B06: DM–CMB The Dark Matter (DM) Search using the Cosmic Microwave Background (CMB)

Eiichiro Komatsu (Max Planck Institute for Astrophysics / Kavli IPMU) Symposium, March 7, 2023



ESA's Planck



Credit: ESA







Credit: ESA

Temperature (smoothed) + Polarisation

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Standard Cosmological Model (ACDM) Requires New Physics Physics beyond Standard Model of elementary particles and fields

Dark Sector: What is dark matter (CDM)? What is dark energy (Λ)?

behind cosmic inflation?

Polarisation of the CMB may hold the answers to these questions.

Early Universe: What powered the Big Bang? What is the fundamental physics



Standard Cosmological Model (ACDM) Requires New Physics Physics beyond Standard Model of elementary particles and fields

- **Dark Sector**: What is dark matter (CDM)? What is dark energy (Λ)?
 - Cosmic birefringence in cross-correlation of E- and B-mode polarisation
- Early Universe: What powered the Big Bang? What is the fundamental physics behind cosmic inflation?
 - Imprint of primordial gravitational waves in B-mode polarisation
- Polarisation of the CMB may hold the answers to these questions.



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Many of the B06 activities are explained in this article. Review Article Published: 18 May 2022 New physics from the polarized light of the cosmic microwave background Key Words:

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Cosmic Microwave Background (CMB) Polarization **Parity Symmetry**



The Science Targets: Examples How can we use the CMB polarisation to learn about the DM?

- **Do the DM fields violate parity symmetry?**
 - Why not? The weak interaction violates parity symmetry.
 - E.g., axion-like fields.
 - polarised light of the CMB?
- Do the DM fields have a higher spin?

 - waves which can be observed in the CMB polarisation?

• **Example project:** How does the parity-violating DM field affect the propagation of

• Why not? The Higgs field is the only known field of elementary particles with zero spin.

• **Example project:** Do higher-spin fields generate new features in the gravitational

The Team A small yet "dream team"





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Credit: WMAP Science Team The surface of "last scattering" by electrons (Scattering generates *polarisation*!)

What powered the Big Bang?

What is dark matter/energy?



Achievements: Highlight (4.2022 – 3.2023) Do the DM fields violate parity symmetry? New measurement and interpretation of "cosmic birefringence"

- - Eskilt, **EK**, "Improved constraints on cosmic birefringence from the WMAP and Planck cosmic microwave background polarization data", published in PRD.
 - Nakatsuka, Namikawa, EK, "Is cosmic birefringence due to dark
 - from early dark energy", published in PRD.
 - dark energy", published in JCAP.

energy or dark matter? A tomographic approach", published in PRD.

Murai, Naokawa, Namikawa, EK, "Isotropic cosmic birefringence"

Gasparotto, Obata, "Cosmic birefringence from monodromic axion

heard this.

I have a new idea!

