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MATHEMATICAL, PHYSICAL AND ENGINEERING SCIENCES

Fundamental aspects of nonequilibrium thermodynamics

Theme issue compiled and edited by Peter Ván

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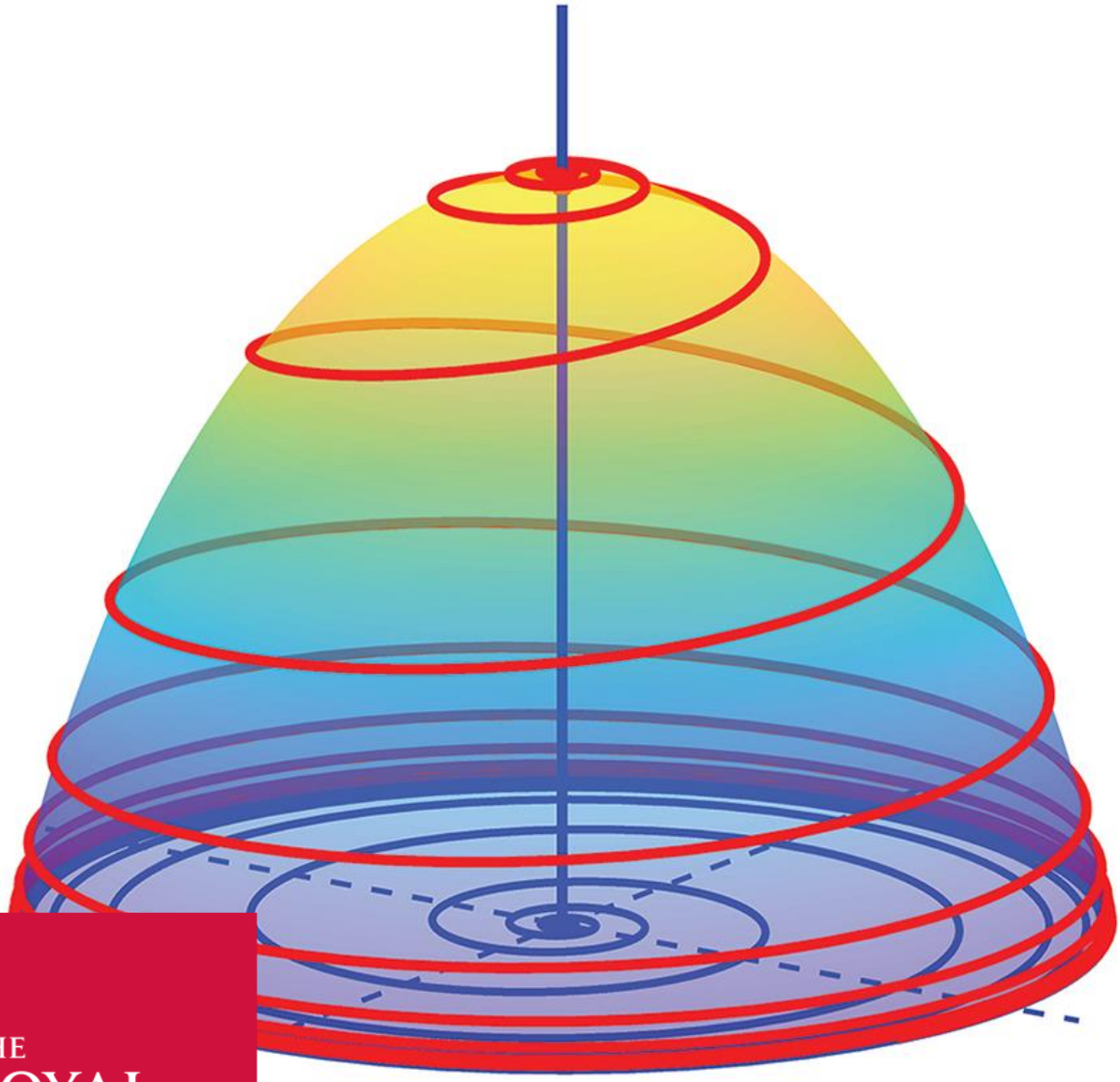

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About this issue

Non-equilibrium thermodynamics is a theory where the powerful methods of equilibrium are missing. Non-equilibrium thermodynamics is considered as an emergent theory; its fundamental principles, like the second law, are due to microscopic or mesoscopic properties of matter. Nonequilibrium thermodynamics is a general framework; its universal principles provide strict bounds on macroscopic material properties, restricting the possible micro- or mesodynamics as well. Recent developments show that the latter approach (nonequilibrium thermodynamics without the hyphen) may unify dissipative and nondissipative evolution. Universal principles lead to universal consequences.

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Cover image:
The red spiral represents the von Neumann entropy $S = -k\mathrm{Tr}(\rho \ln \rho)$ of a single isolated qubit with an initial mean energy $\langle E \rangle = \mathrm{Tr}(H\rho)$ along a combined Hamiltonian and steepest-entropy-ascent time evolution describing its approach from far non-equilibrium towards the maximumentropy stable-equilibrium state $(\langle X \rangle = 0, \langle Y \rangle = 0, \langle Z \rangle = \langle E \rangle)$. The blue spiral in the $\langle X \rangle$–$\langle Y \rangle$ plane represents the corresponding constant-energy time evolution of the state of the qubit.
Image courtesy of Professor Gian Paolo Beretta.

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