Frontier of Statistical Physics and Information Processing 2013

Heat engine driven by purely quantum information

Jung Jun Park[1], Kang-Hwan Kim[2], Takahiro Sagawa[3,4] and Sang Wook Kim[5*]
[1]Department of Physics, Pusan National University, Busan 609-735, Korea
[2]Department of Physics, Korea Advanced Institute of Science and Technology, Daejeon 305-701, Korea
[3]The Hakubi Center for Advanced Research, Kyoto University, Yoshida-ushinomiya cho, Sakyo-ku, Kyoto 606-8302, Japan
[4]Yukawa Institute for Theoretical Physics, Kyoto University, Kitashirakawa-oiwake cho, Sakyo-ku, Kyoto 606-8502, Japan
[5]Department of Physics Education, Pusan National University, Busan 609-735, Korea

The key question of this talk is whether work can be extracted from a heat engine by using purely quantum mechanical information. If the answer is yes, what is its mathematical formula? First, by using a bipartite memory we show that the work extractable from a heat engine is bounded not only by the free energy change and the sum of the entropy change of an individual memory but also by the change of quantum mutual information contained inside the memory. We then find that the engine can be driven by purely quantum information, expressed as the so-called quantum discord, forming a part of the quantum mutual information. To confirm it, as a physical example we present the Szilard engine containing a diatomic molecule with a semi-permeable wall.

[1] S. W. Kim and M.-S. Choi, Phys. Rev. Lett. **95**, 226802 (2005).
[2] S. W. Kim, T. Sagawa, S. De Liberato and M. Ueda, Phys. Rev. Lett. **106**, 070401 (2011).
[3] J. M. Parrondo and J. M. Horowitz, Physics **4**, 12 (2011).
[4] J. J. Park, K.-H. Kim, T. Sagawa and S. W. Kim, arxiv.org/1302.3011