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Multi-scaling Limits for Relativistic Diffusion Equations with Random Initial Data

Let $u(t, \mathbf{x}),\ t > 0,\ \mathbf{x} \in \mathbb{R}^n$, be the spatial-temporal random field arising from the solution of a relativistic diffusion equation with the spatial-fractional parameter $\alpha \in (0, 2)$ and the mass parameter $\mathfrak{m} > 0$, subject to a random initial condition $u(0, \mathbf{x})$ which is characterized as a subordinated Gaussian field. In this talk, we report the large-scale (the macro) and the small-scale (the micro) limits for the renormalization of the solution field $u(t, \mathbf{x})$. Both the Gaussian and the non-Gaussian limit theorems are discussed. The small-scale scalings involve not only to scale on $u(t, \mathbf{x})$ but also to rescale the initial data $u(0, \mathbf{x})$; this is a new-type result for the literature. In the two scalings, the parameter α and the parameter $\mathfrak{m}$ play distinct roles for the scaling (renormalizing) and the limiting procedures. A working project with G.-R. Liu.