Science Book V2: Chapter on BSM/Particle Physics

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

CMB-S4

Science Book v1 – arXiv:1610.02743

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.