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Superconducting antenna concept for gravitational waves

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The most advanced contemporary efforts and concepts for registering gravitational waves are focused on measuring tiny deviations in large arm (kilometers in case of LIGO and thousands of kilometers in case of LISA) interferometers via photons. In this presentation we discuss a concept for the detection of gravitational waves using an antenna comprised of superconducting electrons (Cooper pairs) moving in an ionic lattice. The major challenge in this approach is that the tidal action of the gravitational waves is extremely weak compared with electromagnetic forces. Any motion caused by gravitational waves, which violates charge neutrality, will be impeded by Coulomb forces acting on the charge carriers (Coulomb blockade) in superconductors, as well as in normal metals. We started with a design, which avoids the effects of Coulomb blockade. It exploits two different superconducting materials used in a form of thin wires —"spaghetti."The spaghetti will have a diameter comparable to the London penetration depth, and length of about 1-10 meters. To achieve competitive sensitivity, the antenna would require billions of spaghetti, which calls for a challenging manufacturing technology. If successfully materialized, the response of the antenna to the known highly periodic sources of gravitational radiation, such as the Pulsar in Crab Nebula will result in an output current, detectable by superconducting electronics. The antenna will require deep (0.3K) cryogenic cooling and magnetic shielding. This design may be a viable successor to LISA and LIGO missions, having the prospect of higher sensitivity, much smaller size and directional selectivity. We further simplified the bimetallic antenna design into a monometallic one, which should be easier to implement. This concept of compact antenna may be of benefit also in terrestrial applications since gravitational wave detectors may serve as gravity gradiometers.

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