

Gravitational waves from self-interacting cosmic strings

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based on work with Jose J. Blanco-Pillado and Ken D. Olum

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 - Locally: self-interactions with these GWs, **backreaction**, changes the loop's shape.
 - Far away: a large population of loops, filling the universe, emitting GWs over a long period of time, leads to a **stochastic gravitational wave background** (SGWB).

Two big questions:

- 1) How does backreaction change the shape of a string loop?
- 2) How do those changes affect the loop's evolution and GW emission?

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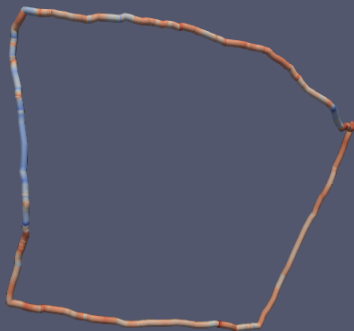
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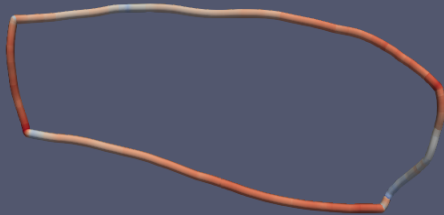
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- The statistical properties of this corpus (we look at $\mathcal{O}(100)$ loops) are what we're interested in!

Sample loop, 0% evaporated



Sample loop, 50% evaporated



Loops form jagged, but backreaction smooths them out

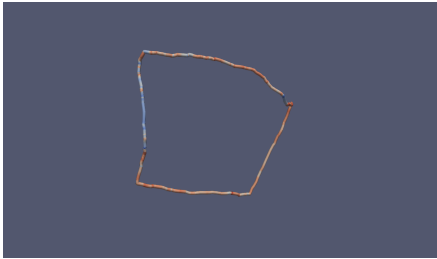


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- The rate and scale of smoothing observed in simulation agrees with analytical predictions (see 1808.08254, 1903.06079)

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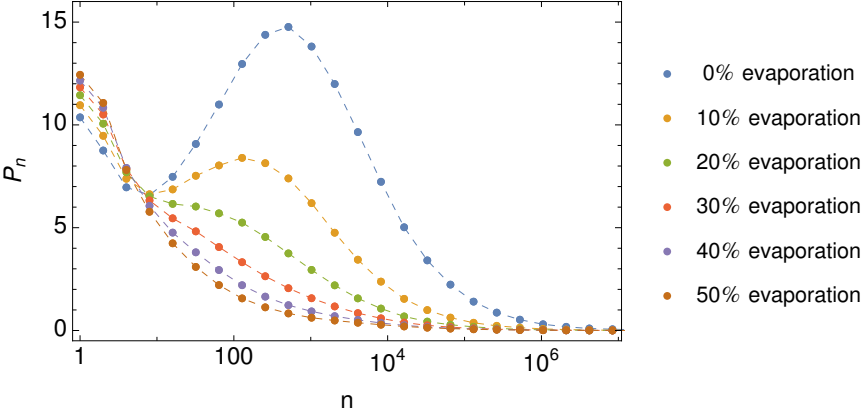
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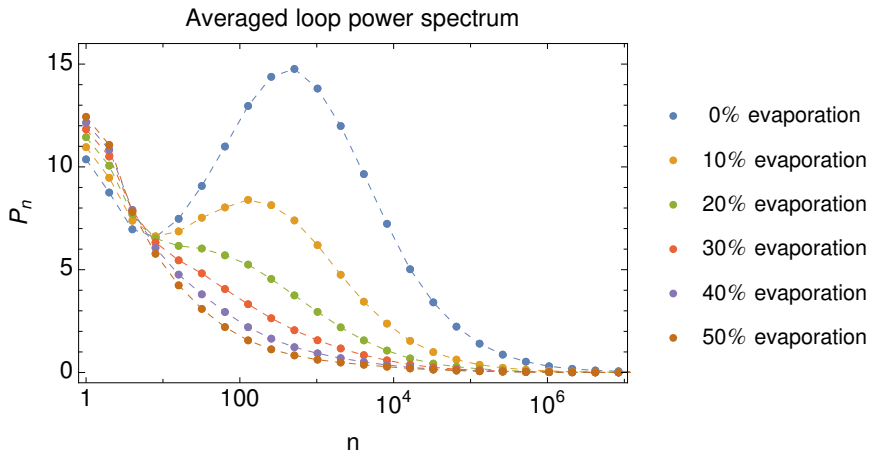
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 - Use the toy model of backreaction to smooth loops from simulation and find an average power spectrum; looks cuspy at $n \gg 1$ with some variation at low modes (called **BOS**; see 1709.02693).

Backreaction reduces the power in high-frequency modes

Averaged loop power spectrum



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Caveat: this plot is for loops without major self-intersections anywhere in their evolution!

