Downward Causation in Fluid Convection

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Abstract

Recent developments in nonlinear dynamics have found wide application in many areas of science from physics to neuroscience. Nonlinear phenomena such as feedback loops, inter-level relations, wholes constraining and modifying the behavior of their parts, and memory effects are interesting candidates for emergence and downward causation. Rayleigh-Bénard convection is an example of a nonlinear system that, I suggest, yields important insights for metaphysics and philosophy of science. In this paper I propose convection as a model for downward causation in classical mechanics, far more robust and less speculative than the examples typically provided in the philosophy of mind literature. Although the physics of Rayleigh-Bénard convection is quite complicated, this model provides a much more realistic and concrete example for examining various assumptions and arguments found in emergence and philosophy of mind debates. After reviewing some key concepts of nonlinear dynamics, complex systems and the basic physics of Rayleigh-Bénard convection, I begin that examination here by (1) assessing a recently proposed definition for emergence and downward causation, (2) discussing some typical objections to downward causation and (3) comparing this model with Sperry ' s examples.

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