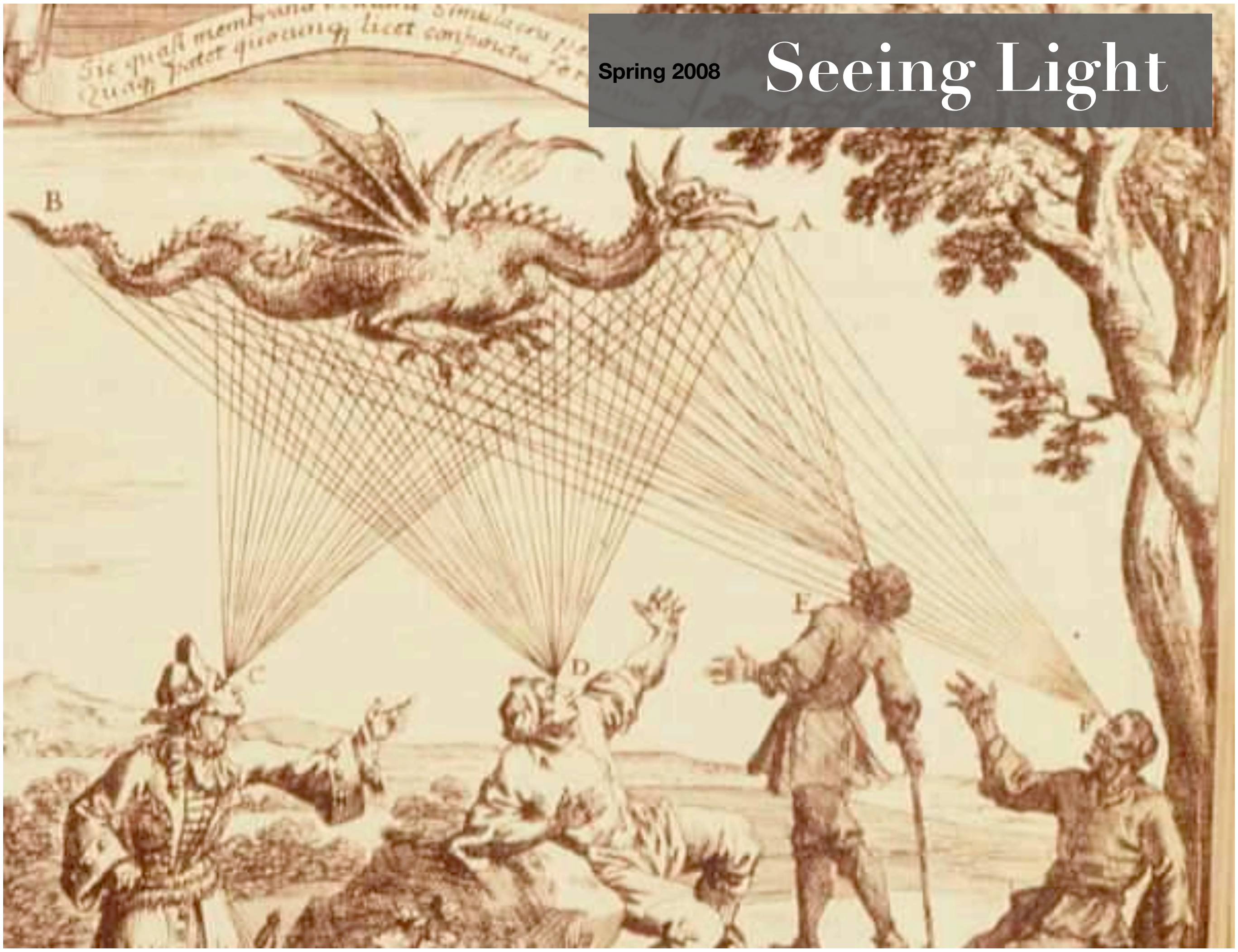
Spring 2008

Seeing Light



Course goals and content

My goal is to change how you ``see'': you will gain a deeper understanding of light and vision that you can apply to your interests and to your experience.

Light is essential to most people's experience of the world. It is a central tool *and* object of study in science. We will address questions in light and vision: What is color? Do all of us see the same colors? Why are peacock feathers and DVDs iridescent? Is there a limit to the resolution of a camera? What makes a rainbow? How do TVs make an image? Why can nothing go faster than the speed of light? How does light show us that predicting the future is impossible?

First things to do

1. Read this syllabus
2. Acquire a textbook
3. Acquire two lab books

Instructor

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Home phone: (315)423-0321 (before 9 PM)

Office hours: 1:30-2:30 PM Tuesdays and Thursdays; I am often free for drop-by discussions.

Course web page

You can find course information, including assignment descriptions and records of your course grades, at

http://blackboard.syr.edu

Log in, using your SU NetID, to access the course.

Should you be taking this course?

This course has no advanced science prerequisites. We will use some algebra, scientific notation (powers of 10), and trigonometry, but this course does not require a calculus course. We will cover a broad range of topics, from the history of science through color vision through the wave nature of light and the nature of space and time. If you meet the prerequisites and are interested in getting a deeper understanding of light and vision, then don't drop this course, yet.

