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Millimetre-wave polarisation calibration CubeSat

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Investigating the polarisation of the cosmic microwave background (CMB) provides us with the opportunity to study the formation of the early universe, in particular it reveals the effect of gravitational waves caused by inflation after the Big Bang. Experiments studying the CMB polarisation use ground and balloon-based polarimeters operating in the millimetre wave range, and these require both precise and absolute measurement of the polarisation orientation. Ideally, the orientation will be measured to within 0.01 degrees, which will allow systematic errors of the detector and false polarisation signals to be filtered out. The required precision can be achieved with the use of a known-source acting as a calibrator, for which a CubeSat is proposed. The satellite contains several linearly polarised sources in the sub-100GHz frequency range, with the exact polarisation orientation determined through pre-launch testing, as well as an accurate attitude determination and control system (ADCS). It could serve as a calibrator for current CMB polarimeters, such as QUIJOTE in the Canary Islands and ACTPOL in Chile, as well as for future European polarisation studies.

Work on this CubeSat project focused on selecting the signal frequencies required by the detectors and specifying the components needed to achieve optimal signal-to-noise ratio at the polarimeters. This led to the design of a calibration CubeSat, which includes the layout, orbit, power budget and testing requirements, with prototypes manufactured for layout definition and to test the concept using a drone. Future work will focus on an integrated CubeSat design with a precise and agile ADCS, as well as more refined predictions of the satellite's operation and possible further testing on a high altitude balloon.

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