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M3Or4B-02 [Invited]: Sub-Kelvin cooling systems for quantum computers

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Future large-scale quantum processors (i.e. 100s of qubits), especially those based on superconducting circuits, will require large cooling powers (˜10s of microW) at very low temperatures (<50 mK) with stringent temperature stabilities to avoid quantum decoherence and thus guarantee successful operation of such systems. One attractive option for providing this cooling is through Continuous Adiabatic Demagnetization Refrigerators (CADR). Scalable state-of-the-art CADRs at NASA's Goddard Space Flight Center have successfully shown to lift 6 μW of heat at 50 mK with a 1 μK temperature stability while rejecting its heat to a cryocooler at 4K. Carefully planned and proper heat sinking of cables, attenuators, and microwave components at various temperature stages (between 4K and base temperature) is critical in the cooling architecture of quantum computers and can be provided through proper staging of each unit within the CADR system. As an alternative method of cooling, dilution refrigerators with the potential to meet cooling requirements of emerging large-scale quantum processors are also discussed.

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