Fission Waves and Dancing Solitons

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Abstract: Reaction-diffusion processes are encountered in an astonishing variety of natural phenomena, from animal coat patterns to the spread of epidemics. Under the right conditions, reaction and diffusion mechanisms can couple to produce self-stabilizing waves, known as solitons, that propagate at constant velocity. Numerical studies have shown that soliton-like fission waves can arise in fertile nuclear media such as natural uranium. Fission waves have been investigated as a potential way to operate a nuclear fission reactor in a manner that is self-stabilizing and inherently safe. Using a neutron reaction-diffusion numerical model we have discovered, however, that fission waves are oscillatory. A coupling mechanism in the transmutation chain between ^{238}U and ^{239}Pu drives this oscillation. We confirm our findings using a linear stability analysis of the neutron reaction-diffusion model in one and three dimensions, with a transmutation chain of 1459 nuclides.

Bio: Dr. Osborne received his Ph.D. in high energy physics from the University of Glasgow in Scotland. Shortly after completing his graduate studies he worked as a market risk analyst for the JPMorgan Chase investment bank, splitting his time between their Glasgow and New York City offices. Dr. Osborne went on to pursue postdoctoral research in nuclear engineering at the University of Texas at Austin. He is now a Research Assistant Professor at The Colorado School of Mines.