

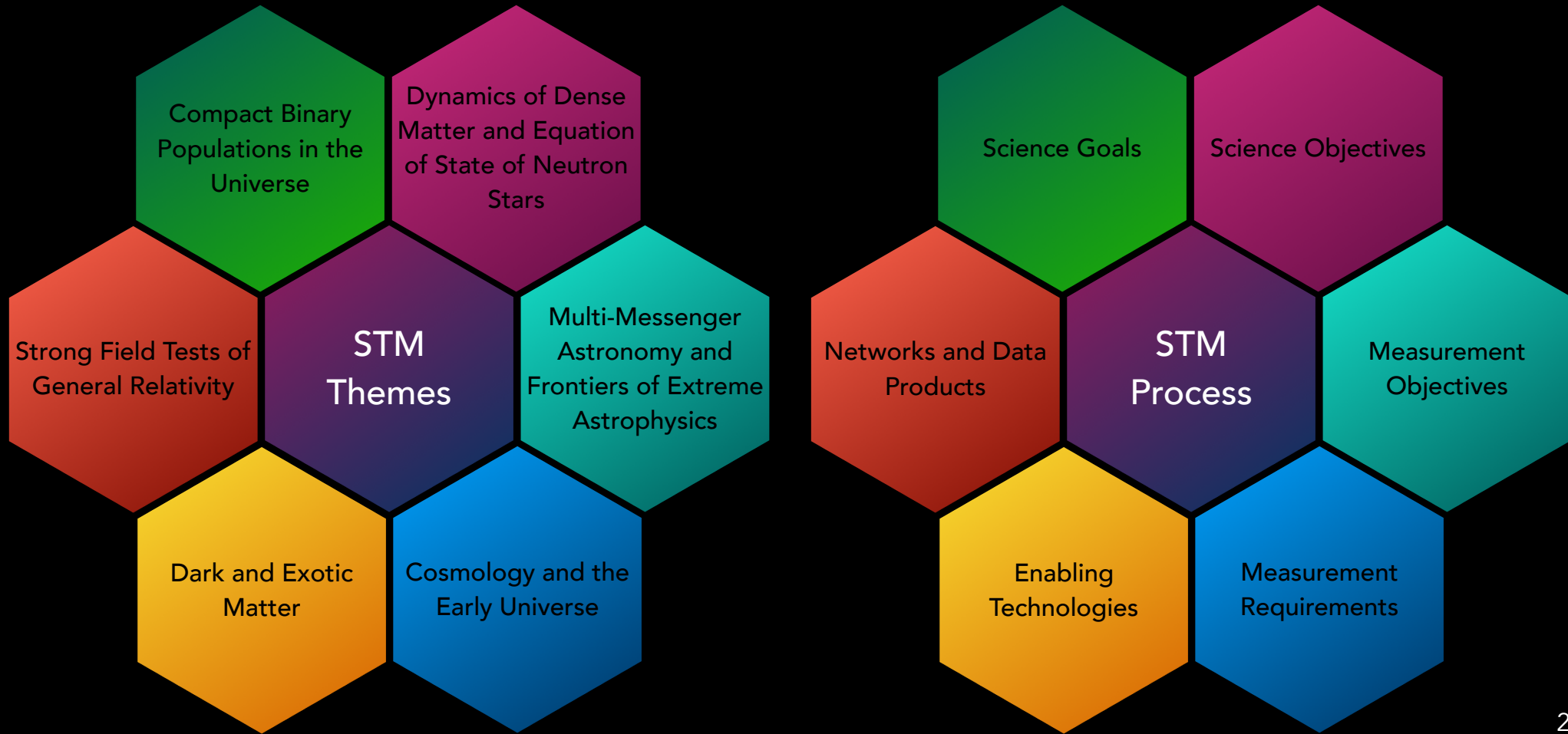
SCIENCE TRACEABILITY MATRIX FOR COSMIC EXPLORER

Nils Andersson¹ and B. S. Sathyaprakash²

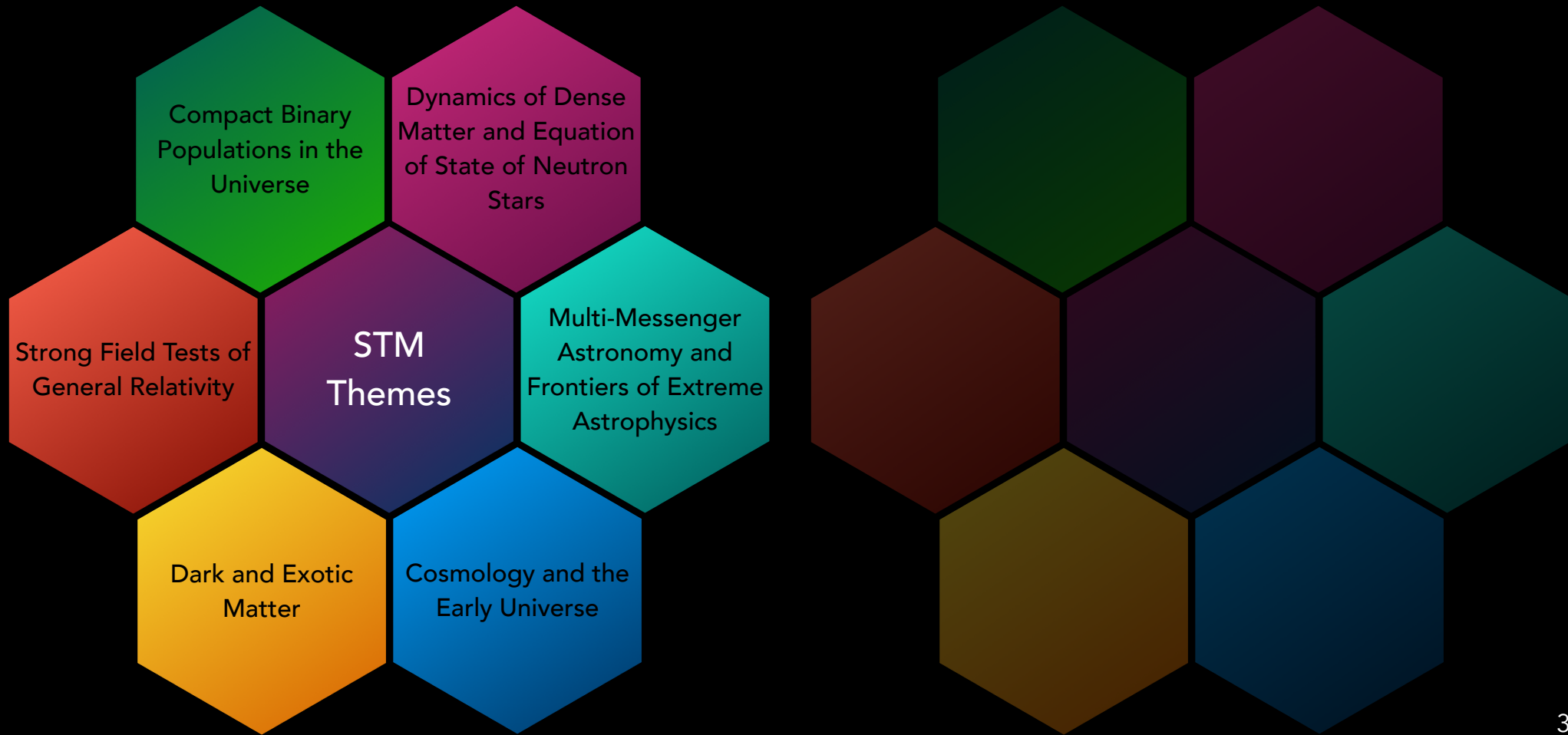
¹University of Southampton, ²The Pennsylvania State University



