

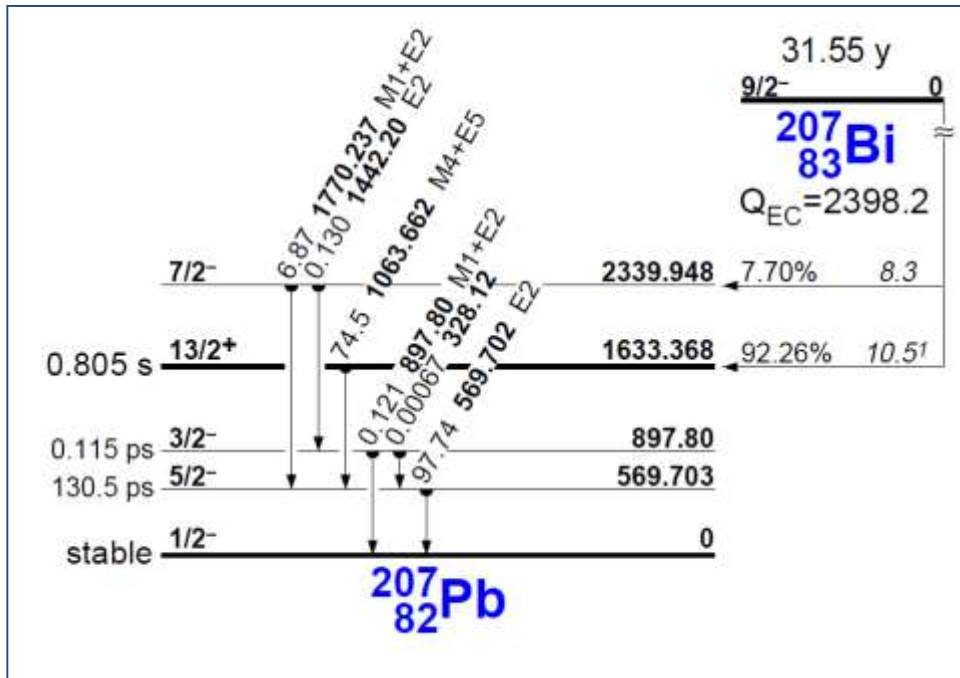
Some rare decays of ^{207}Bi

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In SuperNEMO detector, we have a lot of ^{207}Bi sources which are used for calibrations. ^{207}Bi usually decays through EC to ^{207}Pb with emission of γ 's, e^- and X rays.



But if we look into tables of atomic masses [M. Wang et al., Chin. Phys. C 45 (2021) 030003], we will see that **other decay modes are possible**, in particular:

- (1) Double EC $^{207}\text{Bi} \rightarrow ^{207}\text{Tl}$;
- (2) α decay $^{207}\text{Bi} \rightarrow ^{203}\text{Tl}$.

(2) α decay $^{207}\text{Bi} \rightarrow ^{203}\text{Tl}$; $Q_{\alpha} = 3281.8 \pm 2.1 \text{ keV}$ ($9/2^{-} \rightarrow 1/2^{+}$)

Very similar to α decay $^{209}\text{Bi} \rightarrow ^{205}\text{Tl}$; $Q_{\alpha} = 3137.3 \pm 0.8 \text{ keV}$ ($9/2^{-} \rightarrow 1/2^{+}$)
discovered very recently [P. De Marcillac et al., Nature 422 (2003) 876]

$T_{1/2} = (2.04 \pm 0.08) \times 10^{19} \text{ yr}$ [J.W. Beeman et al., PRL 108 (2012) 062501]

Because ^{209}Bi and ^{207}Bi α decays are very similar
in Q_{α} value and in $\Delta J^{\Delta\pi}$ change, we also have to
expect $T_{1/2} \sim 10^{18} - 10^{19} \text{ yr}$.

- (1) Not enough ^{207}Bi nuclei to observe this decay; and
- (2) SuperNEMO technology does not allow to see α 's emitted from the sources.



Conclusions

We will not see 2EC of ^{207}Bi (only observed to-date in ^{78}Kr , ^{124}Xe , ^{130}Ba , 2 ν mode, with $T_{1/2} \sim 10^{22}$ yr) but we could set the first limits for this process in ^{207}Bi (both for 0 ν and 2 ν) making our life and papers more interesting.

and one more proposal:

