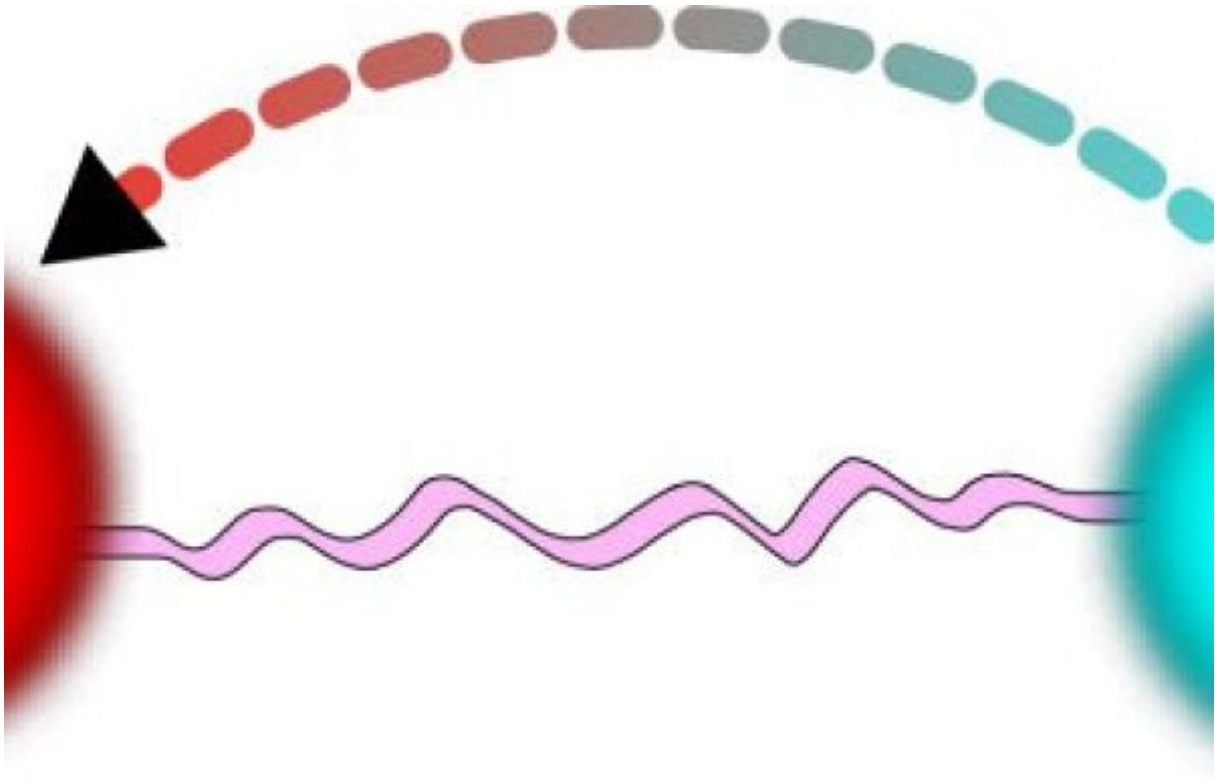


A new view of thermodynamics

ICFO researchers propose a solution to the laws of thermodynamics for correlated scenarios.

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Thermodynamics is one of the most successful physical theories ever formulated. Though it was initially developed to study steam engines and, in particular, the problem of conversion of heat into mechanical work, it has survived even after the scientific revolutions of relativity and quantum mechanics.

Despite being considered very robust and applicable to a wide range of scenarios, the laws of thermodynamics have been postulated assuming that the system is initially uncorrelated from its surrounding bath. Thus, the laws are known to break down when systems are in fact correlated in some way with their environments.

In a recent paper published in *Nature Communications*, ICFO researchers Dr. Manabendra N. Bera, Dr. Arnau Riera, led by ICREA Prof. at ICFO Maciej Lewenstein, in collaboration with Dr. Andreas Winter from the Autonomous University of Barcelona, present a study in which they extend thermodynamics to be also valid in these correlated scenarios. To do so, they propose a consistent redefinition of heat (and work) and introduce it by properly taking into accout the information flow from system to bath in terms of the conditional entropy.

In their study, the researchers generalize thermodynamics to physical scenarios that allow the presence of correlations, including those where strong correlations do occur. They exploit the connection between information and physics, and introduce a consistent redefinition of heat dissipation by systematically accounting for the information flow from system to bath in terms of the conditional entropy.

In summary, the work poses a solution to the apparent violations of thermodynamics in correlated scenarios and generalizes such approach by reformulating its zeroth, first, and second laws.