

Homework Set 3

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2/20/25**3.1) Line Width**

- 3.1.1) [2] How is the energy width of an excited nuclear state, that decays by emitting a photon, related to the line width of this photon?
- 3.1.2) [1] How are both energy widths related to the lifetime of the excited state?
- 3.1.3) [GS] [2] If an excited nuclear state is allowed to decay by photon and by neutron emission, which decay mode is preferred and why is it preferred? Why is the energy width of the neutron larger, the same, or smaller than the energy width of the photon?

3.2) Radioactive Decay

- 3.2.1) [4] Naturally occurring uranium is a mixture of ^{238}U (99.28 %) and ^{235}U (0.72 %) isotopes. How old must the material of the solar system be, if one assumes that at its creation both isotopes were present in equal quantities? Interpret this result! The lifetime of ^{235}U is $1.015 \cdot 10^9 \text{ y}$. For the lifetime of ^{238}U use the decay chain in Fig. 3.7!
- 3.2.2) [2] How much ^{238}U has decayed since the formation of the earth's crust $2.5 \cdot 10^9 \text{ y}$ ago?

3.3) α -Decay

- 3.3.1) [7] The binding energy of an α -particle is 28.3 MeV . Estimate from which mass number A onward α -decay is energetically allowed! Use the liquid drop model and neglect the pairing term!

3.4) Selection Rules

- 3.4.1) [GS] [3] An even-even nucleus in its ground state decays by α -emission. Which J^P states are available to the daughter nucleus?