Physics 4311: Thermal Physics - Projects

A. Explore a special topic, give in-class presentation

For projects leading to an in-class presentation, please form teams of up to three students. Each presentation topic can be selected only once. Your work should result in a 20 to 25 minute talk explaining the topic to your fellow students. The talks are scheduled for the last week of classes, i.e., for May 6 and May 8, 2025.

1. **Real gases, van-der-Waals equation, and the liquid-gas transition**
   Textbook (Blundell+Blundell), chapters 26, 27, parts of 28
   Goldenfield, *Lectures on phase transitions and the renormalization group*, Addison-Wesley, Reading, 1992, chapter 4 (instructor has copy)

2. **Bose-Einstein condensation of atomic gases**
   E.A. Cornell and C.E. Wieman, *Nobel Lecture*, Rev. Mod. Phys. **74**, 875 (2002)
   J.R. Anglin and W. Ketterle, *Bose-Einstein condensation of atomic gases*, Nature **416**, 211 (2002)
   W. Ketterle, *Experimental studies of Bose-Einstein condensation in a gas*, Physics Today, Dec 1999, p30-35
   K. Burnett et al., *The theory of Bose-Einstein condensation of dilute gases*, Physics Today, Dec 1999, p37-42
   C.J. Pethick and H. Smith, *Bose-Einstein condensation of dilute gases*, Cambridge University Press, 2002

3. **Superfluid liquid helium**
   T. Guenault, *Basic superfluids*, Taylor and Francis, London, 2003, chapters 1 and 2
   A.J. Leggett, *Quantum Liquids*, Oxford University Press, 2006, chapter 3

4. **Thermodynamics of Earth's atmosphere**
   Textbook (Blundell+Blundell), chapter 37
   Material on the 2021 Physics Nobel Prize on nobelprize.org

5. **White dwarf stars and neutron stars**
   Textbook (Blundell+Blundell), chapters 35 and 36
   S.A. Kaplan, *The Physics of stars*, Wiley, Chichester, 1982, chapters 5 and 6 (instructor has copy)
   R.K. Pathria, *Statistical Mechanics*, Butterworth-Heinemann, Oxford, 1996, section 8.4
   Lecture 29 of David Boal's Astrophysics course, https://www.sfu.ca/∼boal/390.html

B. Computer simulation projects, could lead to presentation or term paper

1. **Molecular dynamics simulation using Daniel Schroeder's HTML5 applet**
   (does not require coding)
   https://physics.weber.edu/schroeder/md/
   see article in American Journal of Physics 83 (3), 210-218 (2015),
   https://physics.weber.edu/schroeder/md/InteractiveMD.pdf

2. **Monte-Carlo simulations of a two-dimensional Ising model**
(does require coding) • K. P. N. Murthy, *An Introduction to Monte Carlo Simulation of Statistical Physics Problems*, https://arxiv.org/abs/cond-mat/0104167
• M.E.J. Newman and G.T. Barkema *Monte Carlo Methods in Statistical Physics*, Oxford University Press, Oxford, 1999, chapters 2, 3
• N. Giordano, *Computational Physics*, Prentice Hall, Upper Saddle River, 1997, sections 8.3, 8.4