Nuclear moments and transition probabilities in the vicinity of the doubly magic ^{208}Pb by off-line measurements.

The case of ^{210}Pb.

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Shell closures, B(E2)'s and nuclear moments

- ^{208}**Pb – accepted as robust doubly-magic nucleus** while ^{16}O and ^{40}Ca are soft towards particle-hole excitations
- Energies – good indicators, reproduced by the theories, but not strongly dependent on the interactions
- **Transition probabilities (B(E2)'s)** – first order test to the theories
- **Nuclear magnetic moments (μ)** – the real measure of the purity of the wave functions!
- Combined **B(E2)** and **μ** - the ultimate experimental test – still missing data for 2^+ states close to ^{208}**Pb**!

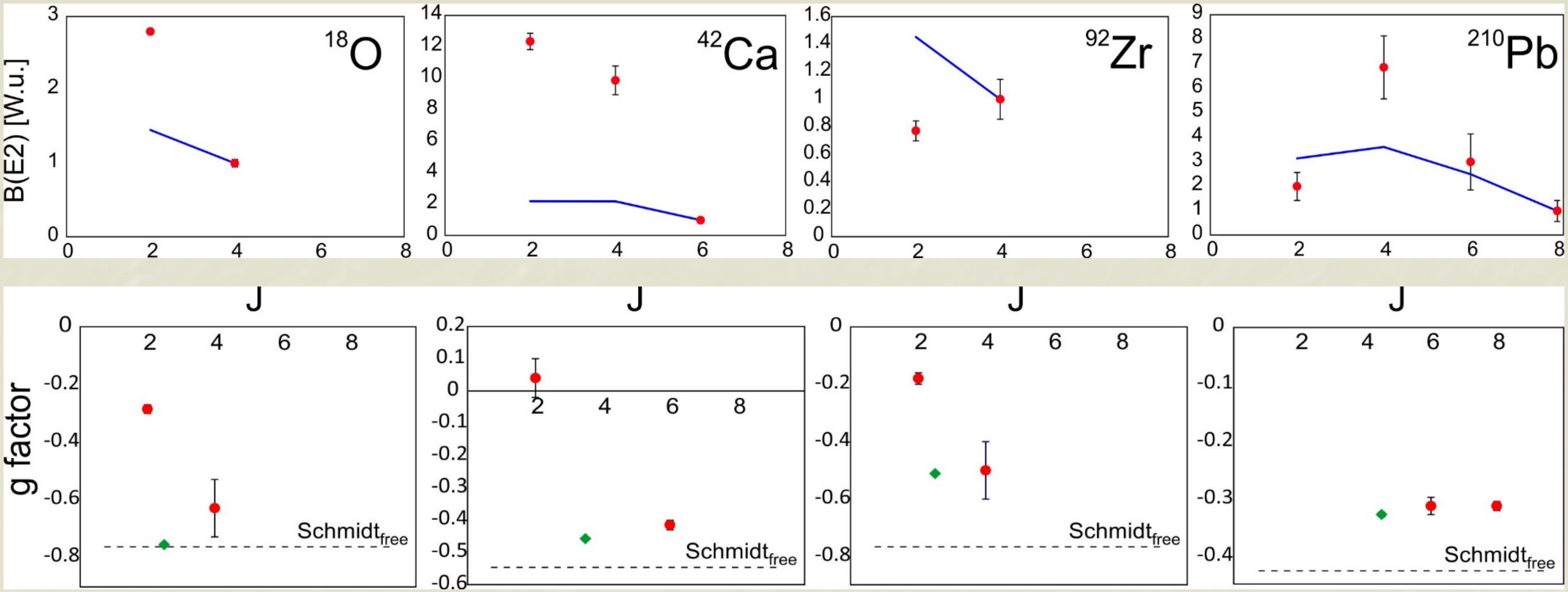
Doubly-magic + 2 nucleons

- Nuclei with 2 nucleons outside doubly-magic core – a test for basic shell-model assumptions.
- Low-excitation states – used to determine two-body residual interactions ≈ Recoupling of the spins of pure j^2 configuration.
- ***Transition probabilities for a simple j^2 configuration:***

$$B(E2; J_i \to J_i - 2) = 4(2J_i - 3) \begin{Bmatrix} j & J_i - 2 & j \\ J_i & j & 2 \end{Bmatrix}^2 |\langle j \| T(E2) \| j \rangle|^2$$

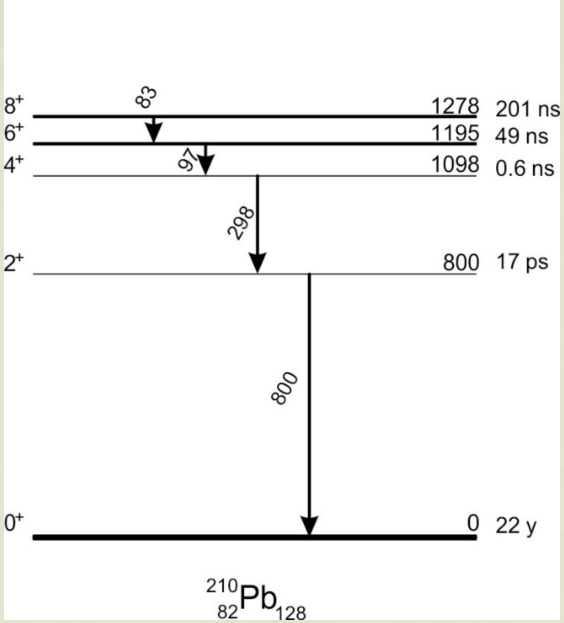
- Magnetic moments: ***g(J) = g(j)* – identical *g* factors for all states in the multiplet**

