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The spectrum of the vacuum as a primary reference for radiometry[1] SAMUEL LEMIEUX, University of Ottawa, ENNO GIESE, Ulm University, ROBERT FICKLER, University of Tampere, MARIA CHEKHOVA, Max Planck Institute for the science of light, Erlangen, Germany, ROBERT BOYD, University of Rochester — The quantum-mechanical fluctuations of the electromagnetic vacuum exhibit a specific functional dependence on frequency. At the same time, the rate of spontaneous emission of photon crucially depends on their amplitude. In this work, we use the spectrum of vacuum fluctuations to trigger parametric down-conversion (PDC), a nonlinear optical process based on three-wave mixing with only one input field. Since we can relate the output of phase-matched PDC to the spectrum of the vacuum, PDC qualifies as a reference for the calibration of radiometric instruments. In particular, we deduce the spectral response of a spectrometer using spontaneous PDC—this is a relative calibration. In the strong-coupling regime of PDC, spontaneous emission stimulates the emission of more photons in a nonlinear manner, leading to a distortion of the frequency spectrum. Since there is a one-to-one correspondence between the number of downconverted photons and the spectral shape of high-gain PDC, we possess all the necessary knowledge to deduce the spectral quantum efficiency of the spectrometer—this is an absolute calibration. We experimentally demonstrate that our calibration method compares well against the results obtained with a reference lamp for relative calibration.

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