Mass hierarchies from self-organized criticality

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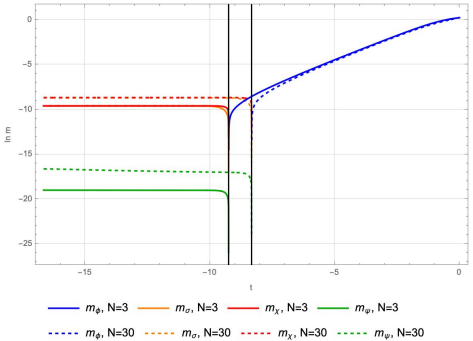
Luttinger-Dirac-Yukawa model

$$\Gamma_k = \int d^4x \Big[- Z_{\chi,k}\, \bar{\chi} G_{\mu\nu} \partial_\mu \partial_\nu \chi + Z_{\psi,k}\, \bar{\psi} i \gamma_\mu D_\mu \psi$$
$$+ \tfrac{Z_{\phi,k}}{2}\, \partial_\mu \phi\, \partial_\mu \phi + U_k(\phi)$$
$$- h_{\chi,k}\, \phi\, \bar{\chi} \gamma_{11} \chi + i h_{\psi,k}\, \phi\, \bar{\psi} \psi$$
$$+ \tfrac{1}{4} F^i_{\mu\nu} F^i_{\mu\nu} + \frac{1}{2\alpha} (\partial_\mu A^\mu_i)^2 + \bar{\eta}^i \partial^\mu \nabla^{ij}_\mu \eta^j \Big]$$

- Luttinger fermions χ + Dirac fermions ψ, both Yukawa-coupled to a dynamical scalar ϕ
- Dirac sector coupled to $SU(N)$ gauge fields (treated perturbatively, one-loop β_g)

Seesaw-type mechanism



$$m_\psi \ll m_{\sigma,\chi} \sim \Lambda_F \ll \Lambda_{UV}$$

Mass hierarchies without fine tuning!