

Snowmass Day



# CF5. Dark Energy and Cosmic Acceleration: Cosmic Dawn and Before



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# Overview

## Cosmic probes of cosmology in the early Universe from Inflation Era through the Cosmic Dawn

- Topics include:
  - growth of structure probes (e.g. 21cm power spectrum in the dark ages)
  - probes of expansion history (e.g. BAO with black hole mergers, CMB)
  - primordial non-gaussianity
  - inflation
- Experiments include:
  - High-z gravitational wave observatories
  - 21cm projects
  - CMB/mm-wave survey projects

# Synthesizing community input

- Prior to break, LOIs and input from Snowmass Community Planning meeting was synthesized together with the CF5 Working Group:
  - Adrian Liu, Emanuele Castorina, Mike Neimack, Kevin Huffenberger, Dan Green, Renee Hlozek, Robert Caldwell
- Several broad themes emerged.

#	Title	Lead Author	Broad THEMES	EXPT CLASS
168	Searching for Evidence of a Conformal Scalar and Conformal Invariance in the Universe	Mottola	Origins, Relics	CMB
113	Dark Matter and Early Universe Physics from Measurements below the Galaxy Formation Threshold	Bectol	Relics, DM	astronomy
242	Cosmology with Millimeter-Wave Line Intensity Mapping	Karkare	Origins, Relics, DE	LSS/Mapping
253	Beyond Pairs: Using Higher-Order Statistics to Illuminate the Universe's Contents and Laws	Slepian	Origins	LSS/Mapping
188	Inflation and Dark Energy with the MegaMapper: probing fundamental physics with $z > 2$ spectroscopy	Ferraro	Origins, DE	LSS/Mapping
27	Packed Ultra-wideband Mapping Array (PUMA): Science Opportunities	Zlosar	Origins, Relics, DM, DE	LSS/Mapping
16	CMB-HD: An Ultra-Deep, High-Resolution Millimeter-Wave Survey Over Half the Sky	Sehgal	DM, Relics, Origins	CMB
211	Cosmic dawn: A probe of dark matter at small scales	Munoz	DM, Relics	LSS/Mapping
262	Complementarity of ground- and space-based observations of the cosmic microwave background	Lee	Origins, Relics	CMB
240	CMB-S4: Primordial Gravitational Waves and Inflation	CMB-S4	Origins	CMB
245	Primordial Non-Gaussianity with Millimeter-Wave Line Intensity Mapping	Karkare	Origins	LSS/Mapping
36	Future of CMB	Wu	Origins, Relics	CMB
102	The Stochastic Gravitational Wave Background as a Probe of New Physics from the Early Universe	Caldwell	BSM, Origins, Relics	GW
223	Probing Physics at the Highest Energy Scales with Primordial Features	Wallisch	Origins	CMB, LSS/Mapping
64	Cosmological Collider: Precision calculation and probes of new physics	Wang	Origins	CMB, LSS/Mapping
138	Gravitational Wave as a probe of phase transitions during inflation	An	BSM, Origins, DE	CMB, GW
212	A 21-cm based standard ruler at $z \sim 20$	Munoz	DE	LSS/Mapping
239	A deci-Hz Gravitational-Wave Lunar Observatory for Cosmology	Jani	BSM, Origins, Relics, DE	GW
59	Probing Fundamental Physics using the Stochastic Gravitational Wave Background from the Early Universe	Zhao	BSM, Origins, Relics	GW
104	Complementarity between collider and gravitational wave signatures of a first-order electroweak phase transition	Musolf	BSM, Origins	GW, collider
51	Software and Statistics for Discovery in Cosmic Frontiers Experiments	Connolly	DE, DM, Origins	LSS/Mapping
211	Probing the Electroweak Phase Transition with Exotic Higgs Decays	Carena	BSM, Origins	collider
51	Primordial Non-Gaussianity	Pimentel	Origins	LSS/Mapping

# White Papers

## Soliciting 9 white papers (see next slide) from the community

- Want interested members of the community to write these solicited white papers
  - Welcome to submit an independent white paper, but please also contribute to these solicited papers
  - Each paper has “community volunteers” to help coordinate writing
- Two “flavors” of solicited white papers
  - “Theory” white papers that synthesize the theoretical landscape highlighting the interest and importance of these topics to High Energy Physics.
    - E.g.: see first section of <https://arxiv.org/pdf/1309.5381.pdf>
  - “Measurement” white papers that discuss how different experimental approaches advance our understanding of the above topics including projected experimental reach. These papers can also include discussing the current and future state of the field and associated technical challenges.
    - E.g.: see second section of <https://arxiv.org/pdf/1309.5381.pdf>

# Solicited White Papers

## Theory

- Inflationary science through non-gaussianity, primordial features & B-modes with [Dan Green](#), [Marilena Loverde](#)
- Light relics with [Dan Green](#), [Marilena Loverde](#), [Renee Hlozek](#)
- BSM Cosmology (e.g. early universe phase transitions) with [Robert Caldwell](#)
- Beyond Standard Cosmology (e.g. low & high-z cosmology) with [Robert Caldwell](#), [Renee Hlozek](#)

## Measurement

- Stochastic GW Background with [Robert Caldwell](#), [Deirdre Shoemaker](#)
- 21cm (PUMA, “Cosmic Dawn Array”) with [Adrian Liu](#), [Danny Jacobs](#), [Laura Newburgh](#)
- Mm-wave LIM with [Clarence Chang](#), [Adrian Liu](#), [Jeff McMahon](#)
- CMB (e.g. CMB-HD, CMB from ground & space) with [Kevin Huffenberger](#), [Clarence Chang](#)
- Optical Survey (e.g. Megamapper) with [Laura Newburgh](#) & [Clarence Chang](#)

# Thank you!