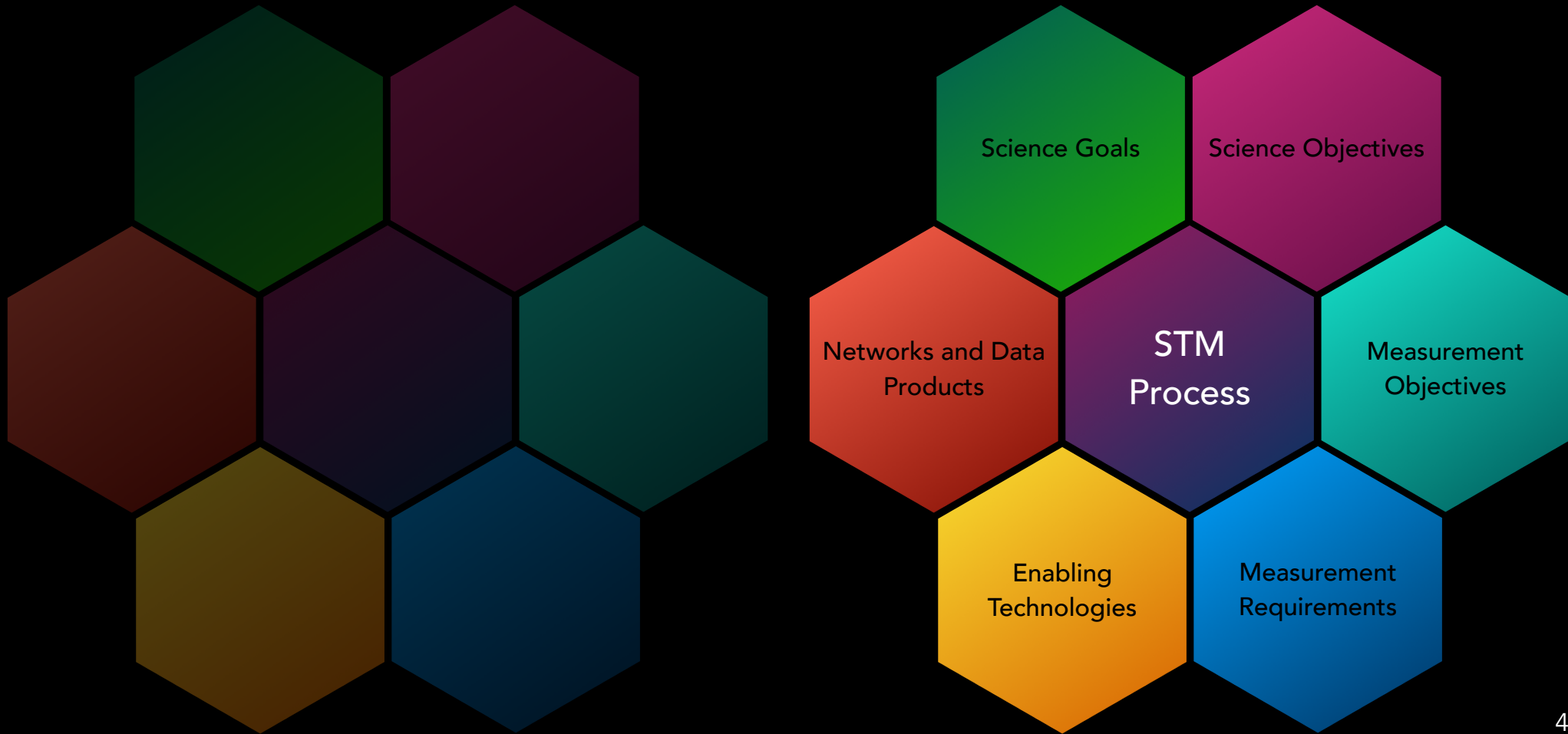
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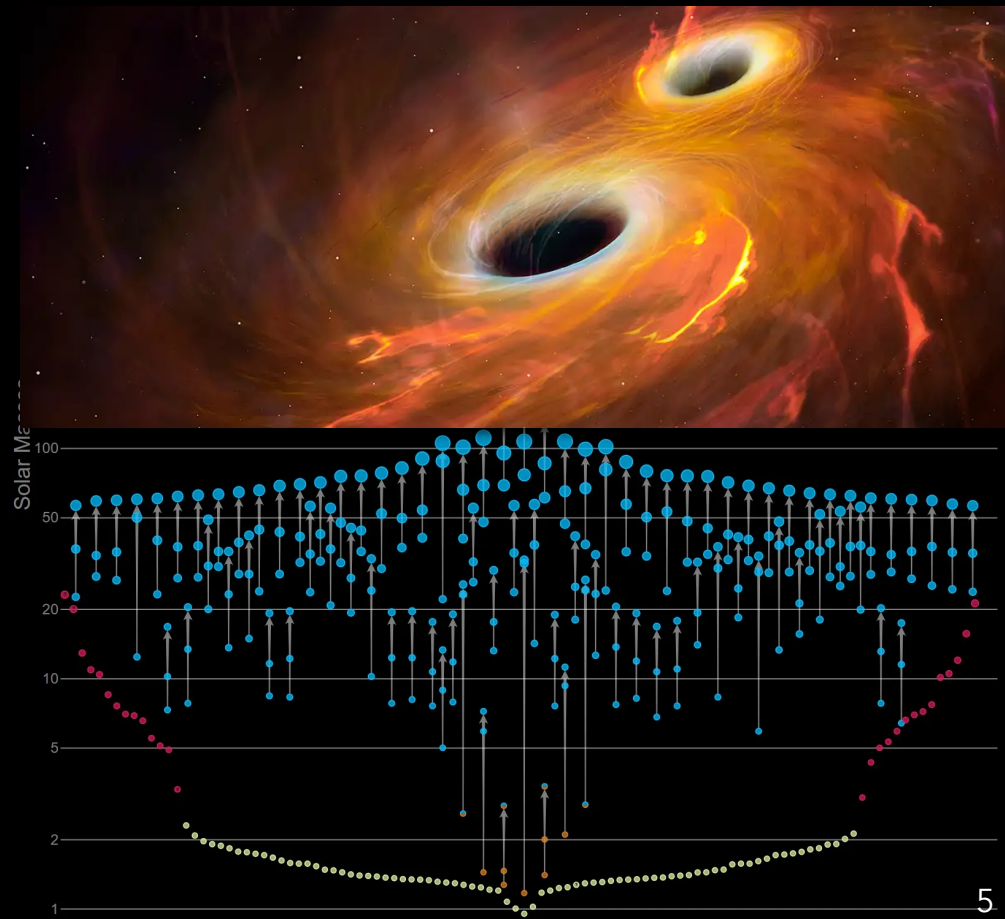
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