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Bragg peak modeling and matter-wave interferometry in gaseous track detectors

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A two-parameter analytical formula, based on the quantum electron-ion transport cross section, is used to describe the stopping power of ionizing particles penetrating gases, as for instance in gaseous detectors in low-energy nuclear physics. The electrons of the target are described as a free electron gas (FEG), while the electron-ion interaction is described by a phenomenological velocity-dependent Yukawa potential, allowing to calculate the stopping power both below and above the Bragg peak.

Given the simplicity of the model, surprisingly good results are obtained when comparing with experimental stopping powers, suggesting that the analytical formula could be useful for the design of (active-target) time-projection chambers. Moreover, relating this stopping power with transverse decoherence [GS23] could help designing new matter-wate interferometry experiments in such detectors.

Finally, the model could be used in ab initio gaseous detector simulations, allowing to test fundamental questions in the quantum measurement problem, in particular the hypothesis that the microscopic state of the apparatus fully determines the measurement result [SNM13].

[GS23] D. Gaspard and J.-M. Sparenberg, Phys. Rev. A 107 (2023) 022214
[SNM13] J.-M. Sparenberg, R. Nour and A. Manço, EPJ web of conferences 58 (2013) 01016

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