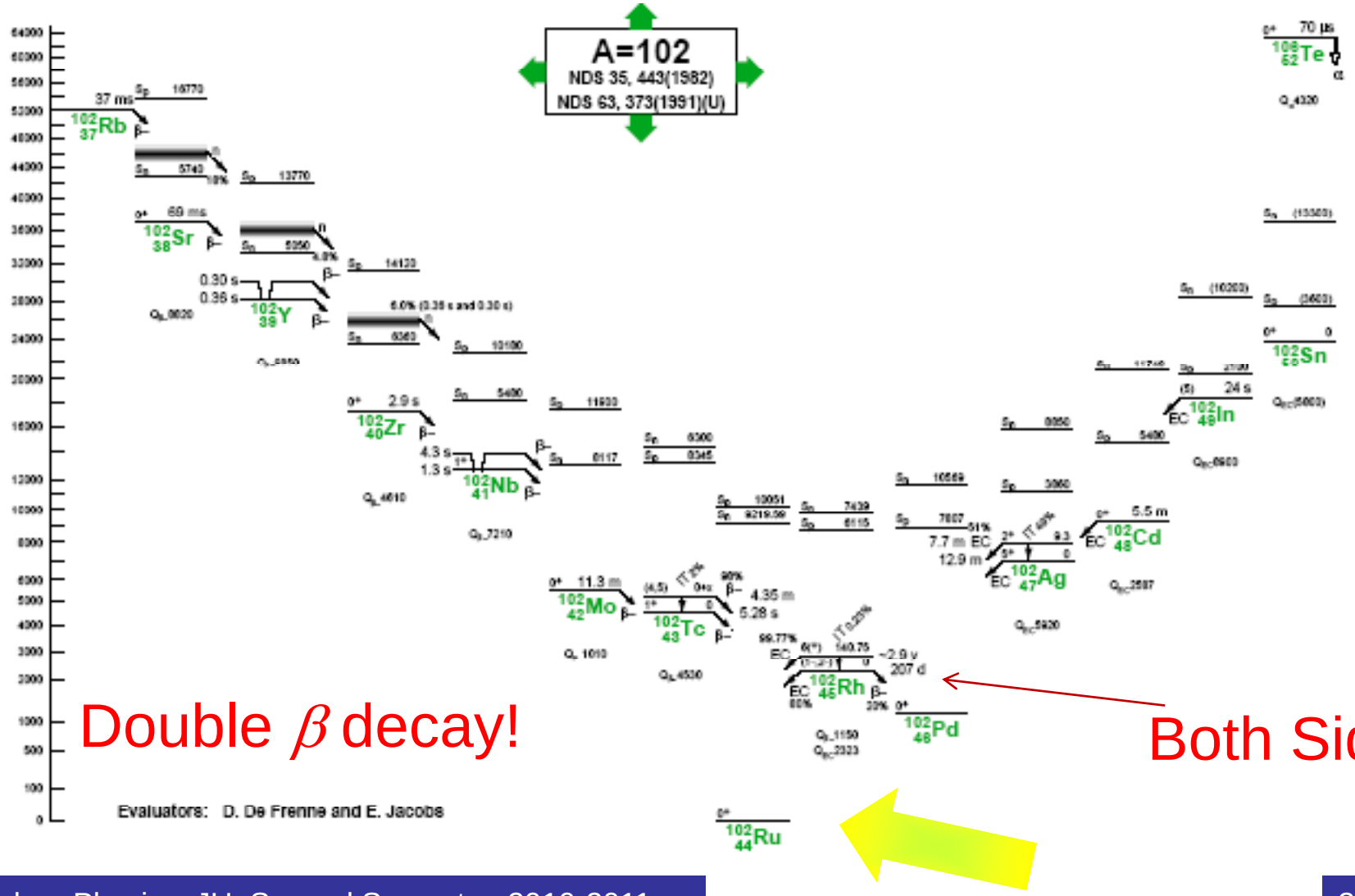
$$\gamma = 4a_a A^{-1} + a_C A^{-1/3}$$

$$\left.\frac{\partial M}{\partial Z}\right|_A = 0 \Rightarrow Z_{\min} = -\frac{\beta}{2\gamma}$$