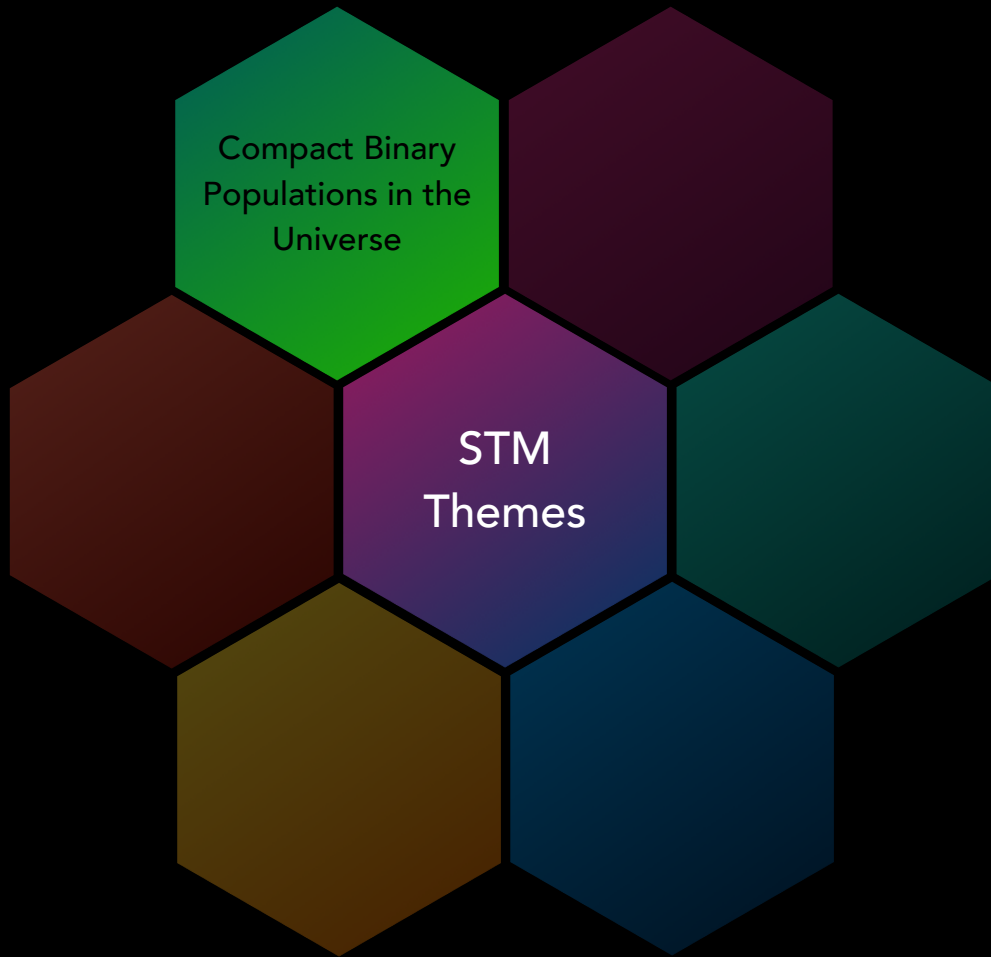
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Compact Binary
Populations in the
Universe

