ΠΑΝΕΠΙΣΤΗΜΙΟ ΚΡΗΤΗΣ
ΤΜΗΜΑ ΦΥΣΙΚΗΣ

CRETE CENTER FOR QUANTUM COMPLEXITY AND NANOTECHNOLOGY

# ΓΕΝΙΚΟ ΣΕΜΙΝΑΡΙΟ ΤΜΗΜΑΤΟΣ ΦΥΣΙΚΗΣ

# PHYSICS COLLOQUIUM

**Thursday, 07 November 2013**

**17:00 -18:00**

**3rd Floor Seminar Room**

## "What is temperature?"

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## Abstract

In daily use, the concept of "Temperature" is identified as the measurable "degree of heat" of a substance. Here we encounter already different temperature scales: From Fahrenheit, Celsius, C°, etc., up to the scale expressed in Kelvin. As a consequence of the second Law in thermodynamics there exists in fact a lowest temperature, but seemingly no highest one. In thermodynamics, the concept of a temperature is introduced as a physical state variable associated with the change in the amount of reversible heat as a function of a related change in entropy S, -- but precisely which entropy S? With thermodynamic entropy being a strictly monotonic increasing function of internal thermal energy its partial derivative is necessarily positive: Its inverse is identified as the *absolute thermodynamic* temperature T, which therefore can never be negative. Nevertheless, the concept of *negative* absolute temperatures as a new state of matter has recently been proposed and widely advertised in the context of experiments with interacting ultracold bosons: – a concept which this speaker critically commentates. Moreover, in the framework of classical statistical physics we encounter the "Equipartition Theorem", according to which each energy-carrying degree of freedom possesses on the average the same thermal energy. Matters become more complex on the atomic scale, entering the regime of quantum dynamics where this "Equipartition Theorem" no longer holds. At small scales, notions such as work, heat and temperature need to be reassessed. Also, does the temperature eventually fluctuate? -- These issues become even more obscure when describing the influence of the theory of relativity. Even among experts it is then often unclear what the means are for measuring the temperature of a fast moving system: Is a moving body now *hotter or colder*, or does it maintain the *same* temperature?