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Cross-correlation heterodyne detection part I: Measuring the vacuum fluctuations at microwave frequencies MATTEO MARIANTONI, EDWIN P. MENZEL, M. A. ARAQUE CABALLERO, F. DEPPE, E. HOFFMANN, T. NIEMCZYK, A. MARX, R. GROSS, Walther-Meissner-Institut and TU Muenchen, Germany, E. SOLANO, Departamento de Quimica Física, Universidad del Pais Vasco / Euskal Herriko Unibertsitatea, Spain — In order to gain a profound insight into the fundamental properties of quantum electrodynamics (QED), studying the zero-point fluctuations of microwave radiation represents an important task. Here, we present a full experimental characterization of the vacuum fluctuations by measuring the Planck distribution of its noise power at microwave frequencies and very low temperatures. We observe a cross-over from thermal noise to vacuum quantum noise and quantify the level of vacuum fluctuations for a narrow frequency band centered around 5.85 GHz. We demonstrate the change of the vacuum fluctuations level with the center frequency. Finally, we perform a new type of heterodyne detection particularly suitable for circuit QED systems. It is based on microwave beam splitters and cross-correlation measurements and allows for the reconstruction of the entire covariance matrix of the vacuum. We acknowledge support from SFB631, NIM, EuroSQUIP, and the Ikerbasque Foundation.

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