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Seminar über Microwavephysics and Atmospheric Physics

Referent: Prof. Luis Enrique García Muñoz, Universidad Carlos III de Madrid

Titel: Can a mm-wave detector's sensitivity approach the quantum limit at room temperature?

The cosmic microwave background (CMB) radiation is a relic from the recombination epoch of the early universe. Its intensity anisotropies and near black body spectrum were predicted and observed, allowing the refinement of the cosmological standard model. However, extremely weak hypothesized signatures such as spectral distortions with respect to a black body, and the B-mode polarization due to primordial gravitational waves are yet undetected. The CMB intensity, spectrum, and polarization, are currently observed with radio telescopes on earth and in space whose instrumentation (radiometers) require cryogenic conditions in order to minimize the internally generated thermal noise. Here we show that microwave-to-optical up-conversion in high Q nonlinear whispering-gallery mode (WGM) resonators can be used for ultra-low-noise radiometry of the CMB at room temperature. We found that radiometers with similar or better sensitivity than a 85K-cooled high-electron-mobility transistor (HEMT) receiver can be achieved at room temperature with high efficiency up-converters and photodetectors. We experimentally demonstrate up- conversion of 80 GHz microwave signals into 194 THz optical signals inside lithium niobate cavities, showing two orders of magnitude higher efficiency than the best reported so far. These results demonstrate the versatility of WGM cavities made of nonlinear crystals, as ultra-low-noise and highly efficient electro-optic up-converters for frequencies ranging from microwave to THz. And the question arises: "Can a mm-wave detector's sensitivity approach the quantum limit at room temperature?"

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