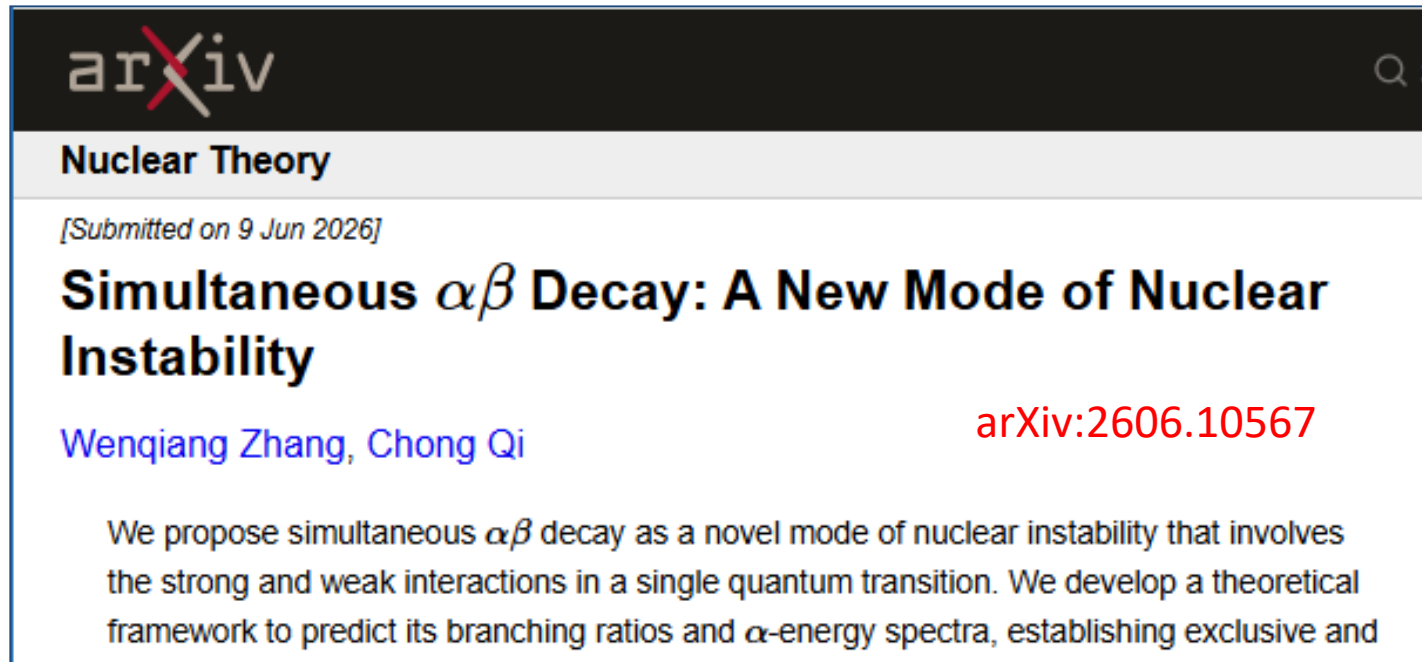
Search for $\alpha\beta$ decay of ^{150}Nd

(but this is with the NEMO-3 data, if it is still possible)

$\alpha\beta$ decay: transformation $(A,Z) \rightarrow (A-4,Z-1)$ with simultaneous emission of α and β particles

Old (~20 years) idea of Slava Kobychev from our group in Kyiv, but not published.

Possible if $M(A,Z) > M(A-4,Z-1)$ – no law is violated.



The image shows a screenshot of an arXiv preprint page. At the top left is the arXiv logo. Below it, the category 'Nuclear Theory' is displayed. The submission date is '[Submitted on 9 Jun 2026]'. The title is 'Simultaneous $\alpha\beta$ Decay: A New Mode of Nuclear Instability'. The authors are 'Wenqiang Zhang, Chong Qi'. The arXiv ID is 'arXiv:2606.10567'. The abstract text reads: 'We propose simultaneous $\alpha\beta$ decay as a novel mode of nuclear instability that involves the strong and weak interactions in a single quantum transition. We develop a theoretical framework to predict its branching ratios and α -energy spectra, establishing exclusive and

