# Engineering graphene Josephson junction for sensitive photon detector

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Abstract

Sensitive microwave detectors are essential in radioastronomy, dark-matter axion searches and superconducting quantum information science. The conventional strategy to obtain higher-sensitivity bolometry is the nanofabrication of ever smaller devices to augment the thermal response. However, it is difficult to obtain efficient photon coupling and to maintain the material properties in a device with a large surface-to-volume ratio owing to surface contamination. Here we present an ultimately thin bolometric sensor based on monolayer graphene. To utilize the minute electronic specific heat and thermal conductivity of graphene, we develop a superconductor–graphene–superconductor Josephson junction bolometer embedded in a microwave resonator with a resonance frequency of 7.9 gigahertz and over 99 per cent coupling efficiency. The dependence of the Josephson switching current on the operating temperature, charge density, input power and frequency shows a noise-equivalent power of $7 \times 10^{-19}$ watts per square-root hertz, which corresponds to an energy resolution of a single 32-gigahertz photon, reaching the fundamental limit imposed by intrinsic thermal fluctuations at 0.19 kelvin [1]. We will also discuss our experimental demonstration of 1,550-nm infrared single photon detector [2] as well as theoretical modelling for ultra-light dark matter search using graphene-based sensor [3].

## REFERENCES

[1] Gil-Ho Lee et al., Nature, 586 (2020) 42–46
[2] Evan D. Walsh et al., arXiv:2011.02624
[3] Doojin Kim, Jong-Chul Park, Kin Chung Fong, Gil-Ho Lee., arXiv:2002.07821