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Integral equation study for nuclear fano factor determination in noble liquids

It is known that for noble liquids, experimental data on the Fano factor for nuclear recoils remain sparse; consequently, many experiments fix this factor to unity, assuming binomial statistics. In this work, we present a formal theory, based on the Lindhard integral equation, to compute the statistical variance arising from nuclear recoil energy depositions. The model is based on the solution to a new second-order, non-homogeneous integro-differential equation for the atomic motion variance, Ω_v^2 . Furthermore, we demonstrate that at second order and for low energies, the probability distribution energy governing nuclear recoil fluctuations is determined by a Beta function. Finally, we discuss the implications of incorporating this variance into dark matter searches.

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