Quantum Energy Teleportation and Black Hole

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The development of techniques for manipulation of quantum information has opened the door to a variety of protocols for accomplishing unprecedented tasks. In particular, a new protocol of quantum teleportation, quantum energy teleportation (QET), was proposed in 2008 to achieve energy transportation in an operational meaning simply via local operations and classical communication —without breaking any known physical laws. This is achieved by extracting zero-point energy of entangled many-body systems by local operations dependent on information obtained by a distant measurement. QET can be implemented, at least theoretically, to various physical systems, including spin chains, cold trapped ions, harmonic chains, and quantum fields. Besides, it has been recently presented that QET would be experimentally verified by using quantum Hall edge currents. QET provides a new method extracting energy from black holes: We perform a measurement of quantum fields in vacuum states and obtain information about the quantum fluctuation. Then positive-energy wave packets of the fields are generated during the measurement and gravitationally collapse into a black hole. Even after formation of the black hole, we can retrieve a part of the collapsing matter energy outside the horizon by using QET. This energy extraction yields a decrease in the horizon area, which is proportional to the entropy of the black hole. However, if we accidentally lose the measurement information, we cannot extract energy anymore. The black-hole entropy is unable to decrease. Therefore, the obtained measurement information has a very close connection with the black hole entropy. This line of argument is expected to lead to further understanding of the origin of black hole entropy, which is often discussed in string theory. An introductory review of QET is available on WEB: http://www.tuhep.phys.tohoku.ac.jp/~hotta/extended-version-qet-review.pdf