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Nuclear demagnetisation cooling of a nanoelectronic device ALEX JONES, IAN BRADLEY, TONY GUÉNAULT, Lancaster University, UK, DAVID GUNNARSSON, VTT Technical Research Centre, Finland, RICHARD HALEY, STEPHEN HOLT, YURI PASHKIN, Lancaster University, UK, JARI PENTTILÄ, Aivon Oy, Finland, JONATHAN PRANCE, Lancaster University, UK, MIKA PRUNNILA, VTT Technical Research Centre, Finland, LEIF ROSCHIER, Aivon Oy, Finland — We present a new technique for on-chip cooling of electrons in a nanostructure: nuclear demagnetisation of on-chip, thin-film copper refrigerant. We are motivated by the potential improvement in the operation of nanoelectronic devices below 10 mK. At these temperatures, weak electron-phonon coupling hinders traditional cooling, yet here gives the advantage of thermal isolation between the environment and the on-chip electrons, enabling cooling significantly below the base temperature of the host lattice. To demonstrate this we electroplate copper onto the metallic islands of a Coulomb blockade thermometer (CBT), and hence provide a direct thermal link between the cooled copper nuclei and the device electrons. The CBT provides primary thermometry of its internal electron temperature, and we use this to monitor the cooling. Using an optimised demagnetisation profile we observe the electrons being cooled from 9 mK to 4.5 mK, and remaining below 5 mK for an experimentally useful time of 1200 seconds. We also suggest how this technique can be used to achieve sub-1 mK electron temperatures without the use of elaborate bulk demagnetisation stages. [1] Bradley et al., arXiv:1611.02483 (2016)

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