STM
Themes

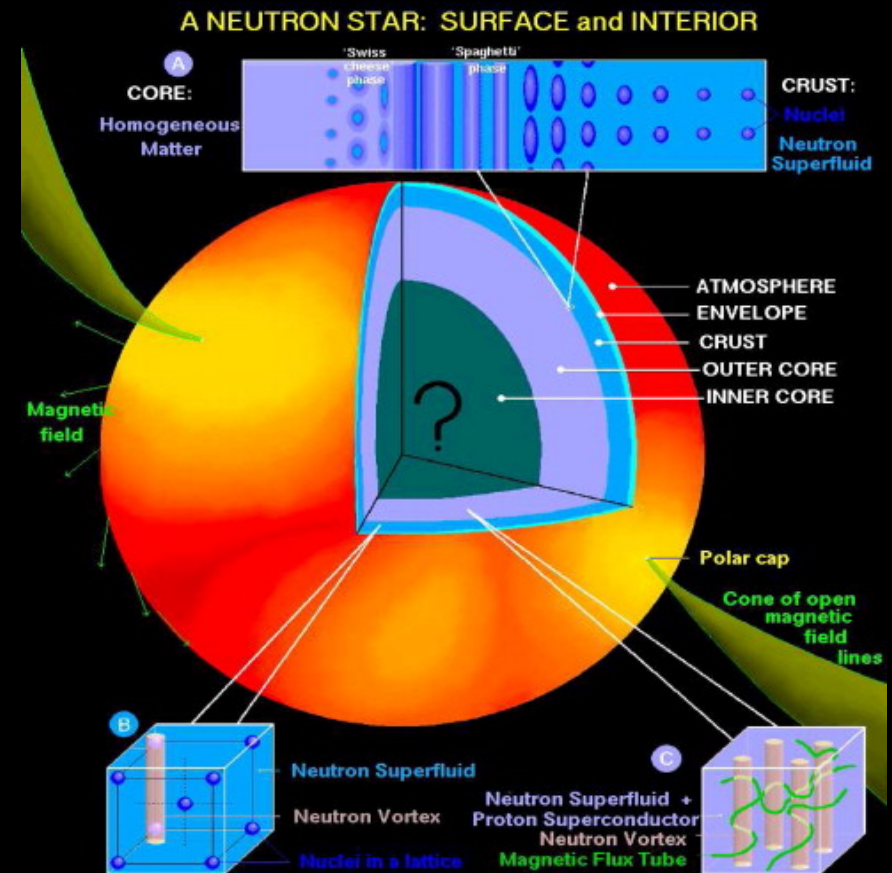
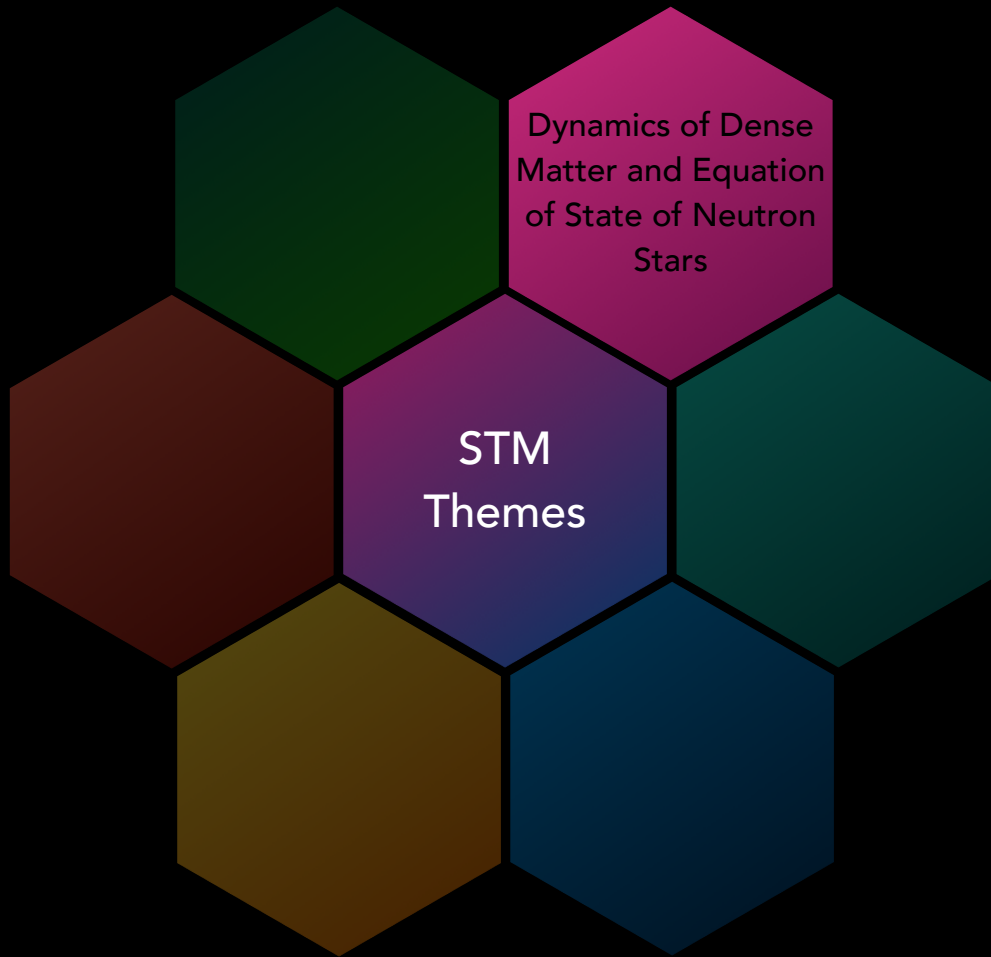


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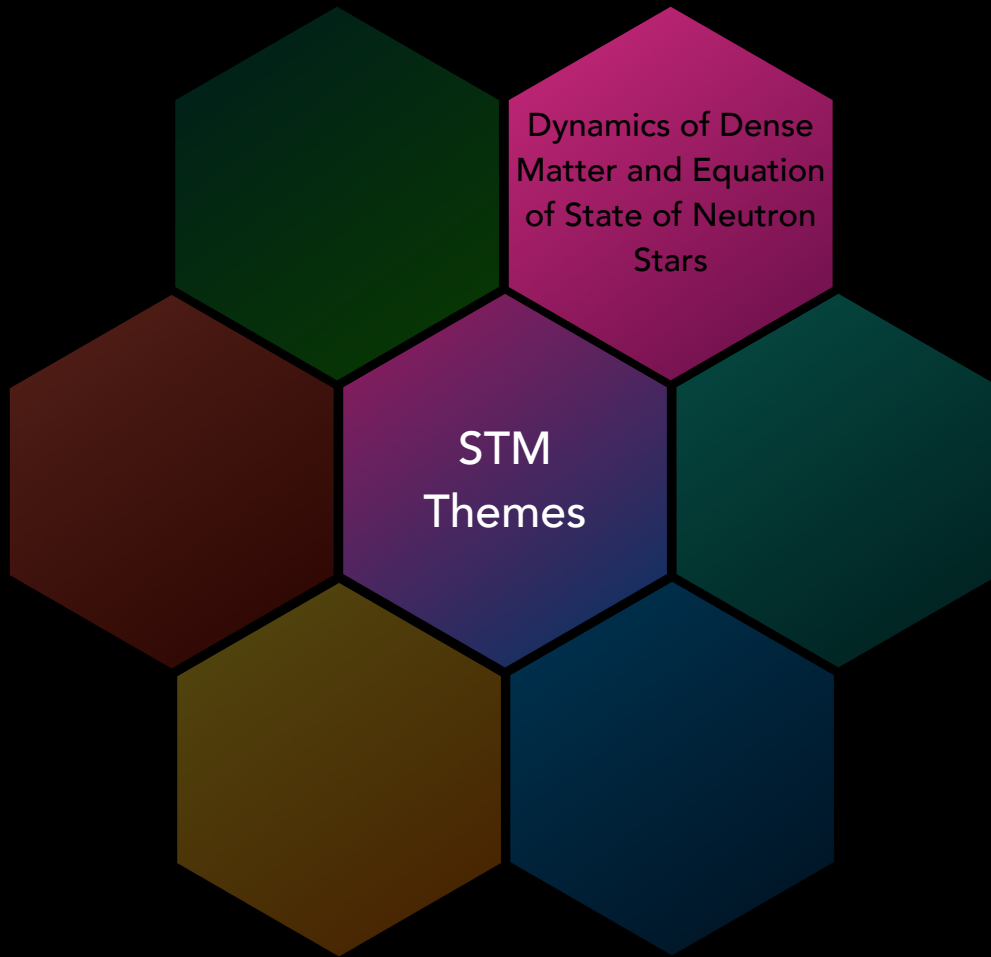


- How does the black hole population in the early Universe compare to the local population?
- Do high- and low-mass stellar black hole merger rates evolve differently with redshift?
- When and how did the first black holes form?
- Do “light seeds” contribute significantly to the formation of supermassive black holes?
- How does the neutron star population in the early Universe differ from that observed locally?
- What is the relationship between the growth of black holes and the evolution of galaxies?

