

Temperature fluctuations cause excess noise

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The thermal noise of the electric current has been well known for almost a century. In an article published this week in *Physical Review Letters*, a group of researchers from the Low Temperature Laboratory of Aalto University (Finland) and Technical University of Delft (The Netherlands) show that also fluctuations of temperature may contribute to the current noise.

In a single-electron transistor (SET), the workhorse of modern nanoelectronics, the current noise induced by the [temperature fluctuations](#) is exceptionally large. As the group shows in their work Fano factor, a number which characterizes the magnitude of the current noise, can be hundreds of times larger than what previously has been estimated.

[Electrons](#) carry not only charge but also heat. Charge and [heat transport](#) are stochastic processes: both of them fluctuate in time, causing noise. In small non-linear electronic components a change in the temperature causes a variation of the current. The coupling between temperature and current is particularly large in SETs and, as they show, for some parameters heat current noise is the most essential source of charge current noise. The phenomenon studied in their work is on one hand detrimental for the use of SETs, but on the other hand it can be used to measure the fluctuations of the heat current, which is otherwise rather difficult.

"Overheating will be a major problem in the miniaturization of electronic components. Because of this it is important to study the

heating processes and noise associated with them accurately. This work helps in understanding the electronic heating processes in nanoelectronics components and opens a new way for measuring temperature fluctuations," says Academy Research Fellow Tero Heikkilä.

More information: M.A. Laakso, T.T. Heikkilä, and Yuli V. Nazarov, Fully overheated single-electron transistor, [dx.doi.org/10.1103/PhysRevLett.104.196805](https://doi.org/10.1103/PhysRevLett.104.196805)

Provided by Aalto University

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