PAT - Assignment 3

Mikkel Willén
`bmq419`

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Abstract

This study aims to model and simulate critical mass phenomena within the Janus playground. Critical mass is a pivotal concept in nuclear physics, referring to the minimum amount of fissile material needed to sustain a nuclear chain reaction. The focus will be on three core problems: the calculation of critical mass for a given fissile material, the dynamics of a chain reaction, and the conditions for achieving and maintaining supercriticality.

The primary challenges include adapting continuous mathematical models of critical mass into a discrete format suitable for Janus, which only accepts integer inputs. The first model involves calculating the critical mass threshold for various fissile materials by simulating the number of neutrons produced and absorbed in the material. The second model examines the dynamics of a sustained chain reaction, focusing on the balance between neutron production and loss. The third model investigates the conditions necessary for achieving supercriticality, where the reaction becomes self-sustaining and grows exponentially.

These problems, while straightforward in theoretical physics, present significant implementation challenges within the constraints of the Janus playground. Specifically, we will investigate if Janus can accurately handle the reversibility of critical mass equations, maintaining consistency in forward and reverse simulations. The results will be validated through a series of controlled experiments, comparing the outputs against known physical data. Trace outputs of the simulations will be included in the appendix for verification purposes.

Should these problems prove too elementary or be resolved rapidly, additional, more complex critical mass scenarios will be introduced to further test the capabilities of Janus.