

Entanglement in a quantum heat engine

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Popular abstract

Heat engines are an integral part of modern society and have been since the industrial revolution. Simply speaking, they are machines that convert heat into work. From the early steam engines to the turbines in a nuclear power plant they have powered civilization. Because of this, it is only natural that we would seek the limits of these machines, how big, efficient and reliable can they become? These are all very important questions that have been studied for a long time within the fields of mechanical engineering and thermodynamics. There is one question in particular where classical thermodynamics is no longer enough, it is one posed by physicists all over the world, in all manner of subjects; what happens when it becomes really, really small?

It turns out that it is possible to make heat engines truly microscopic. At this size classical thermodynamics can no longer properly describe the system. We must turn to quantum mechanics to fully understand them. There are many motivations to why quantum mechanics is needed. The most relevant reason is that quantum mechanics describe phenomena that have no counterpart in classical physics. The most famous of which is quantum entanglement. In short, entanglement correlates particles in such a way that if one particle is measured it changes the state of the other entangled particles, no matter how far apart they are at the time. It is entanglement within these microscopic engines that is the topic of this work.

In 2015 a group of physicists showed that entanglement could be generated in a quantum heat engine without any form of external control [Jonatan Bohr Brask et al. *New J. Phys.* 17 (2015)]. This means that entanglement is generated solely from the temperature difference that drives the engine. This has the potential of being very useful, as access to entangled states are vital for applications such as quantum teleportation and quantum computing. In this project, an identical system is analyzed by applying a different method. It is found that the generated entanglement can be stronger than originally suspected, provided that the right conditions are met.