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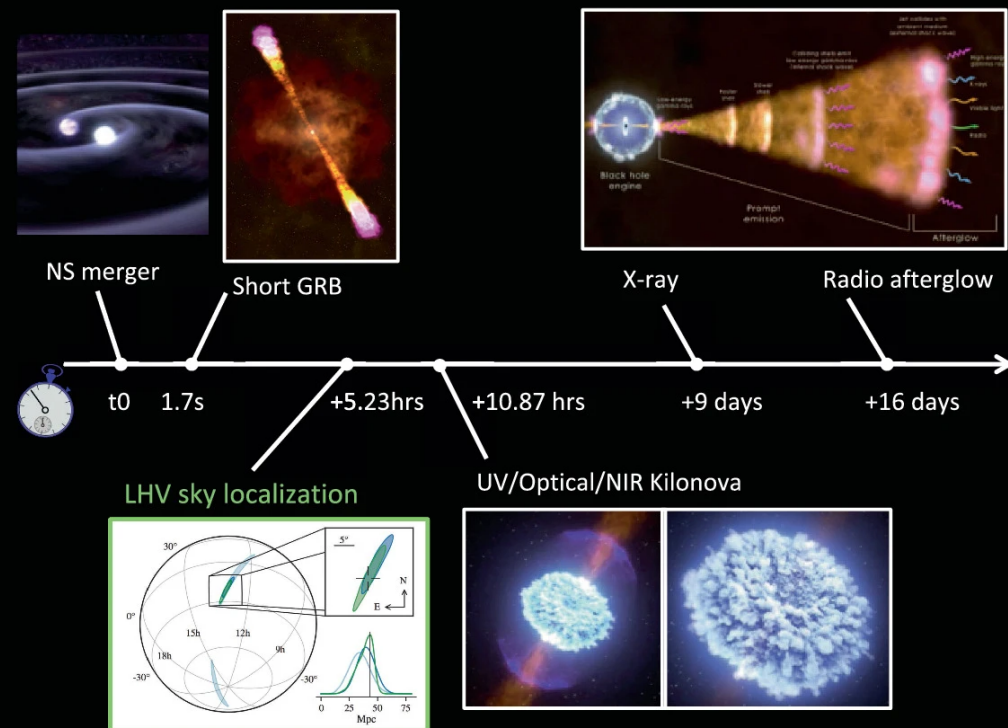


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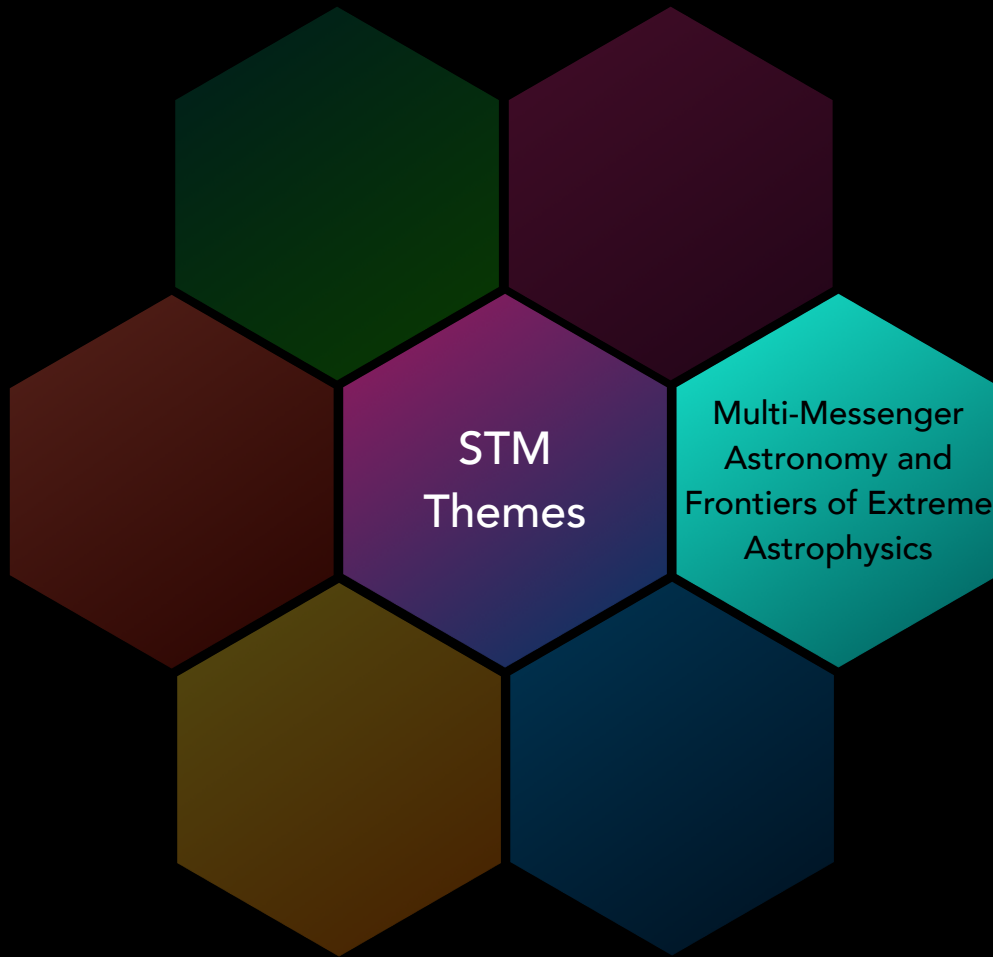


- What is the maximum mass a neutron star can support?
- What is the minimum possible radius of a neutron star?
- How does tidal deformability vary with neutron star mass?
- What constraints on the EOS can be obtained from post-merger oscillations?
- Can we distinguish between nucleonic, hyperonic, and quark matter EOS models?
- Do EOS constraints evolve with redshift, reflecting cosmic time evolution?

