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# Scaling solutions of wiggly cosmic strings

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Cosmic strings may have formed in the early universe due to the Kibble mechanism. While string networks are usually modeled as being of Nambu-Goto type, this description is understood to be a convenient approximation, which neglects the typically expected presence of additional degrees of freedom on the string worldsheet. Previous simulations of cosmic strings in expanding universes have established beyond doubt the existence of a significant amount of short-wavelength propagation modes (commonly called wiggles) on the strings, and a wiggly string extension of the canonical velocity-dependent one-scale model has been recently developed. Here we improve the physical interpretation of this model, by studying the possible asymptotic scaling solutions of this model, and in particular how they are affected by the expansion of the universe and the available energy loss or transfer mechanisms—e.g., the production of loops and wiggles. In addition to the Nambu-Goto solution, to which the wiggly model reduces in the appropriate limit, we find that there are also solutions where the amount of wiggliness can grow as the network evolves or, for specific expansion rates, become a constant. Our results show that full scaling of the network, including the wiggliness, is much more likely in the matter era than in the radiation era, which is in agreement with numerical simulation results.

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