

Functional differential equations and entropy

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Abstract

The second law of thermodynamics says entropy is non-decreasing, and the H-theorem tries to prove that entropy increases to a maximum, in thermodynamic equilibrium. The 19th c. saw a huge debate on the paradox that the second law of thermodynamics is **incompatible** with Newtonian physics. This ended with Boltzmann's suicide and the Ehrenfest model of Markovian evolution.

The central issues were the reversibility and recurrence paradoxes, which are not properly resolved in physics texts even today since they admit no proper resolution within the Newtonian paradigm of physical time evolution governed by ordinary differential equations (ODEs).

However, with retarded functional differential equations (FDEs), these paradoxes are instantly resolved. Retarded FDEs are irreversible, information-theoretic entropy increases; volume is no longer conserved in phase space, hence the recurrence paradox too fails. FDEs arise naturally in many-particle motion in electrodynamics (and relativity), as a system of ODEs (Heaviside- Lorentz force) **coupled** with partial differential equations (PDEs, Maxwell's equations).

But how are FDEs relevant to thermodynamics? Kinetic theory and molecular dynamics involves intermolecular forces (van der Waals forces, Lennard-Jones 12-6 potential etc.) which phenomenological forces are regarded as being electrostatic in origin (or due to quantum effects). But since the molecules are constantly moving, these forces ought to be electro**dynamic** forces not electrostatic ones, hence FDEs are surely involved.

Speaker Bio

Professor C. K. Raju holds a BSc (Hons) in physics, an MSc in mathematics from Mumbai, followed by a PhD from the Indian Statistical Institute, Kolkata. He has long been a Professor in various departments in universities in India and abroad. He played a key role in building the first Indian supercomputer Param, and is engaged in decolonising mathematics.

He has authored several radical [books](#) which have been [highly praised](#), and his [several articles](#) have also drawn [high praise](#) from both referees and readers. He has [lectured](#) on six continents, ranging from prominent universities and institutes such as [MIT](#), [Cape Town](#), [UNISA](#), to [refugee camps in Palestine](#), and remote village schools in India.

He has received numerous [honours and awards](#), including the [TGA award](#) in Hungary in 2010, for [correcting Einstein's mistake](#), Longer [cv](#) and [photo](#) on [website](#).