Numerical relativity for next-generation gravitational-wave probes of fundamental physics

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Snowmass 2021 CF7 Update
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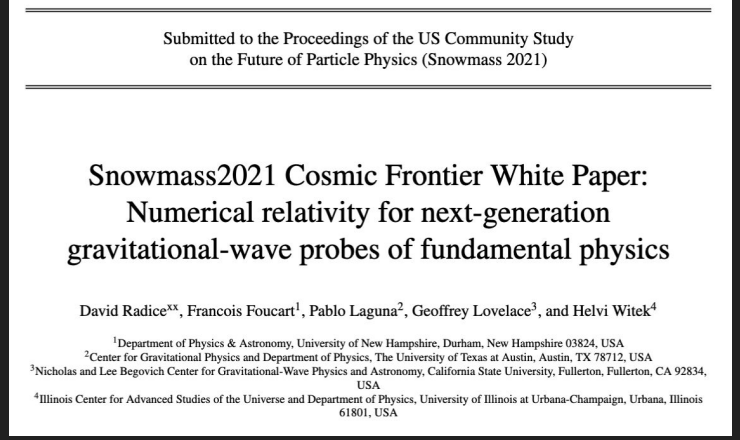
Whitepaper contents

- Motivation
- Gravitational waveform modeling
- Nuclear physics and neutron stars
- High-precision gravitational-wave observations
- Testing gravity in the nonlinear regime
- Black holes as cosmic particle detectors
- Summary and future directions

Whitepaper status

- Current draft in progress on overleaf
- 7 pages so far
- Section status
  - Motivation — 4 paragraphs + 1 figure drafted, need to resolve comments
  - Gravitational waveform modeling — need to flesh out bullets
  - Nuclear physics and neutron stars — 6 paragraphs + references drafted
  - High-precision gravitational-wave observations — 3 paragraphs + references drafted
  - Testing gravity in the nonlinear regime — 2 paragraphs + references drafted
  - Black holes as cosmic particle detectors — 1 paragraph + references drafted
  - Summary and future directions — need to flesh out bullets



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Snowmass2021 Cosmic Frontier White Paper:
Numerical relativity for next-generation
gravitational-wave probes of fundamental physics

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Key messages for topical group report

- Next-generation gravitational-wave detectors (LIGO Voyager, Cosmic Explorer, Einstein Telescope, NEMO) will probe fundamental physics with unprecedented sensitivity
  - Nuclear physics & neutron stars: nature of dense matter
  - Testing gravity in the nonlinear regime with high-fidelity gravitational-wave observations
  - Black holes as cosmic particle detectors: complementary to other experiments
- Accurate theoretical models of the observed waves are critical for realizing this goal
- Challenge: these models will require numerical relativity calculations on supercomputers that achieve at least an order of magnitude more accuracy than today’s state of the art