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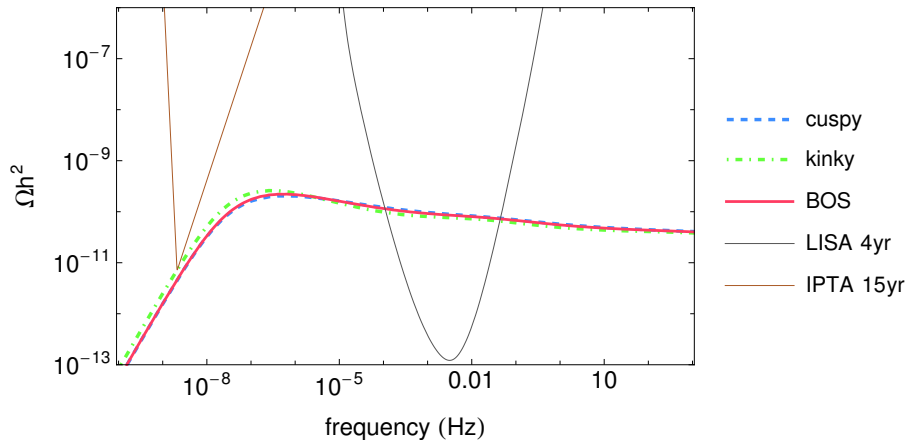
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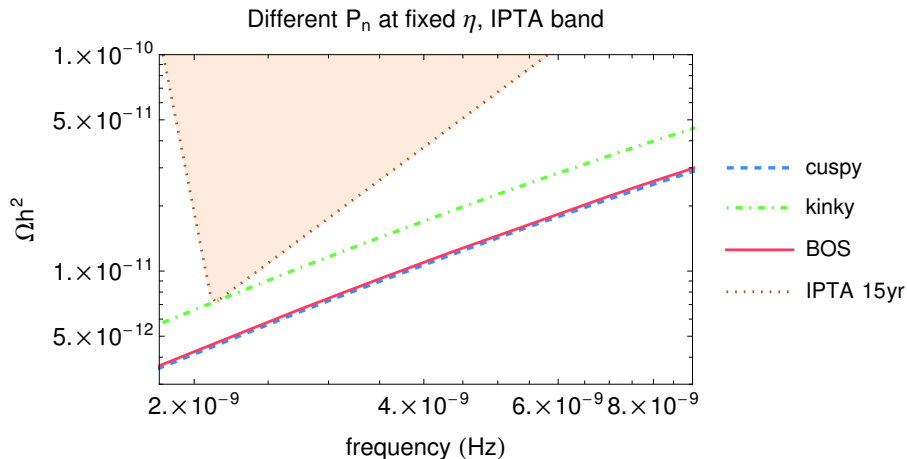
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 - Example: if self-intersections are more common than in the toy model, we'd expect a kinkier final spectrum.

Different P_n affect the SGWB only slightly

Different P_n at fixed $\eta \sim 10^{13}$ GeV

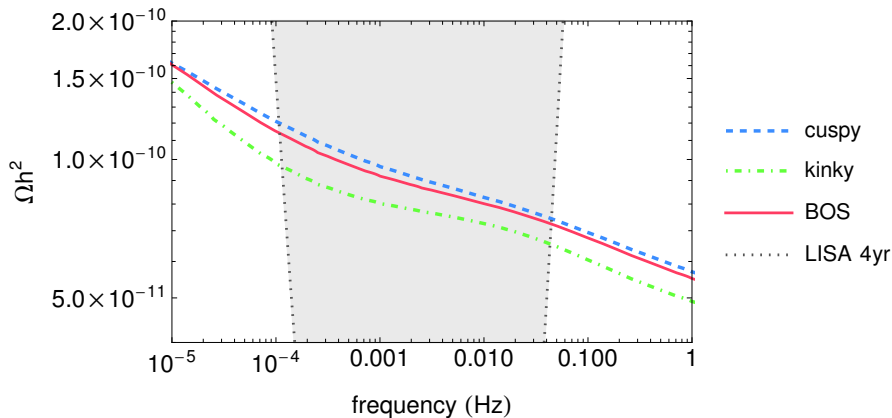


At \sim nHz frequencies, kinkier spectra are more detectable



At \sim mHz frequencies, cuspy spectra are more detectable

Different P_n at fixed η , LISA band



- Backreaction takes initially kinky loops and makes them smooth(er), but probably not as smooth as existing toy models.
- Backreaction can lead to self-intersections, but we currently think the spectrum is only minorly affected by them.
- The stochastic gravitational wave background from backreacted string loops should be very close to current models, but with measurable differences in regions covered by current and future detectors.

Look for more results and more details Soon™!

References:

- “Cosmic string loop shapes”, Blanco-Pillado, Olum, & Shlaer, PRD 92 (2015) [1508.02693]
- “Stochastic gravitational wave background from smoothed cosmic string loops”, Blanco-Pillado & Olum, PRD 96 (2017) [1709.02693]
- “Gravitational backreaction near cosmic string kinks and cusps”, Blanco-Pillado, Olum & JMW, PRD 98 (2018) [1808.08254]
- “Gravitational backreaction simulations of simple cosmic string loops”, Blanco-Pillado, Olum & JMW, PRD 100 (2019) [1903.06079]