Pair production as a probe for the dynamics of nuclear fission and alpha decay

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Electron-positron pairs can be produced via the Schwinger mechanism in the presence of strong electric fields [1]. In particular, the fields involved in alpha decay and nuclear fission are strong enough to produce them. The energy of the e^+e^- pair is related to the relative distance and velocity of the daughter nuclei. Thus, the energy distribution of the produced pairs can give information about the dynamics of the fission and alpha-decay processes. A neck model of nuclear fission is used to illustrate how the pairs can be used as a probe of the dynamics.

The positron spectra for symmetric fission of several heavy nuclei are shown in Fig. 1. Previous experimental investigations have looked for a coincidence between e^+ and e^- [2]. In our approach the coincidence is lost because the electron gets trapped by the nuclei. We suggest an experiment to look for e^+ in coincidence with a fission fragment and not with e^-.

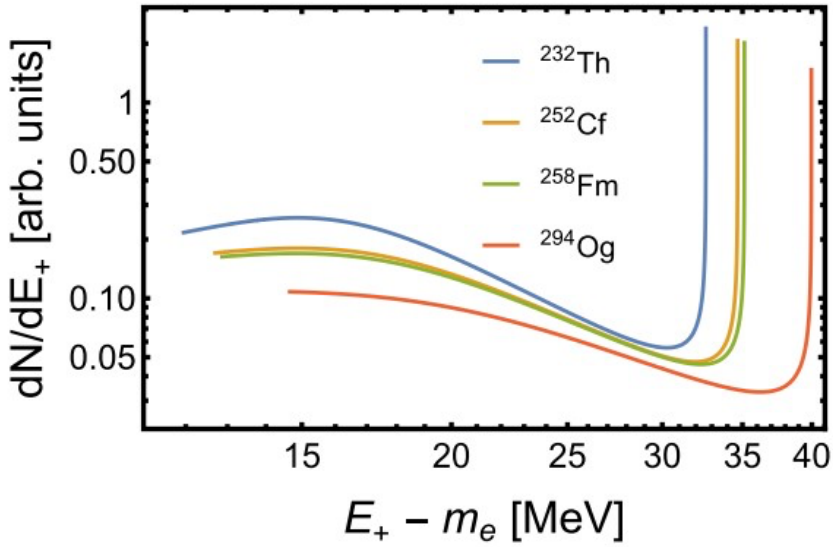

Fig. 1. (Color online) dN/dE_+ for fission of a selection of nuclei. The fission dynamics are based on the neck model. Here, $m_T = m_e$, $\beta = 0$, and $E_k = 2m_e$.

Our model predicts that electron-positron pairs can be created during alpha decay or fission. The energy of the created positron is related through the conservation of energy to the distance between the progeny nuclei. Careful observation of the energy spectrum of pairs produced during fission could reveal the dynamics of the fission process, properties of the vacuum polarization, and the tunneling "dynamics."

[1] T. Settlemyre, H. Zheng and A. Bonasera, Phys. Rev. C **107**, L031301 (2023).
[2] T. Tsunoda *et al.*, Workshop on Dynamical Symmetry Breaking (Nagoya University, Nagoya, Japan pp. 175 (1989).