THz and far-IR sensors: Looking for optimal nanodesign

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The steady and impressive progress in the nanotechnology of superconducting and semiconducting structures leads to new intriguing possibilities for sensors of electromagnetic radiation. A wide range of novel properties, unattainable in microstructures, may be realized through manipulations at nanoscale level.

The sensitivity and energy resolution of a quantum detector is limited by the fluctuations of the number of quasiparticles (electronic excitations) in the sensor. The detector performance can be improved by decreasing its volume (i.e. quasiparticle number, heat capacity and etc.). Potentially, nanosensors might have the sensitivity several orders of magnitude higher than that of state-of-the-art microdetectors. However, simple shrinking of the sensor dimensions to the nano-scale will not do the job. Energy exchange between electrons in nanoscale structures and the environment turns out to be excessively fast for most of applications. Another substantial problem is related to inefficient electromagnetic coupling to nanostructures comprised small number of electrons.

Taking in mind the above challenges and new technological opportunities, we consider novel approaches to practical realization of controllable electron kinetics in nanostructures. We review recent experiments in this field and discuss new ideas in design of ultimate detectors, photon counters and calorimeters based on superconducting and semiconducting nanostructures. Novel nanosensors are expected to deliver the unique performance: the noise equivalent power of the order 10^{-20} W/√Hz and the energy resolution of 10^{-21}-10^{-23} J. These sensors are of great interest for single-molecule spectroscopy, submillimeter astronomy, and nanoscale thermophysics and chemistry.