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Terahertz Imaging of cyclotron emission from quantum Hall conductors

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Microscopy of extremely weak terahertz (THz) waves via photon-counting method is reported. A quantum-dot photon detector [1] is incorporated into a scanning terahertz microscope [2]. By using a quantum Hall detector [3] as well, measurements cover the intensity dynamic range more than five orders of magnitude. The minimum intensity reaches as lo as 10ˆ-21watt (one photon per one second). Applying the measurement system to the study of semiconductor quantum Hall (QH) devices, we image cyclotron radiation emitted by non-equilibrium electrons generated in QH electron systems. Owing to the unprecedented sensitivity, a variety of new features of electron kinetics are unveiled [4]. It is stressed that the present approach is in marked contrast to the THz- wave applications recently discussed extensively in a wide variety of fields including clinic, security, and environment. In the vast majority of those applications, room-temperature operation is implicit. The intensity of treated THz radiation is hence well beyond the level of 300K black body radiation (roughly 10ˆ-7 watts or 10ˆ14 photons/s per square centimeter in a 1/10 relative band width). From the scientific viewpoint, however, detecting extremely weak THz waves from an object without external illumination such as applied in the present work is of strong importance, because the microscopic kinetics of an object can be probed only in such a passive method. Besides semiconductor electric devices studied here, we will also discuss possible applications of the present method for molecular dynamics, micro thermography, and cell activities..

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