IS THERMODYNAMICS FUNDAMENTAL?

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ABSTRACT

The answer to this question depends very strongly on what one takes ‘thermodynamics’ and ‘fundamental’ to mean. A typical interpretation of ‘fundamental’ would be ‘not being reducible to something else’, and based on this interpretation it is often held that thermodynamics is not fundamental because it can be reduced to the behavior of individual particles in the framework of statistical mechanics. These reductions, however, do at a closer look often rely on assumptions or concepts that come from thermodynamics, implying that thermodynamics — while not being in conflict with the microscopic laws of physics — also can tell us something over and above what we learn from these microscopic laws. A good illustration of this is the problem of explaining the irreversible approach to thermodynamic equilibrium from the reversible Hamiltonian equations. It turns out that these explanations rely on assumptions that Hamilton’s equations themselves cannot justify. Moreover, also here one faces terminological issues: The way one can explain the approach to equilibrium depends strongly on what one takes ‘equilibrium’ to mean.