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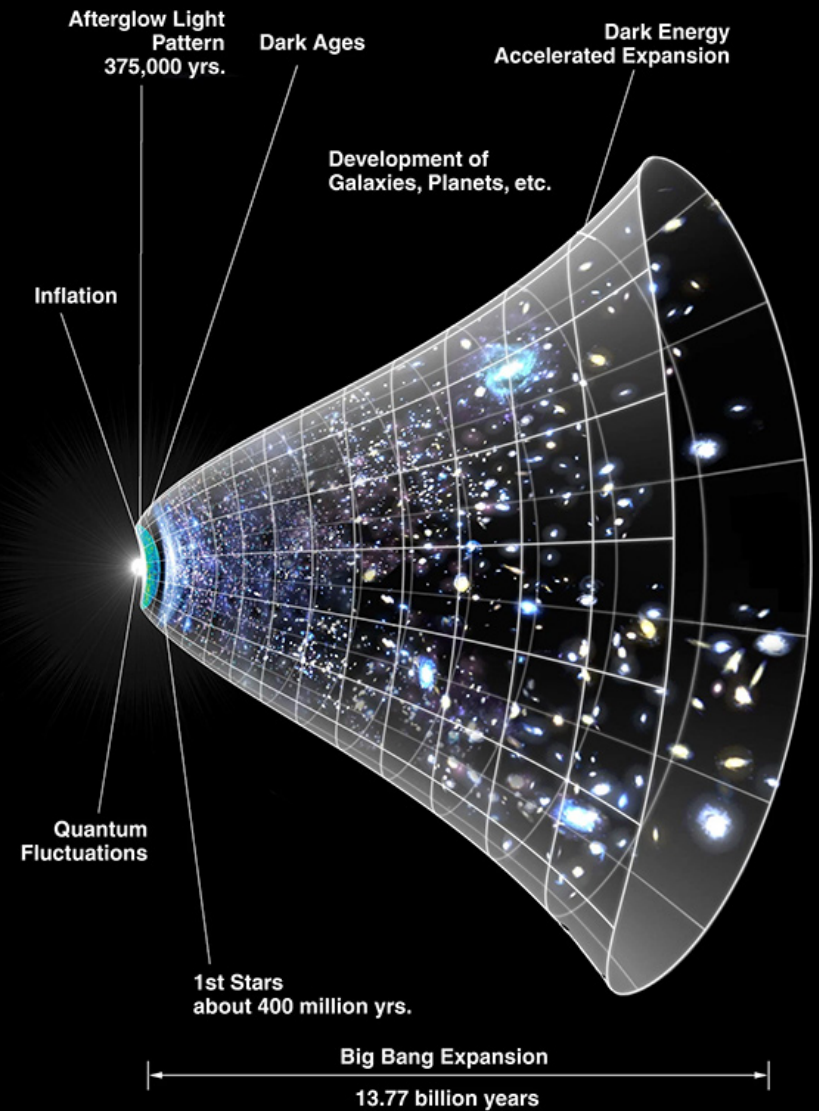
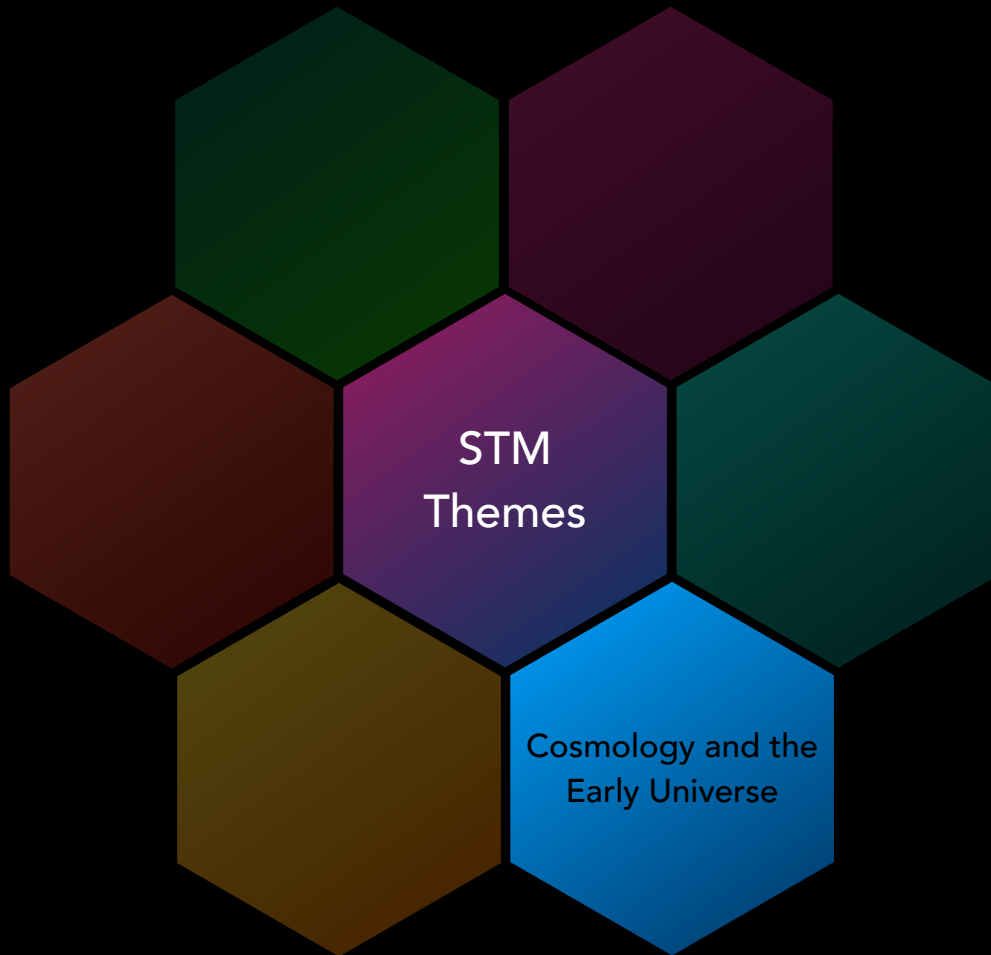


