Could dark energy be studied in the lab?

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It might be possible to measure the properties of "dark energy" in the laboratory according to physicists in the UK and Canada. A relatively simple experiment based on superconducting devices known as Josephson junctions could show if some or all of the dark energy in the universe is due to quantum fluctuations of the vacuum (C Beck and M Mackey 2004 *arXiv.org/abs/astro-ph/0406504*).

Quantum fluctuations mean that the vacuum is not empty as is assumed in classical physics. These fluctuations, also known as zero-point fluctuations, are a consequence of the uncertainty principle, and they give the vacuum a structure that manifests itself in a variety of different ways such as the Casimir effect. Physicists have already measured the effects of this "vacuum energy" in circuits containing Josephson junctions.

A series of astrophysical observations have suggested that as much as 73% of the universe is made of dark energy -- a gravitationally repulsive material that is causing the expansion of the universe to accelerate. However, no one knows what dark energy is made of. Vacuum energy is one candidate for dark energy, although the amount of energy in the vacuum predicted by theory is some 120 orders of magnitude more than the amount indicated by observations.

In 1982, Roger Koch and colleagues, then at the University of California at Berkeley and the Lawrence Berkeley Laboratory, performed an experiment in which they measured the frequency spectrum of current fluctuations in Josephson junctions. Their system was cooled to millikelvin temperatures so that thermal vibrations were reduced to a minimum, leaving only zero-point quantum fluctuations. Now, Christian Beck at Queen Mary University of London and Michael Mackey at McGill University in Montreal have re-analysed these results in the light of recent astrophysical estimates of the density of dark energy in the universe.

Beck and Mackey argue that the zero-point fluctuations measured by Koch's team imply a non-zero density for the vacuum energy, and say that this value cannot exceed the value for the density of dark energy in the universe. Using this premise, they predict that there should be a cut-off in the spectrum of the fluctuations at a frequency of around 1.69×10^{12} Hertz.

Beck and Mackey believe that future experiments with a new generation of Josephson junctions that work at higher frequencies could help to clarify whether or not this cut-off exists. Such experiments would also show if dark energy is indeed related to vacuum energy.

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