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Algorithmic Quantum Cooling MAN HONG YUNG, SERGIO BOIXO, ALAN ASPURU-GUZIK, Harvard University, HARVARD TEAM — Efficient methods of cooling are essential for exploring the fundamental properties of low temperature physics. A remarkable cooling method is known as the evaporative cooling (or "coffee" cooling), where energetic particles are filtered away so as to lower the mean energy of the rest of the system. Inspired by the idea of evaporative cooling, we developed a method called algorithmic quantum cooling (AQC) for achieving the goal of cooling for any physical system which is simulable by a quantum computer. The novel feature of AQC is that the evolution of the state of the system is modeled as the movement of a one-dimensional classical random walk; the walker plays the role of the motion of the gas particles in an ordinary evaporative cooling. The implementation of this method is analogous to the setting of Maxwell's demon, where the experimentalist can monitor the heat-up or cool-down of the system, and apply feedback control to the resulting states. Here we cover the results of the connection of AQC with quantum non-demolition measurement, a scaling analysis of AQC, and the application of amplitude amplification to achieve quantum speedup. Experimental realization of AQC can be accomplished with currently available technologies.

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