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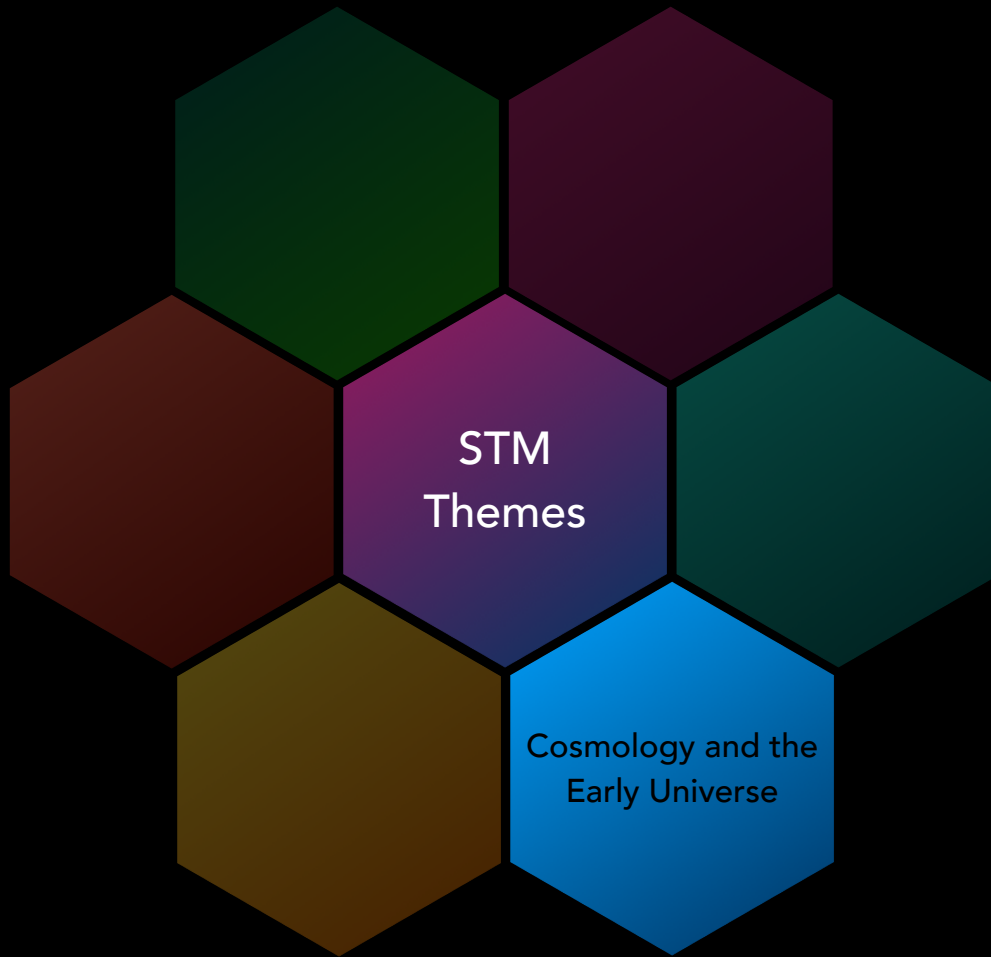


- What are the progenitors of short gamma-ray bursts?
- Do kilonovae accompany all binary neutron star mergers?
- What are the r-process nucleosynthetic yields from mergers?
- How can joint GW–EM detections constrain the Hubble constant and other cosmological parameters?
- How do gravitational-wave and electromagnetic observations together constrain merger environments?
- What fraction of binary neutron star mergers are observed in both gravitational waves and electromagnetic signals?

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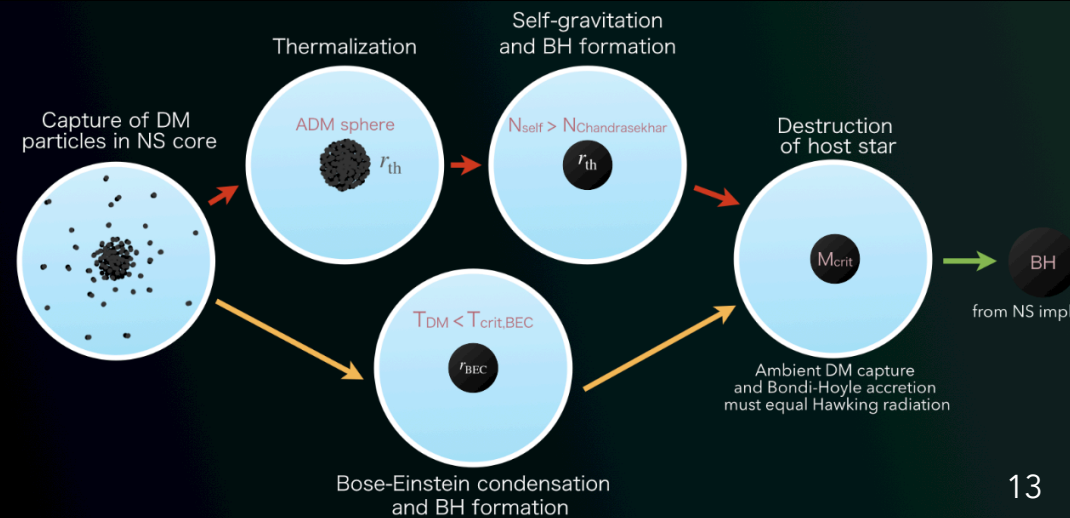


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- How precisely can standard sirens measure the Hubble constant?
- Can gravitational waves probe the dark energy equation of state?
- What constraints on modified gravity arise from GW propagation effects?
- How can gravitational waves measure the growth of structure at intermediate redshifts?
- What synergies exist between GW observations and large-scale structure surveys?
- How do statistical standard sirens compare with individually identified "golden events"?

