Fringe E-Fields of Flat and Cylindrical Deflectors and a New Proposal for the Proton EDM Experiment

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Most fundamental particles have a magnetic dipole moment. None yet is found to also have an electric dipole moment (EDM), i.e., a displacement of positive and negative charges along the direction of North and South poles. If these particles are discovered to have an EDM, this would indicate that nature violates the fundamental symmetries of P-parity and T-time to a significant degree, altering our understanding of nature and helping to resolve the mystery of the matter-antimatter asymmetry of our universe. A new proposal, the $60 M proton EDM experiment, suggests using an electric storage ring with special parameters to study charged particles with high sensitivity at three orders of magnitude more sensitive than any previously planned hadronic experiment. However, with the necessity of monitoring and guiding equipment in the storage ring, it is inevitable that straight sections should also be included, breaking the continuity of the plates. This raised the issue that electric fringe fields have never been estimated analytically to the required accuracy and could potentially ruin the specially required conditions for the experiment to work. This problem has been solved completely and tested using various methods, constituting a major breakthrough in the physics of describing particle propagation in electric fields. Analytic expression have been derived from implicit mappings using a number of parameter transformations and special functions. A slight modification of the pEDM ring geometry has been proposed that satisfies the conditions for a successful proton EDM experiment.

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