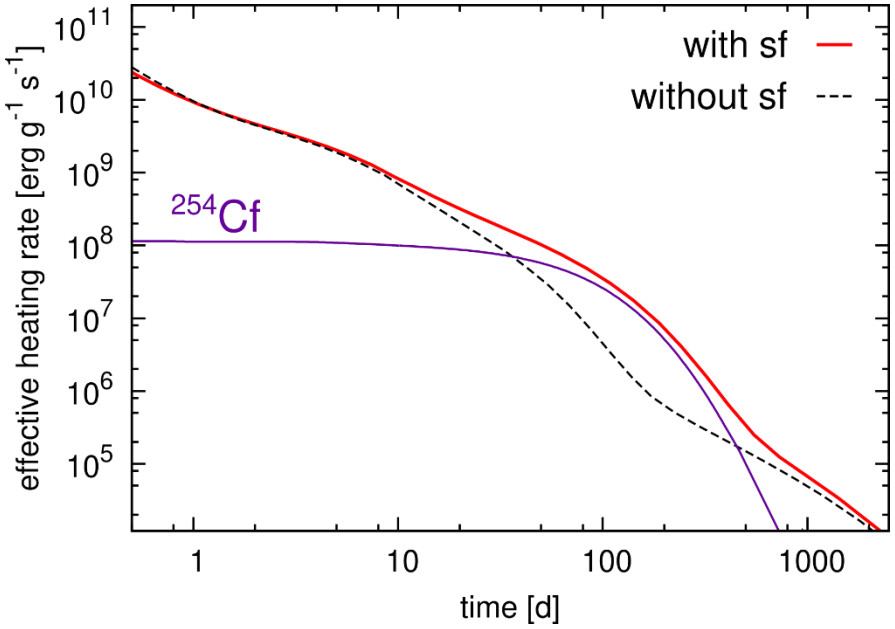
Californium-254 and Kilonova Light Curves

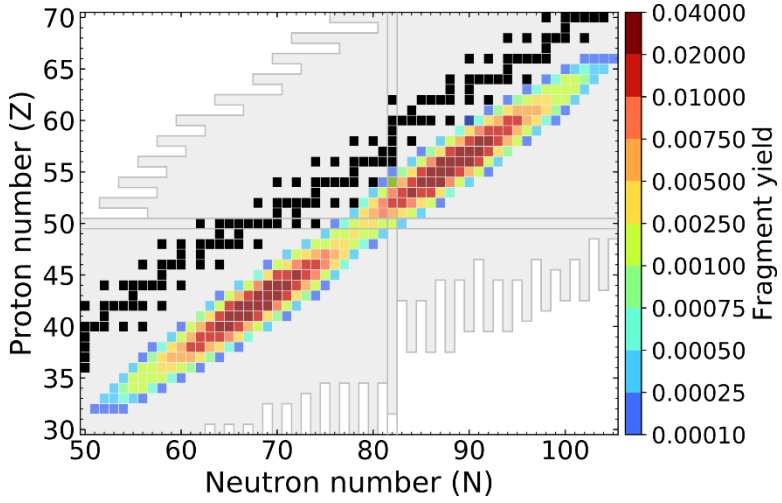
OBJECTIVES

- The source of kilonova luminosity is mainly the radioactive decay of unstable nuclei synthesized by the r-process.
- Most radioactive energy from the r-process is emitted in beta-decays or alpha-decay. Can fission contribute significantly?
- We investigate the process of radioactive decay from nucleosynthesis simulations, and estimate light curves from the Q-value of each nuclear reaction and radioactive energy transfer.



Effective heating rates, including energy partitioning between decay products and their thermalization, with and without the contribution from spontaneous fission of actinides, in particular ^{254}Cf

Two-dimensional fission fragment mass yield for the spontaneous fission of ^{254}Cf. Black squares are stable nuclei, with the extent of the FRDM2012 mass model outlined in light gray.



IMPACT

- We identified a single isotope, ^{254}Cf, which has a particularly high impact on the brightness of electromagnetic transients associated with mergers on the order of 15 to 250 days.
- This effect is due to the high Q-value for the spontaneous fission of ^{254}Cf and the uniquely long experimentally measured half life.
- This is the first proposed imprint of single-isotope decay in kilonova light curves: if observed, it could indicate the production of actinides in nucleosynthesis.
- Better models of spontaneous fission in Californium isotopes are needed to estimate sensitivity of results to nuclear data

Reference: Zhu, Y., et al. The Astrophysical Journal Letters **863** (2018): L23.
Contact: Yonglin Zhu (yzhu14@ncsu.edu)