



Science Book V2: Chapter on BSM/Particle Physics

**Update given by Benjamin Wallisch
Input from range of people, in particular Maps2Cell**

Science Book v1 – arXiv:1610.02743

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Decadal Survey Report (DSR): 1907.04473

1.3 The Dark Universe

1.3.1 Light relics

- Cosmic neutrino background
- Other light relics

1.3.2 Neutrino mass

- Observables and forecasts
- Detection scenarios

1.3.3 Dark energy

- Dark energy probes
- Cosmic birefringence

1.3.4 Dark matter

- Dark matter-baryon scattering
- Dark matter-dark radiation interactions
- Axions

Science Book v2

- Just getting started; some brainstorming.
- Build and expand on Science Book v1 in various ways – was very influential.
- Decadal Survey Report is a useful guide (including the title: The Dark Universe).
- Current outline not representative: think bullet points that should be included, but rearranged.

Science Book V2: Science

- Add to N_{eff} science case, in particular physics beyond neutrinos and light thermal relics (cf. [many Science Book citations](#) and [Snowmass white paper on light relics](#)).
- Science with radiation density beyond just N_{eff} , such as interacting radiation, free-streaming and other properties (see also [Snowmass white paper on light relics](#)).
- Update neutrino science (see [Snowmass white paper on neutrinos](#)).

Science Book V2: Science

- Expand dark matter science (see [Snowmass WP on DM with S4](#)).
- New developments on dark energy and modified gravity?
- Cosmic birefringence/parity-violating physics.
- Nod towards tensions (CMB, H_0 , S_8 , ...), where relevant, but not focus. Long-lived document, so focus on broad and exciting science, and not on current tensions.
- Reach out to the broader community (departmental colleagues/...).
- See also the talk by Nathaniel Craig at the [Spring Collaboration Meeting 2023](#) for particle phenomenological viewpoint, for instance.

Science Book V2: Forecasts

- [DRAFT tool](#) provides forecasting capabilities and noise curves (work in progress).
- Everyone welcome to run forecasts/share code and contribute (with standard extensions likely run by Maps2Cell?).
- Focus the forecasts on model-agnostic scenarios and refer to references for specifics?
- Balance the content on relevance of the science for CMB-S4, not the number or length of contributions.