HSCI/PHYS 4111—HISTORY OF 19TH-CENTURY PHYSICS—FALL 2007

TIME AND PLACE: Tuesday, 4:40–7:10 PM; Tate Laboratory of Physics, Rm. 210

INSTRUCTOR: Michel Janssen, Tate Lab of Physics, Rm. 354B. Tel. 4 5880. Email: janss011@umn.edu. Office Hours: W, 11:00 am–12:00 pm; Th, 11:00 am–12:00 pm; or by appointment.

COURSE DESCRIPTION: In this class we study the development of thermodynamics, the kinetic theory of gases, optics, and electromagnetism in the 19th century. While the main focus is on conceptual developments, we will also look at the biographies of the physicists who made the key contributions and at the institutions that enabled them to do so and that in many cases they themselves helped found. We also pay attention to national differences (particularly between England, France, and the German states). Our cast includes (roughly in order of appearance): Carnot, Joule, W. Thomson (Lord Kelvin), Clausius, Helmholtz, Boltzmann, Young, Fresnel, Faraday, Maxwell, Hertz, Michelson, Lorentz, Roentgen, and J.J. Thomson. At the end of the semester, we turn to the experimental discoveries in the late 1890s (X-rays, radioactivity, the electron) that helped usher in the relativity and quantum revolutions of the 20th century.

FORMAT: The course will be run as a lecture course, but with ample opportunity for discussion.

REQUIREMENTS: the basic requirements for this class are to keep up with the reading assignments (see "Schedule" below) and to participate actively in class. Do the reading for any given week before you come to class, so that you are well prepared to follow the lecture and to participate in discussion.

There will be three take-home exams that will test your understanding of the readings and the discussion of them in class. These exams will consist of 3 essay questions each requiring an answer of 1–2 typed, double-spaced pages. Instead of the final take-home exam, you have the option of writing a term paper of about 10–15 pages.

- **Take-Home-I**, on the material covered in sessions 1–5: handed out at the end of class, October 2; **due at the beginning of class October 9**.
- **Take-Home-II**, on the material covered in sessions 7–11: handed out at the end of class November 13; **due at the beginning of class November 20**.
- **Take-Home-III** on the material covered in weeks 12–15: handed out at the end of class December 11; **due Tuesday, December 18, 5 pm**.
- If instead of **Take-Home-III** you choose to write a **term paper**: (1) brief description of your topic plus preliminary list of sources **due at the beginning of class November 13**; (2) paper **due Tuesday, December 18, 5 PM**.

GRADING: 3 take-home exams (25% each); class participation (25%).

All grades will initially be given on a scale from 40 to 100 and will only in the end be converted to letter grades. The conversion will roughly be as follows: 90–100: A; 80–90: B; 65–80: C; 50–65: D; less than 50: F.

POLICIES:

Attendance: Since the discussion of the assigned readings in class is an integral part of the course, attendance is mandatory. Attendance will be taken at the beginning of each class.

Unexcused absences will be reflected in your grade for class participation. More importantly, missing class will put you at a disadvantage when writing your short essays for the take-home exams.

Office Hours: If you have difficulty with the material, do not wait too long and come see me during office hours. I will do my best to answer any questions you may have, from very specific ones to "I'm lost!"

Note on Plagiarism: in all written material you submit, you should present your own ideas and your own arguments in your own words. Use quotations sparingly and give detailed citations whenever you do. Note that simply changing a few words in a quotation does not change the fact that you are quoting. Paraphrasing of this sort, where you use a source almost verbatim without acknowledgment, is a common form of plagiarism. Another common problem may arise from collaborating with other students. You are free to discuss the take-home exams with other students but the work that you submit must be your own, not something jointly written or copied from another student. You will not receive any credit for work that violates these rules against plagiarism.

