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**Neutron Tracking Simulations for the UCN$\tau$ experiment** EVAN ADAMEK, Indiana University, UCNTAU COLLABORATION — The UCN$\tau$ experiment aims to measure the neutron beta-decay lifetime to 1 s total uncertainty and beyond by trapping ultracold neutrons (UCN) in a gravito-magnetic trap, in which UCN will undergo no material wall interactions. To study the feasibility in this experimental technique, we have built Monte-Carlo simulations of the full-scale UCN$\tau$ experiment. The simulation program consists of two major components: one focuses on simulation of the UCN flux in the guide tubes, and the other on UCN tracking inside the trap. The first simulation studies optimized delivery of UCN into the trap and evaluates the effectiveness of relative flux monitoring to infer the number of trappable UCN for each fill. The second simulation tracks UCN, originating from the trap door, over the entire accessible region. Symplectic integrators are used to integrate the equations of motion of UCN using the full potential. Focus is given to studying the phase-space evolution of marginally trapped UCN. These neutrons have a large tangential velocity component and could be leaking out of the trap slowly (due to non-harmonic components in the trapping potential) and thus skewing the accuracy of the neutron beta-decay lifetime. In this talk, we will discuss many of these subtle effects.

Chen-Yu Liu
Indiana University

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