PHYS 3331 Thermal Physics
Spring 2021

1/20/21

Thermal physics involves both thermodynamics and statistical mechanics

According to wikipedia, thermodynamics is the branch of physics that deals with heat, work, and temperature, and their relation to energy, radiation, and the physical properties of matter. Its developement started due to the need to improve the efficiency of steam engines.

* CAN WE COME UP WITH SIMPLE WORKING DEFINITIONS OF:

heat: energy in transfer to or from a thermodynamic system by mechanisms other than thermodynamic work or transfer of matter.

Example: touching a cup of hot coffee.

work: energy transfered by a system to its surrandings which can spontaneously exert macroscopic forces on its surroundings.
Example: piston in a car engine

temperature: a manifestation of thermal energy, expresses if an object is hot or cold, difficult to define further without statistical mechanics.

energy: a conserved quantity that must be transfered to an object in order to do work. Also iffy.

radiation: emission of energy in the form of waves or particles. Example: solar radiation.

matter: a substance that has mass and volume.
Example: your body
IS A NEUTRON MATTER OR RADIATION?

According to wikipedia, statistical mechanics is a mathematical framework that applies statistical methods and probability theory to large assemblies of microscopic entities. It does not assume or postulate any natural laws, but explains the macroscopic behavior of nature from the behavior of such ensembles.

One of my favorite probability books is "Probability Theory: The Logic of Science" by E.T. Jaynes. The main point is that aspects of science such as observation, hypothesis, etc. can only be rigurously explained by probability theory.

In the introduction to KK it says that "in this subject all the physics comes from the logic."

Mechanics, Quantum physics, and electromagnetism arise from observation and mathematics are developed ad hoc, e.g., calculus.

Statistical Mechanics arises from probability, from counting states, that is why it applies to everything in the universe, at every lenght scale and timescale. It is the most general field of physics.

A theory is the most impressive the greater the simplicity of its premises, the more different kinds of things it relates, and the more extended its area of applicability. [Therma] is the only physical theory of universal content which I am convinced will never be overthrown.

A. Einstein

Thermo brings 3 quantities that perhaps you haven't seen in other classes

temperature : average kinetic energy of the particles in a system in thermodynamic equilibrium

entropy : number of states available to the system

free energy : $F = U - TS$

IDEAS?

The universe as I see it has the following structure