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Isotopic feedback and the stability of traveling wave reactors

MARK DEINERT, The University of Texas at Austin — Simulations have shown that fertile nuclear materials could sustain fission waves with soliton like properties and is envisioned as a possible means for producing a self stabilizing power reactor Self limiting stability in neutron chain reactions is rare and when it happens it typically arises through thermal feedback effects that reduce the reaction rate within the system. However, the soliton like properties of fission waves can evolve without these effects. Several studies have suggested that that fission waves in uranium can stabilize through a feedback mechanism between Np239 and Pu239. Here we show that these isotopes play a critical role in determining the excess neutron production in a wave and that their peak concentrations are coupled to the peak intensity of the neutron field. Together the neutron flux and excess neutron production can evolve to a stable node in phase space, independent of thermal feedback or intervention, and stable against perturbations. The critical factors affecting this behavior are the half-life of Np239 and the reaction cross sections for Np239 and Pu239. We use numerical simulations to show that the initial composition and geometry of the system determine the steady state behavior of the wave.

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