This 3-credit course is listed as an Honors (HNR) course and with a grade of ``B'' or higher can be used to satisfy the breadth and quantitative/creative expression Honors requirements. It is also listed as a PHY course and can therefore count towards the lower division portion of a degree in Physics. This course counts as a lab science course for Arts & Sciences and may also satisfy lab requirements in other colleges.

You will ...

• Study how notions of light and vision have evolved over the last 2500 years. People have had some crazy ideas about light and vision, at least from our current viewpoint. But this shows how scientific theories evolve. The elaboration and refinement of scientific knowledge by experiment, both historically and through your lab experiments, will be a central theme of the course.

• Study the geometric aspects of light: how it can be described by rays and how it can be described by waves.

• Learn about color. We will study the spectrum of visible light and properties of light sources, objects, and how our eyes function. This will allow us to understand the richness of perceived color, even thought it is only a coarse description of light.

• Study applications of light to atmospheric effects, photography, and display technologies.

• Review what experiments over the last century have told us about the quantum mechanical nature of light: light is a ``wavicle'' (combination of wave and particle; a photon) whose behavior is fundamentally unpredictable! We will also see how light tells us that space and time are deeply connected.

• See how light tells us almost everything we know about the Universe outside of our solar system and what it tells us about the early history of the Universe.

Required Book

The book simply titled "Light" and was written by by Michael Sobel (1989, University of Chicago Press) is a solid introduction to the study of light and vision. Though most of our reading is outside of this book, it will be useful to have a single complete text on these subjects and we will read most of Sobel's book.

Other books and resources

Here is a list of books that I use as resources for this course and which are on reserve in the Physics Library:

- *Empire of Light*, by Sidney Perkowitz (1998). This is a modern overview of light by an experimental physicist.
- *Color: Why the World Isn't Gray*, by Hazel Rossotti (1985). The focus of this book is, not surprisingly, how light is affected by objects and how the composition of light gives perception of color.
- *Color and Light in Nature*, by Lynch and Livingston (2001). This book has beautiful examples of natural phenomena, including a huge variety of rainbow/halo phenomena, aurora, twinkling stars, and other atmospheric effects.
- *The Fire Within the Eye: A Historical Essay on the Nature and Meaning of Light*, by David Park, whose title says it all.

- *Colour: Art & Science*, edited by Trevor Lamb and Janine Bourriau. This is a collection of essays on color and its role in art.
- *Light and Color in Nature and Art*, by Samuel J. Williamson and Herman Z. Cummins (1983).
- *Introduction to Light: The Physics of Light, Vision, and Color*, by Gary Waldman (1983).

There is a lot of information on light, color, and vision available on-line, of course. Two types of resources that will be of particular interest are primary source material, such as essays by Plato on light, and simulations of the behavior of light and color. These links will be made available through BlackBoard (http://blackboard.syr.edu/).

Assessment of your work

Some work, especially records of your experiments, will be submitted on paper. Most of your other written work can be submitted digitally via Blackboard. Please submit such work in the area marked ``Assignments''.

I use the course grade to indicate how well I believe you have learned the course material. If your submitted work and participation indicate that you understand and can apply the ideas developed in the course, you will receive a grade of ``A''. If you can mostly apply the ideas, but don't demonstrate a complete grasp of what was developed in the course, you will receive a grade of ``B''. My estimate of how well you understand and apply the ideas will be based on the following assessments, with their weight indicated in brackets:

• [10%] Reading logs: For each reading assignment, you are to use BlackBoard to submit a short summary (8-12 sentences) of what you read and a list of two or more questions about the content of the reading, before class starts. [Late reading logs receive zero credit.]

• [40%] Lab notebooks. Purchase any style of book you like - the ``Marble Cover'' books are cheap and easy to carry around, though they have small pages. Large traditional lab books are also fine. It is your choice, but I do require that you maintain two lab books. These notebooks will be a record of the experiments that we carry out in class and those that are assigned for out-of-class completion. When I collect one notebook for review, you can use the other. The guiding principle is that your notes should be a clear record of what activity you carried out, with diagrams of equipment and observations, instructions (procedures and motivation), and a discussion of your results. The more drawings that you have and the more complete your notes, the more likely it is that your lab grade will be high. Note dates and times of observations. A lab notebook is a log of what you do, written in a way that others (or you at a later time) can reconstruct and follow what you did. [Lab scores are reduced 20% per day late.]

• [20%] In-class exams. I will give a mid-term and final exam, which will ask you to discuss concepts developed in class, supported by examples and diagrams. The mid-term and final exams will be of equal weight and will be designed to be completed in about one hour. [I need a valid medical excuse or true emergency (*not* a job interview, for example) to reschedule an exam and rescheduled exams will be oral exams, where I interview you about the course material.]

