On the fluctuation and distributional limit for one-dimensional long-range First-Passage percolation time: linear growth regime

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Abstract: We consider the one-dimensional long-range first-passage percolation model where the edge-weight between two vertices $x \neq y \in \mathbb{Z}$ is distributed as $|x-y|^{\alpha} \cdot \omega_{x,y}$, where $\omega_{x,y}$'s are i.i.d. with $\mathbb{P}(\omega_{1,2} < x) = x^{\kappa+o(1)}$ as $x \to 0$ and $\mathbb{P}(\omega_{1,2} > x) = x^{-\gamma+o(1)}$ as $x \to \infty$ for some constant $\alpha, \kappa, \gamma > 0$. We focus on the linear growth regime for the first passage time, corresponding to $\alpha > 1+2/\kappa$. When $\alpha > 2+2/\kappa$, we prove a Gaussian Central Limit theorem for the centered and scaled first-passage time. This limit holds irrespective of the $\gamma > 0$ value. When $\alpha \in (1+2/\kappa, 2+2/\kappa$, under a particular assumption, we prove a Lévy limit for the first-passage time. The main idea is the existence of a hub structure with positive density, giving an i.i.d. decomposition of the first-passage time.

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