Statistical Mechanics Notes for L. Susskind's Lecture Series, Part 0

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Abstract

This is the first of my notes on the 2013 version of the video series that Leonard Susskind presented on Statistical Mechanics for his Stanford Lecture Series. (He also made a 2009 video series on the same topic.) They can be found on Youtube.

1 Series Introduction

Leonard Susskind is a professor of physics at Stanford University. I have watched and benefitted from many of his video series on topics in physics. I am producing for myself a series of notes on each lecture, which I'll share with my viewership. However, these notes are far from being comprehensive. Though sparse, they do contain most of the important definitions, formulas, and results needed to follow the subject matter as it is presented in the video lecture.

For some comprehensive notes on Chapters 1,2, 9, and 10, see

`https://www.lapasserelle.com/statistical_mechanics/`

For an alternative set of lecture notes, see

`http://www.kensholabs.com/physics/susskind/PHY29.html`

I believe that both sets of lecture notes are for the 2009 lectures, whereas I will concentrate on the 2013 lecture series.

Expect my notes to be very brief, containing little besides the important definitions, significant results and their mathematical proofs. Most of my proofs will follow closely to Professor Susskind's proofs, though, on occasion, I will take a slightly different path. Also, I will adhere closely to Susskind's notations, though I have tried a few alterations for my own clarification. I will try to remember to clue-in the reader the differences between those of his lectures and my notes.

2 The Controversies

The controversies I'm referring to are not particularly brought up in the lecture series itself, but are the kinds of nagging questions that I have brought to the subject for a long time, and still need some kind of resolution. But, as none of these controversies are important to the lecture series itself, this section can be skipped.

There are three major divisions of classical physics that bear more or less on the same subject matter, or at least have significant overlaps: Thermodynamics, kinetic theory, and statistical mechanics.

I have done an Internet search for opinions on this question, but I have not as yet found a clear resolution to this controversy, and it is at least partly controversial because the authorities I read did not agree amongst themselves.

What are the major results of each field and how are theory achieved. When I can identify all of those, perhaps I can better compare and contrast the three field.

Historically, it all began with *thermodynamics* and the exploitation of energy transfers to obtain useful work. It treated substances as being in near equilibrium. Its important results involved equations of state and how to foretell what processes are spontaneous.

Next, came *kinetic theory*, which extended Newtonian mechanics to the realm of the molecules. Its significant results was the theory of gases.

Lastly, came statistical mechanics, which uses a clever definition of entropy and the laws of probability to arrive at its results, the partition function being one of them.

As I learn these subjects better, I will be in a better situation to explain these distinctions better.