• [22%] Course project. This project will consist of writing a paper to support your research into a particular topic of light and vision. This project should include some demonstration of physical principles or involvement in activity where the understanding of light plays a central role. The grade for this work will be based on a proposal [4%], a draft [8%], and a final project [10%], developed throughout the second half of the semester. I strongly recommend that you spread out the work for your project as much as possible. [Course project components are reduced by one grade level (e.g., A- to B+) for each late day, with the first grade reduction taking place at the time they are due.]

• [8%] Participation in class activities. If you actively participate in most of the class discussions, you will receive full credit here. If you miss a noticeable fraction of class meetings, this will be reduced. Discussion with others is necessary to truly appreciate new ideas.

Collaboration, sources, and academic honesty

I encourage you to share ideas with your peers both in and out of class by active discussion. I wish to emphasize that science and knowledge in general advance by discussion and sharing and bouncing ideas off of one another and by reading a wide variety of sources.

The key principle for academic honesty, then, is that you should *properly acknowledge* all of your sources in written or online work. Sources include web pages, books, articles, television shows, and people. For example, if you learn something from someone, you should credit them in your paper or lab notebook. Examples:

• ``Jes Katt suggested that I try this out, which worked out well because I saw a new color at the edge of the sample.''

• ``The principle of pair production (Ref. 23) means that colliding light beams can create matter.'' [Or, alternately, ``The principle of pair production [Sniffler, 1986] means that colliding light beams can create matter.'']

• ``This figure is a screen capture of a tutorial simulation of light reflection that can be seen at http://www.microscopy.fsu.edu/primer/java/reflection/reflectionangles/.'' (please be cautious, using only reliable and persistent web pages).

Such acknowledgement allows the reader to track down the sources of information to learn more, to evaluate the reliability of the information, and to see that others are properly credited for their efforts. A consequence of this principle is that *quotations from sources should be clearly indicated as such*, by offsetting long quotes and including short quotations in quote marks. The principle of acknowledging your sources is central to scientific writing; a large fraction of sentences in scientific papers have citations. This principle avoids plagiarism and makes your work more useful.

Except for properly acknowledged quotations, all work that you submit should be in your own words.

Improperly aiding another student is academically dishonest. Please do not share your written work in any manner, even by e-mailing your work to another student, as you will be held responsible for contributing to academic dishonesty if someone else turns in your work.

Please also be aware of the details of University and College policies on academic dishonesty: the Syracuse University Academic Integrity Policy holds students accountable for the integrity of the work they submit, including citations in written work, exams, and any other assignments. More information and the complete policy can be found at http://academicintegrity.syr.edu.

Accommodations

Students who may need academic accommodations due to a disability are encouraged to please let me know as soon as possible. In order to obtain authorized accommodations, students should be registered in advance of any relevant exam or assignment with the Office of Disability Services (ODS), 804 University Avenue, Room 309, 315-443-4498 and have an updated accommodation letter for the instructor.

HNR250/ PHY200 - Seeing Light Spring 2008

Calendar

aam, 13 January 2008 (created 13 January 2007)

no tags

[The dates of topics may vary; major assignment and exam dates are fixed.]

Date		Topic	Major Assignments
Week 1	Jan. 14, W	**Course Setting**	-
	Jan. 16, M	**Atomists v. Plato**	-
Week2	Jan. 23, W	**Optics in Arab World, 700-1100**	-
Week 3	Jan. 28, M	Rays: Alhazen, Kepler	-
	Jan. 30, W	Spectrum: Descartes, Newton's Opticks	-
Week 4	Feb. 4, M	Color & Waves: Young, Grimaldi, Maxwell	-
	Feb. 6, W	Wireless: Hertz & Marconi	-
Week 5	Feb. 11, M	Mirrors & lenses	-
	Feb. 13, W	Bending light	-
Week 6	Feb. 18, M	The Eye	-
	Feb. 20, W	Color mixing and perception	-
Week 7	Feb. 25, M	Color and Art	-
	Feb. 27, W	Electromagnetic radiation	Project Proposal Due
Week 8	Mar. 3, M	Electromagnetic spectrum & review	-
	Mar. 5, W	MIDTERM EXAM	
SPRING BREAK			
Week 9	Mar. 17, M	Color in textiles	-
	Mar. 19, W	Polarization lab	-
Week 8	Mar. 24, M	Cosmology	-
	Mar. 26, W	TBA	-
Week 11	Mar. 31, M	Diffraction and Interference: Thin films	-
	Apr. 2, W	Diffraction and Interference: *CDs*	-
Week 12	Apr. 7, M	The Sky: Blue sky and rainbows	-
	Apr. 9, W	The Sky: mirages and the "green flash"	First Draft Due
Week 13	Apr. 14, M	Quantum mechanics	-
	Apr. 16, W	Photons and photography	-
Week 14	Apr. 21, M	Relativity: light and space and time	-
	Apr. 23, W	Relativity	-
Week 15	Apr. 28, M	Catching up	-
	Apr. 30, W	NO CLASS	Final Project Due

FINAL EXAM: 8:00-10:00 AM, Wednesday, May 7, in Room 106