Experimental data B(E2), μ at shell closures



- Some discrepancies for the B(E2) of the 2^+ states in ^{18}O and ^{92}Zr
- **B(E2) of 2^+ in ^{210}Pb** – a measurement from 50 years ago with big error bar. Lower than expected value.
- *g* factors of single-particle states (**odd-mass nuclei**) – very close to the Schmidt limits
- *g* factors of 2^+ states in ^{18}O, ^{42}Ca and ^{92}Zr $\Rightarrow$ strong collective contributions
- ***g*(2$^+$) ^{210}Pb** – single-particle? **How pure???**

^{210}Pb – experimental information



J^π	$T_{1/2}$	*g*
2^+	**17(5) ps**	**?**
4^+	0.6(1) ns	?
6^+	49(6) ns	-0.312(15)
8^+	201(17) ns	-0.312(8)

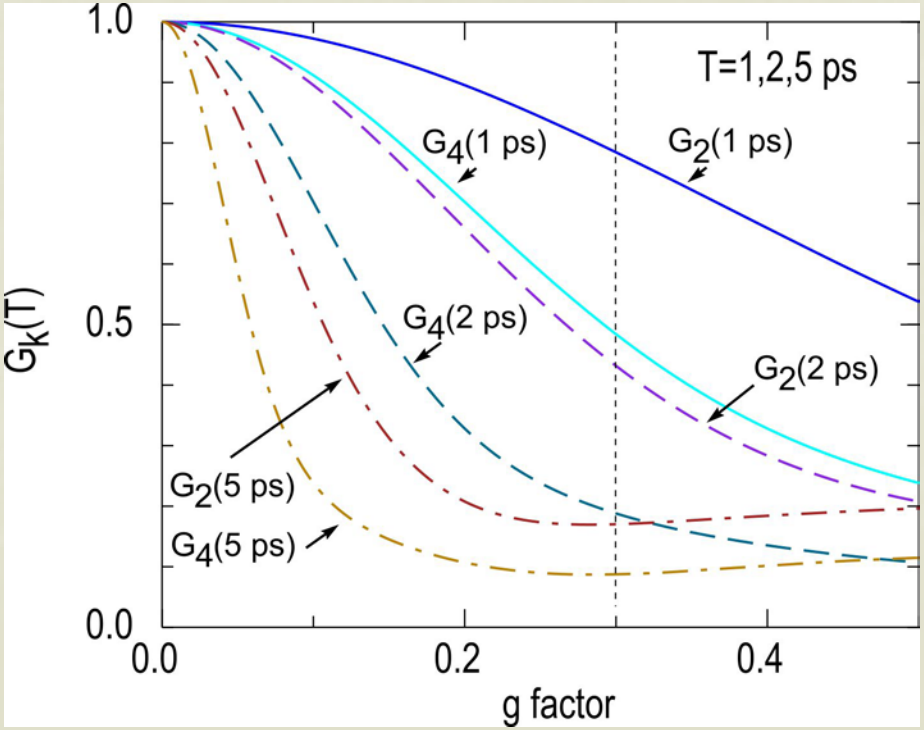
- The aim of the present experiment is to:
  - Determine the **transition probabilities** (B(E2)) for the **2$^+$** and **4$^+$** states in ^{210}Pb (< 5% accuracy)
  - Measure the ***g* factor** of the 2^+ state in ^{210}Pb with ~5% accuracy

Experimental approach

- Post-accelerated (~5 MeV/u) ^{210}Pb ($T_{1/2}$ = 22y) beam
  → **no protons required**, any “old” ISOLDE target can be used
- B(E2) – from Coulomb excitation (normalization to target excitation &/or Rutherford)
- *g* factor – from Recoil In Vacuum (RIV) measurement

Miniball plunger:

- used to define the electron – ion interaction time.
- *g*-factor sensitive distances ~ 1 – 5 ps.
- Plunger lifetime information – complementary to the Coulex B(E2) value



Plunger details

- **target** – any "good plunger material" between Mg (Z=12) and Ni (Z=28)
- **stopper** – high-Z material (e.g. Au) – sufficiently thick to stop the ^{210}Pb beam and thin enough to let the let the recoiling target nuclei go through
- **independent target** (^{120}Sn) → for the B(E2) of the 4^+ state
- CD angular coverage – 14° – 40°
- count-rate calculations (**assuming** ^{58}Ni target and **$2x10^5$ pps ^{210}Pb** beam):
  - 3200 γ's per day in the 2^+ →0^+ transition
  - 60 γ's per day in the 4^+ → 2^+ transition
  - **5 plunger distances** needed – for the RIV measurement
- ^{120}Sn target and **$2x10^5$ pps ^{210}Pb** beam

  → 340 γ's per day in the 4^+ → 2^+ transition

Beam-time request

- **NO proton beam requested!!**
- **15 UT's** (5 days) of 5 MeV/u **^{210}Pb** beam for measuring the B(E2) and the *g* factor of its 2^+ state
- **3 UT's** (1 day) for measuring the B(E2) of its 4^+ state
- **12 UT's** (4 days) of **^{207}Pb** beam (e.g. from mass marker) for calibration of the RIV interaction
- ***Standard ^{22}Ne run*** – for determining the position of the Miniball detectors (overnight)

→ 30 UT's off-line run requested