An analytical derivation of the survival probability of muon penetrating through matters

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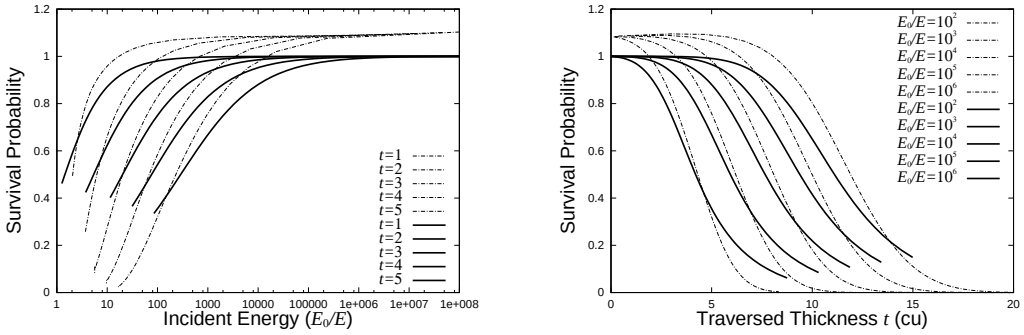

Figure 1: Survival probabilities with $\varepsilon' = 0$ (Approx. A) versus E_0/E at $t = 1$, 2, 3, 4, 5 (left panel) and those versus t with $E_0/E = 10^2$, 10^3, 10^4, 10^5, 10^6 (right panel), derived by the ordinary saddle point method (thin lines) and via the complementary-probability method (thick lines).

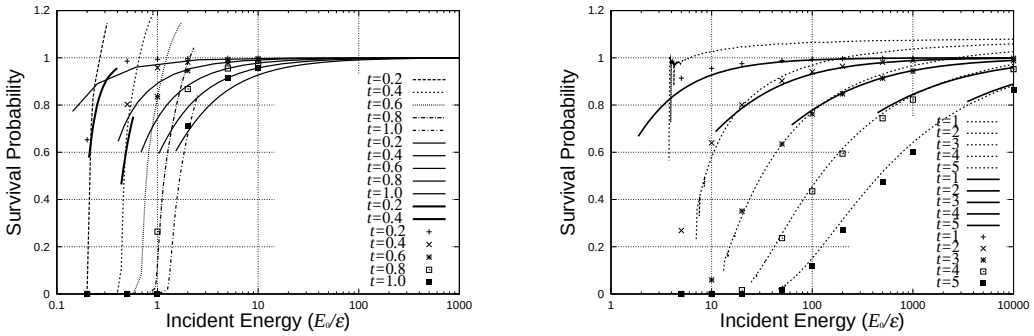

Figure 2: Survival probabilities (Approx. B) versus E_0/ε' at $t = 0.2$, 0.4, 0.6, 0.8, 1 (left panel) and those at $t = 1$, 2, 3, 4, 5 (right panel), derived by the ordinary saddle point method (thin dot lines), via the complementary-probability method (thick lines), via the extended complementary probabilities from large E_0/ε' region (thin lines in the left panel), and by Monte Carlo simulations (dots).

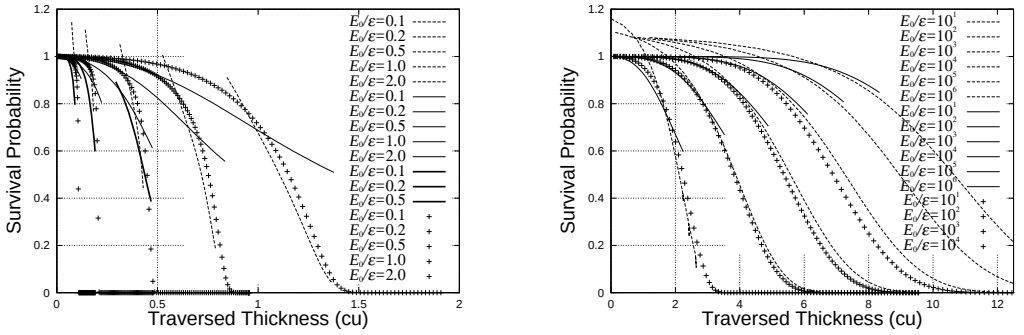

Figure 3: Survival probabilities (Approx. B) versus t with $E_0/\varepsilon' = 0.1$ 0.2, 0.5, 1.0, 2.0 (left panel) and those with $E_0/\varepsilon' =$ 10, 10^2, 10^3, 10^4, 10^5, 10^6 (right panel), derived by the ordinary saddle point method (thin lines), via the complementary-probability method (thick lines), and by Monte Carlo simulations (dots).