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Stage 4 Cosmic Microwave Background Experiment

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Measurements of the CMB have driven our understanding of the universe and the physics that govern its evolution from quantum fluctuations to its present state. They provide the foundation for the remarkable 6-parameter cosmological model, ΛCDM, which fits all cosmological data, although there are some tensions which may hint at new physics, or simply unaccounted systematics. Far from being the last word in cosmology, the model raises deep questions: Is Inflation correct? What is its energy scale? What is the dark matter? What is the nature of dark energy? There is still a lot to learn from the CMB measurements. We are searching for the unique B-mode polarization that would be induced on the CMB by inflationary gravitational waves. We are able to detect the impact of the neutrino background on the CMB, which can be used to provide precise constraints on the number and masses of the neutrinos. We are untangling the correlations in the CMB induced by gravitational lensing to make maps of all the mass in the universe. We are measuring the scattering of the CMB by ionized structures, the Sunyaev-Zeldovich effects, to detect clusters of galaxies and soon to map the momentum of the universe in addition to its density. To realize the enormous potential of these CMB tools we need to greatly increase the sensitivity of CMB measurements. We can expect significant advances in the next few years as the ongoing experiments deploy of order 10,000 detectors (Stage III), but to achieve critical threshold crossing goals we need to go further. The CMB community is therefore planning CMB-S4, an ambitious next generation (Stage IV) ground-based program with order of 500,000 detectors with science goals that include detecting or ruling out large field inflationary models, determining the number and masses of the neutrinos, providing precision constraints on dark energy through its impact on structure formation, as well as searching for cracks in the ΛCDM model.