WEBVISTA COURSE SITE:

To log on to the WebVista course site for this class, go to www.myu.umn.edu. Sign in to "myu." You will be prompted for your UofM Internet ID (i.e., your username as in username@umn.edu) and password (if you do not know your Internet ID or have forgotten your password, call the ADCS helpline at 626-4276). Go to the tab "my courses." There you will find a list of all WebVista sites for courses that you are currently enrolled in. Click on the link to this course. The first time you use WebVista, go to webvista.umn.edu and follow the instructions on configuring your browser (this site also provides an alternative path to WebVista course sites: go to WebVista B and log in). Only a few of the features of WebCT will be used for this class (e.g, the gradebook). The main purpose of the site is to make readings and handouts available to you on-line. Unfortunately, some scans of journal articles and book chapters are not very legible on screen, but they print out just fine. Let me remind you that copyright laws only allow you to make a copy for your own personal use. All files are in html- or pdf-format. To read and print pdf-files, you need (a reasonably recent version of) Adobe Acrobat Reader. For instructions on how to download this program (for free), go to www.adobe.com/products/acrobat/readstep2.html. There is a link to this site on the home page of the course site.

TEXTBOOKS:

- William H. Cropper, *Great Physicists. The Life and Times of Leading Physicists from Galileo to Hawking*. Oxford: Oxford University Press, 2001.
- Emilio Segrè, *From Falling Bodies to Radio Waves. Classical Physicists and Their Discoveries*. New York: Freeman, 1984.

The book by Cropper is available at the U of M Bookstore in Coffman Union. The book by Segrè is out of print. It will be made available electronically along with all other required readings (see "WebVista Course Site" above). **Download the required readings for any given week and bring print-outs of them to class that week.** Failure to do so will be reflected in your grade for class participation.

SCHEDULE

The tables on the following pages give the topic plus the required readings for all fifteen sessions of the semester. All handouts and required readings (except the readings from Cropper) are available electronically. References to course books are given in the author/date format (i.e., Cropper 2001, Segrè 1984).

Session 1	September 4, 2007
Overview.	

Session 2	September 11, 2007
Thermodynamics I.	
Segrè 1984, Ch. 5, Pt. 1, pp. 186–213 ('Heat: substance, vibration, and motion').	
Cropper 2001, Ch. 3, pp. 43–50 (Carnot), Ch. 5, pp. 59–70 (Joule).	

Session 3	September 18, 2007
Thermodynamics II.	
Segrè 1984, Ch. 5, Pt. 2, pp. 213–232 ('Heat: substance, vibration, and motion').	
Cropper 2001, Ch. 6, pp. 71–77 (Helmholtz), Ch. 7, pp. 78–92 (W. Thomson/Lord Kelvin), Ch. 8, 93–105 (Clausius).	
Martin J. Klein, "Carnot's Contribution to Thermodynamics." *Physics Today* 27 (August 1974), 23-28.	
Donald S. L. Cardwell, ''Science and Technology: The Work of James Prescott Joule." *Technology and Culture* 17 (1976): 674–687.	

Session 4	September 25, 2007
Thermodynamics III.	
Fabio Bevilacqua, "Helmholtz's *Ueber die Erhaltung der Kraft*: The Emergence of a Theoretical Physicist." Pp. 291–333 in: David Cahan (ed.), *Hermann von Helmholtz and the Foundations of Nineteenth-Century Science.* Berkeley, Los Angeles, London: University of California Press, 1993.	

Session 5	October 2, 2007
Kinetic Theory of Gases/Statistical Mechanics I.	**Take Home I assigned**
Segrè 1984, Ch. 6, pp. 233–251 ('Kinetic theory: the beginning of the unravelling of the structure of matter').	
Cropper 2001, Part IV (synopsis & Ch. 13), pp. 177–200 (Boltzmann).	

Session 6	October 9, 2007
Kinetic Theory of Gases/Statistical Mechanics II.	**Take Home I due**
Michel Janssen, *Entropy increase and Boltzmann's H-theorem* (handout).	

