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A path from fractional Schrödinger equation to design and discovery of novel quantum materials[1] GAVRIIL SHCHEDRIN, ANASTASIA GLADKINA, LINCOLN D. CARR, Colorado School of Mines — Transport phenomena in multi-scale classical systems, such as disordered media, porous materials, and turbulent fluids, are characterized by multiple spatial and temporal scales, non-locality, fractional geometry, and non-Gaussian statistics. Transport in multi-scale classical materials is described by the fractional diffusion equation, while its quantum analog, fractional Schrödinger equation, governs the dynamics of quantum materials. The fundamental processes of multi-scale quantum materials are carried out on a local fractional space-time metric. We show that the minimization of action on fractional space-time metric with a subsequent evaluation of the Feynman path integral leads to a self-consistent derivation of the fractional Schrödinger equation, which is valid for any order of fractional space-time. We apply the derived fractional Schrödinger equation to multi-scale quantum materials and show that they can be effectively modeled by a system of cold atoms in a multi-frequency optical potential. Specifically we demonstrate that the tunneling matrix element in fractional quantum materials embedded in a single frequency optical potential exactly matches the corresponding matrix element in multi-frequency optical potential.

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