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Use sensors based on electron-phonon decoupling to detect gravitational waves of system Sun – Earth.

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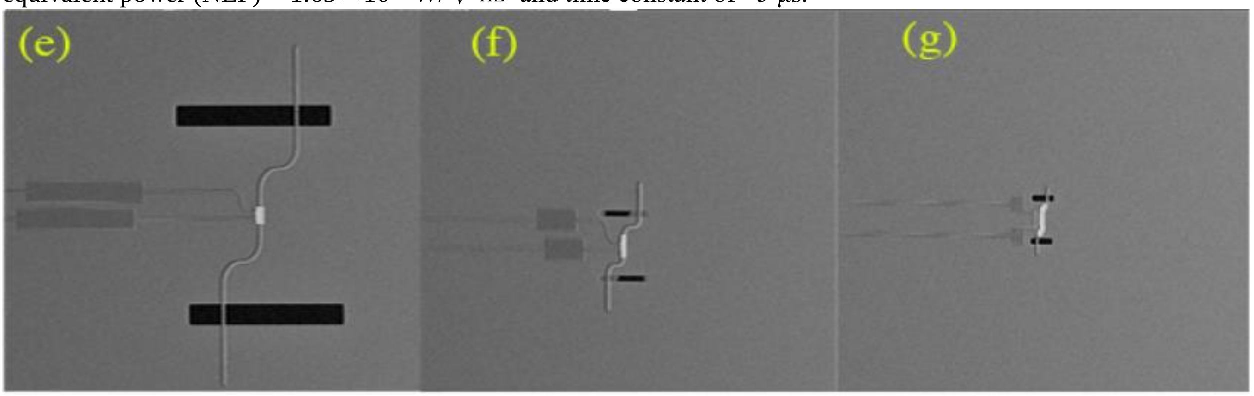
[1] We have successfully fabricated a superconducting transition edge sensor (TES), bolometer that centers on the use of electron-phonon decoupling (EPD) for thermal isolation. The thermal conductance (G) and the time constant for the different geometry device have been measured. For one such device, the measured G is $1.16\cdot10^{-10}$ W/K ($\pm$ $0.61\cdot10^{-10}$ W/K) at 60 mK, which corresponds to noise equivalent power (NEP) = 1.65×10^{-18}W/ $\sqrt{Hz}$ and time constant of ~5 µs.



(e), (f) and (g) are images of 300 GHz, 1 THz, and 3 THz devices, respectively. A thin layer of Bi is deposited to act as an radiation absorber.

[2] According to general theory of relativity system of two objects orbiting each other (binary stars, Sun – Earth…) will radiate gravitational waves. In 1993, Russell Hulse and Joe Taylor were awarded the Nobel Prize in Physics for indirect evidence for gravitational waves.

[3] The gravitational wave power given off (radiated) by Sun-Earth system is:

$$P = \frac{dE}{dt} = -\frac{32}{5}\frac{G^4}{c^5}\frac{(m_1m_2)^2(m_1+m_2)}{r^5},$$

where G is the gravitational constant, c is the speed of light in vacuum. For a system the Sun and Earth, r is about 1.5×10^{11} m and m1 and m2 are about 2×10^{30} kg and 6×10^{24} kg respectively. In this case, the power is about 200 watts. If we assuming the source of this radiation is in “center” of Earth on its surface will be power per square meter = $P/(4\pi R^2) \cong$ part of 4×10^{-13} W/m^2. R is radius of Earth 6,378 km. Size of our sensor is around 1.2×10^{-9} m^2. This gravitational wave power flux per square meter could be detected by greater sensitivity sensor. There is proposal to increase sensitivity: Use for sensor heavy atoms as Au, Pt, Bi or W or its alloys and lover Tc to a few mK. Gravitational waves could interact with heavy atoms of sensor and could modulate its vibrations. Vibrations – phonons will interact with electrons and this interaction we are able detect electronically. We assuming system of 3 detectors perpendicular to each other will be able detect gravitational waves from any direction. Direction of waves is given by centripetal acceleration of Earth. (It is perpendicular or parallel to acceleration.) Due to 24 h rotation of Earth our detectors will go through maximum and minimum of intensity gravitational waves two times within this period. We could detect at noon and midnight compare to 6 am and 6 pm different of type noises (NEP) modulated by gravitational waves radiated from “center” of Earth.

Acknowledgement

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[1] Development of superconducting transition edge sensors based on electron-phonon decoupling.
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[2] Relativistic Binary Pulsar B1913+16: Thirty Years of Observations and Analysis
Joel M. Weisberg; Joseph H. Taylor
Binary Radio Pulsars ASP Conference Series, Vol. TBD, 2004

[3] Gravitational Waves
Edmund Bertschinger; Edwin F. Taylor
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