Theory of thermoelectric properties updated after 23 years

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Credit: Tohoku University

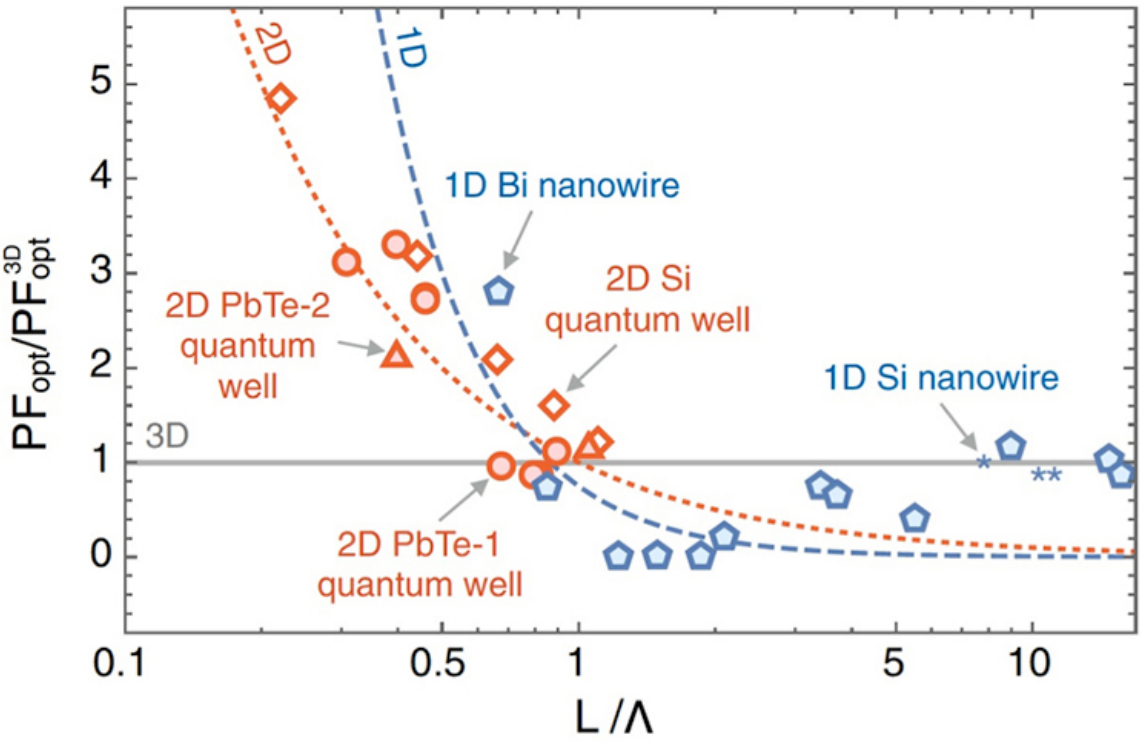
Since the Hicks-Dresselhaus publication in 1993, the researchers have focused the low dimensional materials (2D or 1D) for searching the high thermoelectric material according to their theory of the confinement effect on 1D and 2D thermoelectricity, which was successful.

However, they notice that some 1D nanowire or 2D materials do not show enhancement of the thermoelectric power even though the

confinement length L is sufficiently small.

The new paper by Nguyen points out that "thermal de Broglie wavelength" is an important parameter to the enhancement of thermoelectricity. Thermoelectric power is enhanced only when the confinement length is smaller than the thermal de Broglie wavelength.

This theory gives a precise direction of the material research for better thermoelectric materials in the future.



In the figure, the enhancement of the power factor scaled by that for 3D materials is plotted as a function of the ratio of thermal de Broglie length Lambda to the confinement length L. The lines are theory for 1D and 2D, and

dots are experiments for several materials. It is clear that quantum enhancement occurs when the confinement length is smaller than thermal de Broglie length. Credit: Tohoku University

More information: Nguyen T. Hung et al. Quantum Effects in the Thermoelectric Power Factor of Low-Dimensional Semiconductors, *Physical Review Letters* (2016). DOI: 10.1103/PhysRevLett.117.036602