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Title and Abstract

Towards all-solid state cryocooling from 300 K to 10 mK

The cryogenic systems for quantum computers and related technologies require noisy pumps, cumbersome tanks, and complex plumbing that fill half a room while relying on non-renewable helium isotopes ^{3}He and ^{4}He. Solid state refrigeration platforms that might replace such systems, on the other hand, will require a cascade of new thermoelectric technologies that piggyback upon each other, each performing optimally within a given temperature range. This talk will summarize the challenges in creating an all-solid state milliKelvin refrigeration system and will propose two novel technologies that can help to achieve this goal. The first proposed technology is transverse thermoelectrics which can, in principle, offer cooling power at the high end of the cryogenic temperature range below 150 K. The second proposed technology is an electron heat pump that can operate at the lowest milliKelvin temperature range, using gate-tunable subband degeneracy in a semiconductor quantum well to achieve cooling power. The theory of operation for such a device will be explained and the theoretical cooling powers predicted. Materials challenges and physical constraints to this vision for a possible all-solid state system will be discussed.