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Coherent Gravitational Waveforms and Memory from Cosmic String Loops

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We construct, for the first time, the time-domain gravitational wave strain waveform from the collapse of a strongly gravitating Abelian Higgs cosmic string loop in full general relativity. We show that the strain exhibits a large memory effect during merger, ending with a burst and the characteristic ringdown as a black hole is formed. Furthermore, we investigate the waveform and energy emitted as a function of string width, loop radius and string tension $G\mu$. We find that the mass normalized gravitational wave energy displays a strong dependence on the inverse of the string tension $E_{\rm GW}/M_0 \propto 1/G\mu$, with $E_{\rm GW}/M_0 \sim calO(1)\%$ at the percent level, for the regime where $G\mu \geq 10^{-3}$. Conversely, we show that the efficiency is only weakly dependent on the initial string width and initial loop radii. Using these results, we argue that gravitational wave production is dominated by kinematical instead of geometrical considerations.

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