Session 7	October 16, 2007
Optics I.	
Segrè 1984, Ch. 3, pp. 79–104 ('What is light?').	
Edgar W. Morse, "Young, Thomas." Pp. 562–572 in Vol. XIV of: Charles C. Gillispie (ed.), *Dictionary of Scientific Biography*, New York: Charles Scribner's sons, 1976.	
Robert H. Silliman, "Fresnel, Augustin Jean." Pp. 165–171 in Vol. V of: Charles C. Gillispie (ed.), *Dictionary of Scientific Biography*, New York: Charles Scribner's sons, 1972.	

Session 8	October 23, 2007
Optics II.	
TBA.	

Session 9	October 30, 2007
Electricity and Magnetism I.	
Segrè 1984, Ch. 4, Pt. 1, 105–132 ('Electricity: from thunder to motors and waves').	
TBA	

Session 10	November 6, 2007
Electricity and Magnetism II.	
Segrè 1984, Ch. 4, Pt. 2, 132–181 (Faraday and Maxwell)	
Cropper 2001, Ch. 11, pp. 137–153 (Faraday), Ch. 12, pp. 154–175 (Maxwell and Hertz).	
Martin Goldman, The Demon in the Aether. The Story of James Clerk Maxwell. Edinburg: Paul Harris Publishing, 1983. Ch. 11.	

Session 11	November 13, 2007
Electricity and Magnetism III.	**Take Home II assigned/ Term Paper Proposals due**
James Clerk Maxwell, "On Faraday's Lines of Force" (selection); "On Physical Lines of Force" (selection); "A Dynamical Theory of the Electromagnetic Field" (selection).	
Daniel M. Siegel, "Thomson, Maxwell, and the Universal Ether in Victorian Physics." Pp. 239–268 in G.N. Cantor and M.J.S. Hodge (eds.), *Conceptions of Ether: Studies in the History of Ether Theories 1740-1900*. Cambridge: Cambridge University Press, 1981.	
P. M. Harman, *The Natural Philosophy of James Clerk Maxwell*. Cambridge: Cambridge University Press, 1998. Chs. I, IV– VI.1, pp. 1–12, pp. 71–124.	

Session 12	November 20, 2007
Ether drift I.	**Take Home II due**
Michel Janssen and John Stachel, "Optics and Electrodynamics in Moving Bodies." In: John Stachel, *Going Critical* (in preparation). Pp. 285–302.	

Session 13	November 27, 2007
Ether drift II.	
Michel Janssen and John Stachel, "Optics and Electrodynamics in Moving Bodies." In: John Stachel, *Going Critical* (in preparation). Pp. 302–326.	
Albert A. Michelson and Edward W. Morley, "On the Relative Motion of the Earth and the Luminiferous Ether." *American Journal of Science* 34 (1887): 333–345.	
H. A. Lorentz, "Michelson's Interference Experiment." Pp. 3–7 in: Albert Einstein *et al*., *The Principle of Relativity*. New York: Dover, 1952.	
Segrè 1984, Ch. 4, Pt. 3, pp. 181–185 (Lorentz).	

Session 14	December 4, 2007
Electrons/X-rays/radioactivity I.	
Emilio Segrè, *From X-Rays to Quarks. Modern Physicists and Their Discoveries.* New York: Freeman, 1980. Ch.1, pp. 1–25 (Zeeman, J.J. Thomson, Röntgen), Ch. 2, Pt. 1, pp. 26–29 (Becquerel).	
Theodore Arabatzis, "The Zeeman Effect and the Discovery of the Electron." Pp. 171-194 in: Jed Z. Buchwald and Andrew Warwick, (eds.), *Histories of the Electron: The Birth of Microphysics* Cambridge, MA: The MIT Press, 2001.	

Session 15	December 11, 2007
Electrons/X-rays/radioactivity II.	**Take Home III assigned (due: Tuesday, December 18, 5 pm)**
George E. Smith, "J.J. Thomson and the Electron, 1897-1899." Pp. 21-76 in Jed Z. Buchwald and Andrew Warwick (eds.), *Histories of the Electron: The Birth of Microphysics* Cambridge, MA: The MIT Press, 2001.	