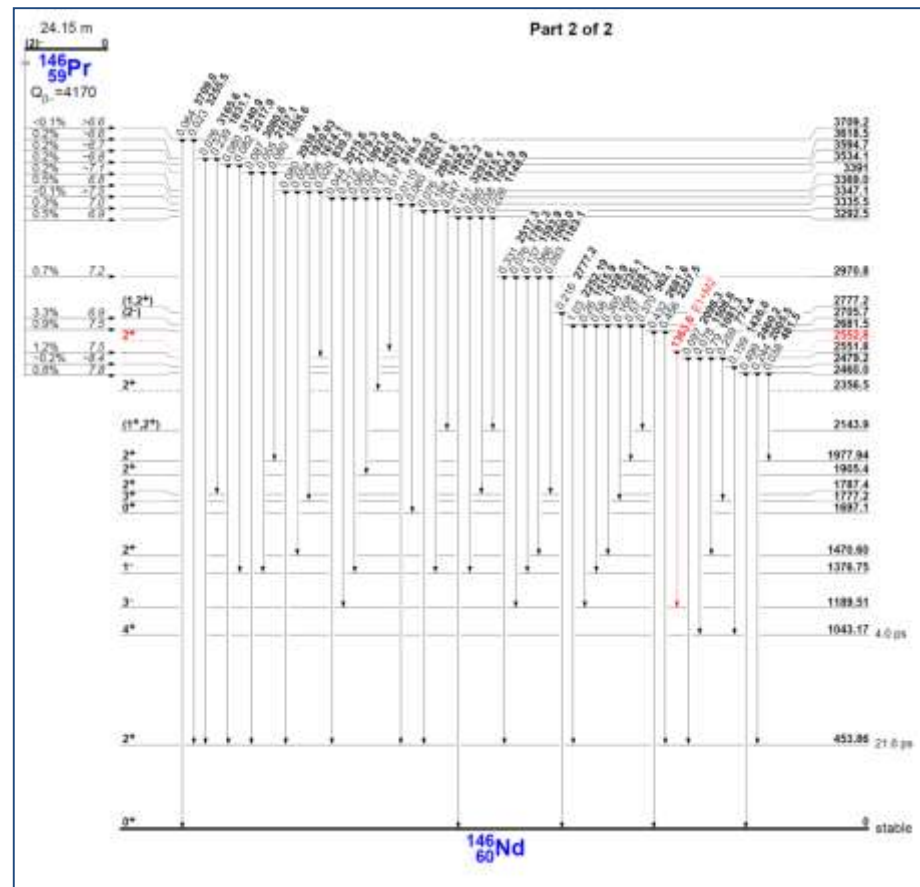
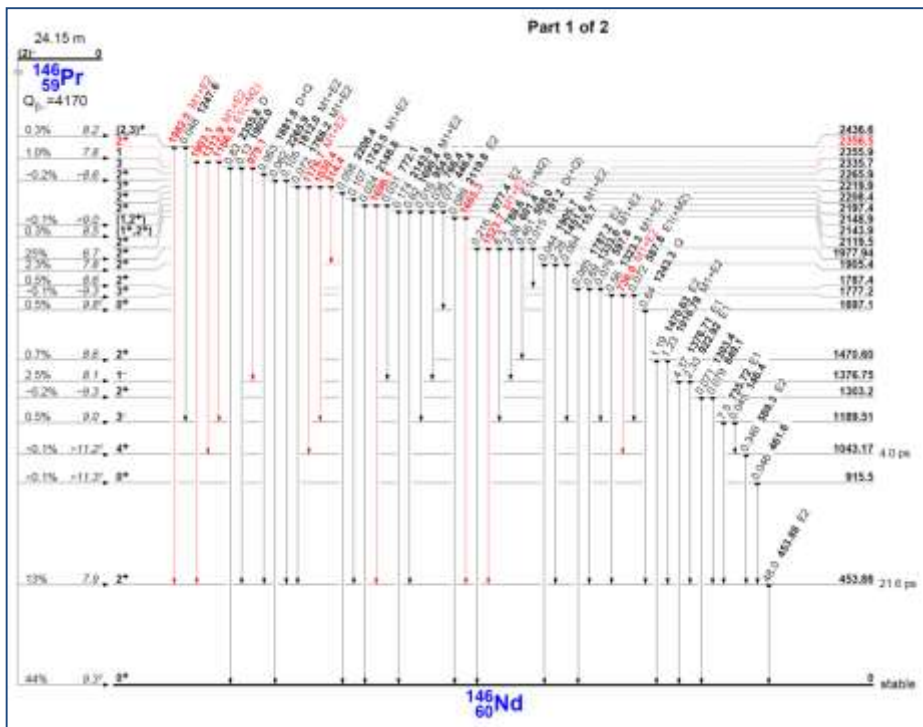
For ^{150}Nd :

α Decay $^{150}\text{Nd} \rightarrow ^{146}\text{Ce}$ is impossible ($Q_\alpha = -479$ keV);

β Decay $^{150}\text{Nd} \rightarrow ^{150}\text{Pm}$ is impossible ($Q_\beta = -83$ keV);

$\alpha\beta$ Decay $^{150}\text{Nd} \rightarrow ^{146}\text{Pr}$ is energetically possible ($Q_{\alpha\beta} = +576$ keV).

Because of low $Q_{\alpha\beta} = 576$ keV, we will not see in NEMO-3 this decay. However, daughter ^{146}Pr is unstable, and we can look for its decay $^{146}\text{Pr} \rightarrow ^{146}\text{Nd}$, $Q_{\beta} = 4250$ keV



We could simulate ^{146}Pr decay in NEMO-3, add this effect to already known model of background and obtain the **first experimental limit for $\alpha\beta$ decay.**