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Fisher/KPP models with memory for fungal growth and their numerical simulation

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Filamentous fungi form interconnected networks which enable them to explore, exploit and efficiently share resources on large scales. In order to understand the mechanics behind network formation and characterize its behavior, we propose a model based on three basic mechanisms: growth under a Langevin dynamics, branching at the tips and on the network, and anastomosis by fusion of crossing filaments. In the limit of large scales with regards to the filament size, we can model the homogenized density as a hyperbolic isothermal Euler equation with nonlinear reaction terms. In the limit of large temperature, the system boils down to a Fisher/KPP model with memory. We are able to analyze the asymptotic velocity of the front in both full and simplified models. However, from a numerical point of view, the handling of parabolic Fisher/KPP equations is very different (and easier) from the full hyperbolic model. For the full model, we use an Asymptotics-preserving approach to accurately recover the correct front propagation velocity.

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