Mass Parabolas and Stability



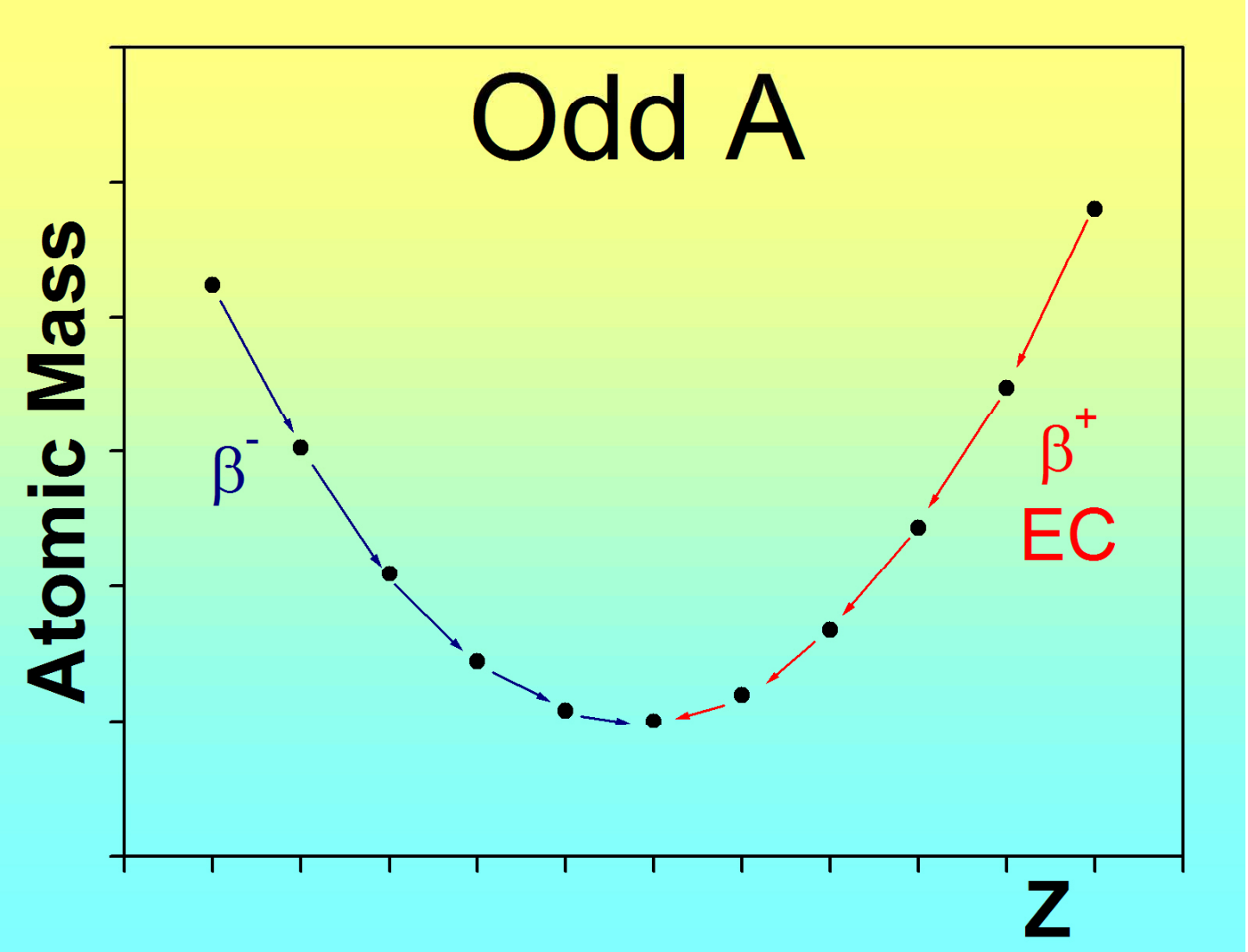
Mass Parabolas and Stability



Double β decay!