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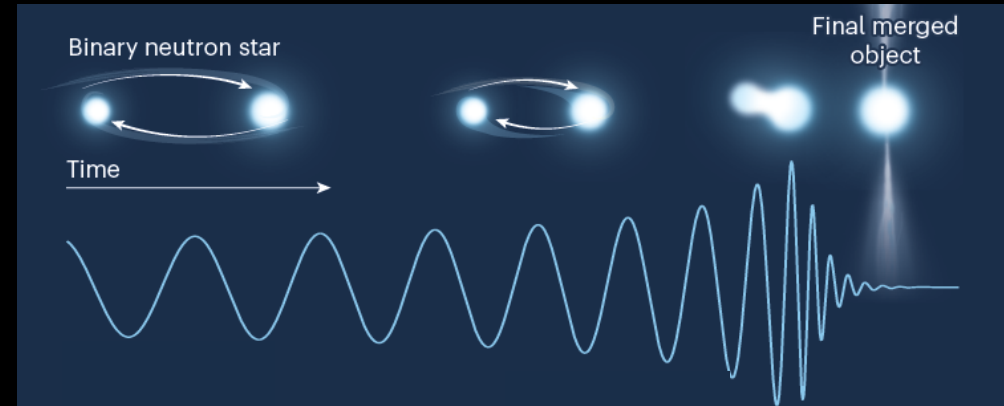
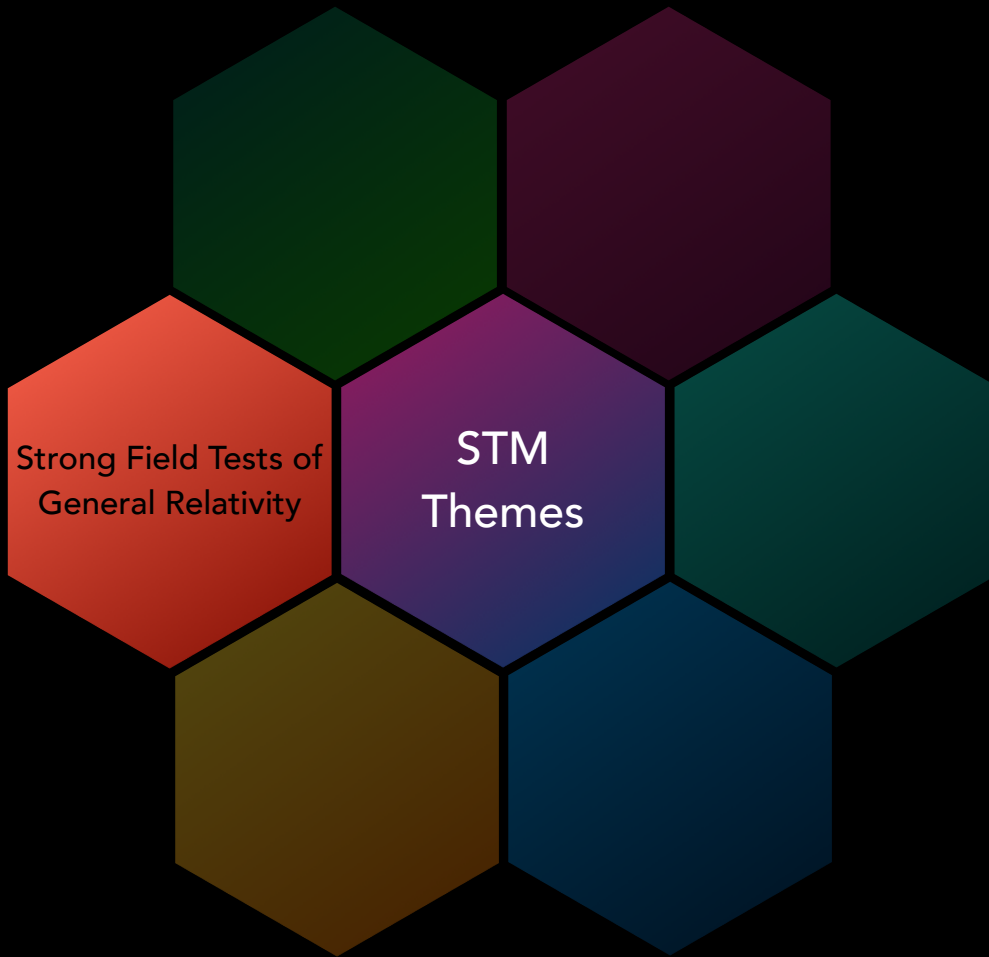


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- How do WIMPs affect orbital dynamics and stellar properties?
- Can axions or axion-like particles produce observable signatures (e.g., superradiance)?
- Could direct interactions of dark matter with detectors leave detectable imprints beyond standard GW signals?
- What impact does dark matter have on large-scale structure formation (in synergy with cosmology)?
- How would exotic states (e.g., neutrinos, hexaquarks) modify neutron star evolution and composition?

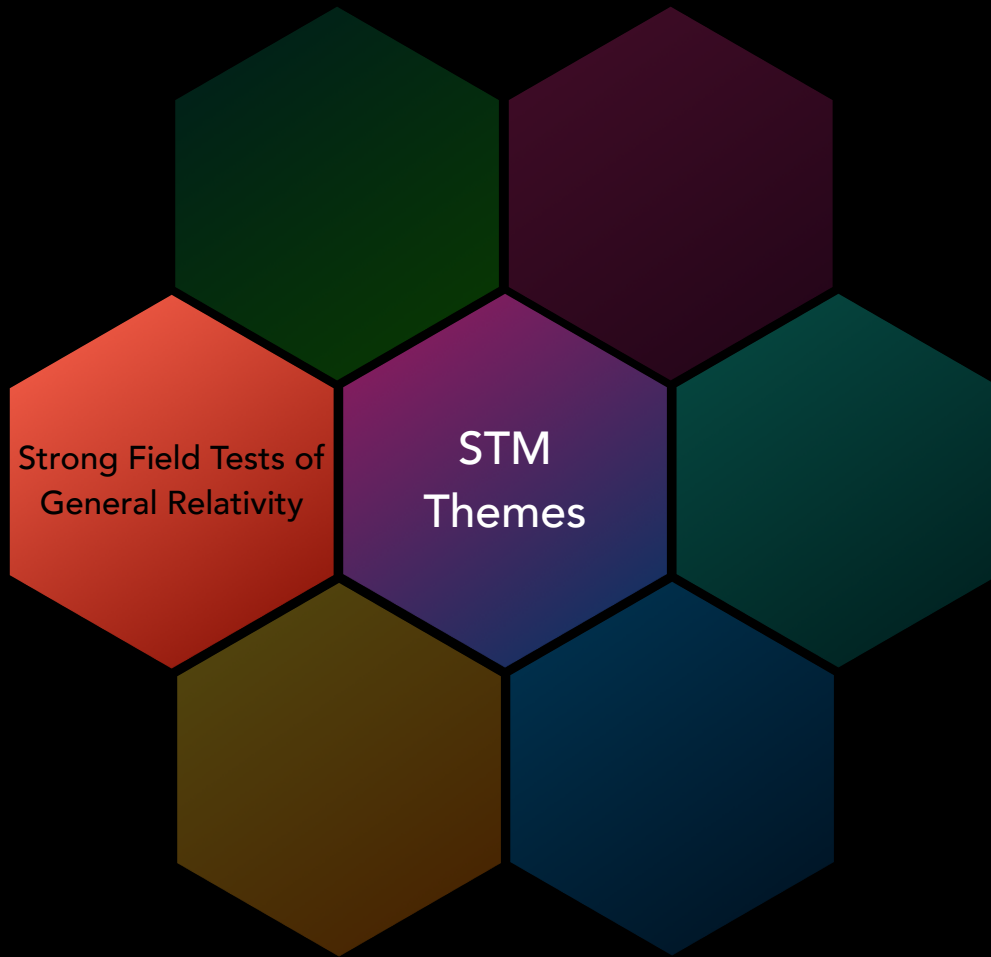
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<https://www.skyatnightmagazine.com/news/what-are-gravitational-waves>



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- Do GW signals from compact binaries agree with general relativity across inspiral, merger, and ringdown?
- Are the remnants of binary black hole and neutron star mergers consistent with the Kerr solution?
- Can we detect or place limits on additional polarizations of gravitational waves?
- What constraints do GW dispersion and amplitude damping impose on modified gravity theories?
- How can multi-mode ringdown observations test the no-hair theorem?
- Are there observable signatures of quantum gravity or exotic compact objects in GW data?

JOINING THE STM

- For more details about the Cosmic Explorer project visit cosmicexplorer.org
- STM is open for anyone interested to join, write to Nils Andersson (N.A.Andersson@southampton.ac.uk) or B.S. Sathyaprakash (bss25@psu.edu)
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