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Nonlinear gravitational-wave memory from cusps and kinks on cosmic strings

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The nonlinear memory effect is a fascinating prediction of general relativity (GR), in which oscillatory gravitational-wave (GW) signals are generically accompanied by a monotonically-increasing strain which persists in the detector long after the signal has passed. This effect is directly accessible to GW observatories, and presents a unique opportunity to test GR in the dynamical and nonlinear regime. We have recently calculated, for the first time, the nonlinear memory signal associated with GW bursts from cusps and kinks on cosmic string loops, which are an important target for current and future GW observatories. In this talk I will describe the resulting analytical waveforms for the GW memory from cusps and kinks, and the corresponding "memory of the memory"and other higher-order memory effects. These are among the first memory observables computed for a cosmological source of GWs, with previous literature having focused almost entirely on astrophysical sources. Surprisingly, we find that the cusp GW signal diverges for sufficiently large loops, and argue that the most plausible explanation for this divergence is a breakdown in the weak-field treatment of GW emission from the cusp. This shows that previously-neglected strong gravity effects must play an important role near cusps, although the exact mechanism by which they cure the divergence is not currently understood. I will argue that one possible resolution is for these cusps to collapse to form primordial black holes (PBHs).

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