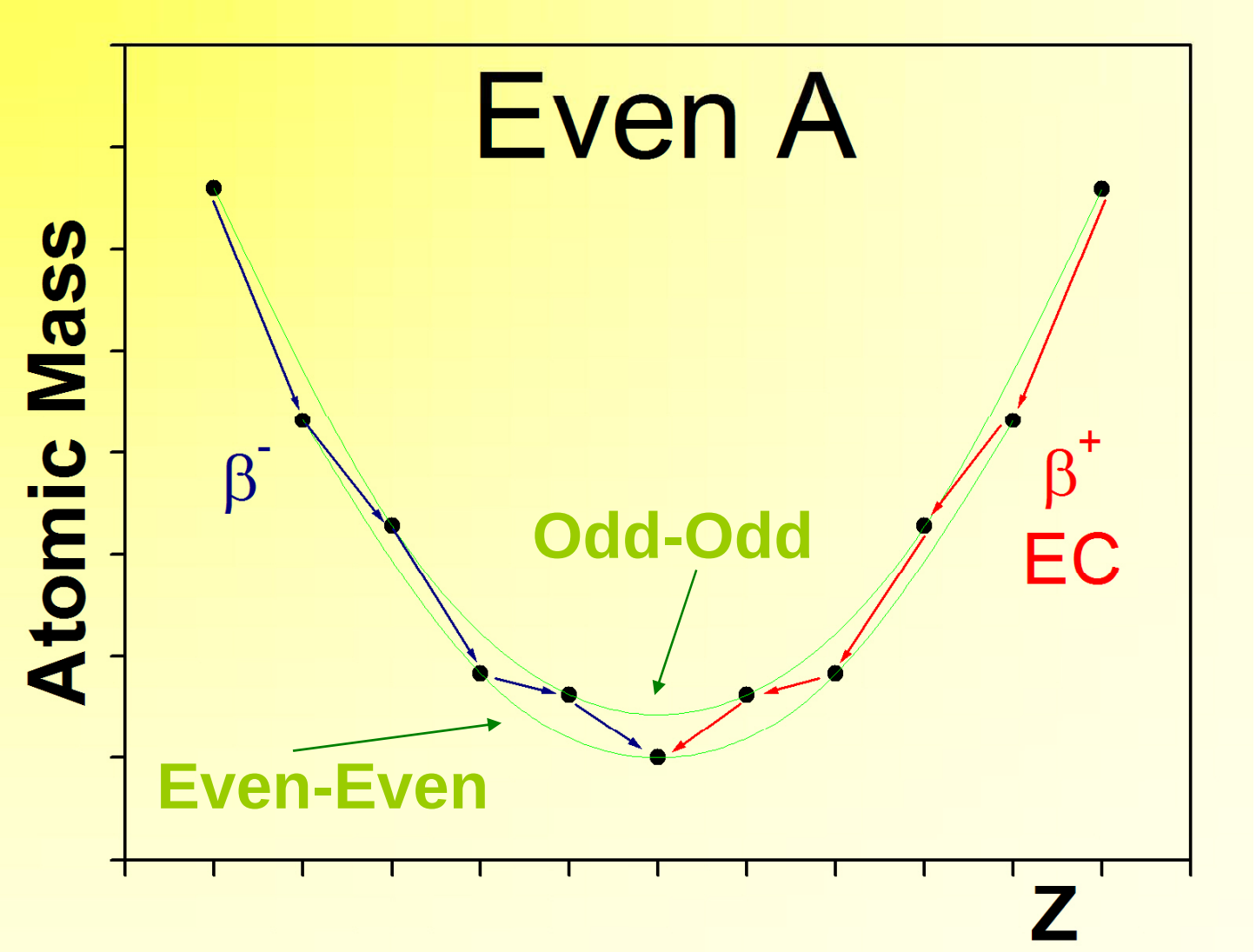
Both Sides!

Mass Parabolas and Stability



Mass Parabolas and Stability

Vertical spacing between both parabolas ?



Nuclear Spin

• Neutrons and protons have s = ½ (m_s = ± ½) so they are fermions and obey the Pauli-Exclusion Principle.

•The Pauli-Exclusion Principle applies to neutrons and protons separately (distinguishable from each other) (**Isospin**).

• Nucleus seen as single entity with intrinsic angular momentum I (orJ).

• Associated with each nuclear spin is a nuclear magnetic moment which produces magnetic interactions with its environment.

•The suggestion that the angular momenta of nucleons tend to form pairs is supported by the fact that all nuclei with even Z and even N have nuclear spin I=0.

• Iron isotopes (even-Z), for even-N (even-A) nuclei I=0.

• Odd-A ▶ contribution of odd neutron ▶ half-integer spin.

• Cobalt (odd-Z), for even-N ▶ contribution of odd proton ▶ half-integer spin.

• Odd-N ▶ two unpaired nucleons ▶ large integer spin.

Nuclear Spin

Z	A	Spin	Natural Abundance	Half-life	Decay
26	54	0	0.059	stable	...
26	55	3/2	...	2.7y	EC
26	56	0	0.9172	stable	...
26	57	1/2	0.021	stable	...
26	58	0	0.0028	stable	...
26	60	0	...	1.5My	β^-

Nuclear Spin

Z	A	Spin	Natural Abundance	Half-life	Decay
27	56	4	...	77.7d	β^+
27	57	7/2	...	271d	EC
27	59	7/2	1.00	stable	...
27	60	5	...	5.272y	β^-