Contribution ID: **294** Type: **Oral presentation (15min)**

Prospective solid-state photonic cryocooler based on the “phonon-deficit effect”

Tuesday 8 July 2014 16:30 (15 minutes)

In this design microwave photons are propagating in a sapphire rod, and are being absorbed by a superconductor deposited on the surface of the rod. The frequency of the radiation is tuned to be less than the energy gap in the superconductor, so that the pair breaking is not taking place. The photon pumping redistributes the electron-hole quasiparticles, so that their distribution function is non-equilibrium, and the “phonon-deficit effect”takes place. There is a dielectric material deposited on top of superconductors, which is an “object to cool”. Its “acoustical density”is supposed to be smaller than that of the superconducting material, so phonons are being “rectified”to propagate from, but not toward it. Thus, the energy flows from this “object to cool” into the superconductor. The best rectification achieved as of today is about factor of five. This is marginal in view of the positive/negative heat flux ratio. To amplify the rectification, one can use the acoustical filtering, which we describe. Filtering can be arranged between the superconductor and the “object to cool”. Having a remarkably high heat conductivity and high acoustic density, the sapphire rod serves not only as a photonic wave-guide, but also as a thermal heat sink. It is thermally anchored to the bigger external heat-bath. If necessary, one can arrange spectral filters between sapphire and superconducting film, so that sapphire would only admit phonons without supplying them to the superconductor in the range of the absorption spectrum of the superconductor. We performed the calculations using parameters of existing materials. The results still can be further enhanced to take into account subtle effects characterizing the design. Our firm belief is that this cooling opportunity is “cool”enough to be pursued experimentally.

Author: Dr GULIAN, Armen (Chapman University)

Co-author: Dr MELKONYAN, Gurgen (GMLabs, Quebeck, Canada)

Presenter: Dr GULIAN, Armen (Chapman University)

Session Classification: Tue-Af-Orals Session 5

Track Classification: C-14: New devices and novel concepts