

CHALLENGES OF NONEQUILIBRIUM THERMODYNAMICS

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ABSTRACT

The presentation critically reviews some general theories (constructal, constructor, Verlinde's gravity, extended thermodynamics, GENERIC, variational methods, etc..) in which thermodynamics, and in particular nonequilibrium thermodynamics, plays an important role. It is then argued that all such attempts of a general theory face the challenge of validation and must pay attention to the following means and measures of performance and validity:

- Prediction of new experiments.
- Resolution of existing paradoxes.
- Theoretical compatibility, in particular the explanation of universality.

These measures of validity may differ for different theoretical approaches, but one aspect deserves special attention: any proposal must demonstrate compatibility with classical theories: classical thermodynamics and continuum physics, including heat conduction, continuum mechanics and electrodynamics. A consistent connection to the classical background can validate the theory with an enormous amount of empirical facts (observations, experiments and engineering experience), and it is also a source of paradoxes, possible new experiments that can be solved, further increasing the credibility of any theory.

There are two types of approaches. If the mechanical principles of a perfect world are extended to thermodynamics, then the origin of dissipation must be explained. On the other hand, if the thermodynamic principles of an imperfect world are primary, then the laws of perfect mechanics must be explained and validated.

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