# GEOL 130 - THE NATURE OF SCIENTIFIC INQUIRY

## FALL 2016

This course is designed for anyone with an interest in the physical sciences. The course considers the nature of scientific inquiry in comparison to other "world views" and the relationship of science to other aspects of human knowledge. We explore how science is done, how new scientific paradigms (broad scientific frameworks) are developed and older paradigms discarded or changed, and the limitations and boundaries of science. We will then examine the history of the main scientific ideas about how our universe functions. Examples of scientific ideas and paradigm shifts will largely come from the physical science (astronomy, physics, chemistry, earth sciences). By the end of the semester I hope that all of you acquire a modern scientific perspective about the natural world around us, a better understanding of what we know and don't know about our universe, and that you develop a more questioning attitude with regards to the methods by which we attempt to learn about the universe.

**Lecture:** SGM room 123. Tu-Th 9:30-10:50. Full participation in lecture strongly encouraged. You will be expected to participate in class activities, including at least 10 surprise quizzes, and answering questions through the use of TopHat. Please bring to class some form of electronic device (computer, iphone, ipad, etc) and get a TopHat subscription.

## Grading:

3 Exams 60% (15% for first, 20% for second, and 25% for third exam),

Lab 30% (attending and passing the lab is required to pass the course)

10 or more random pop quizzes in lecture 10%

Extra Credit (see options below)

1) Read physical science stories in class (1 point for each story, maximum of 5)
2) JEP: A JEP representative will discuss this program in lecture. Successful completion of this option bumps your grade up one quantum level (e.g., B to B+). Contact the JEP office and apply online immediately if interested (http://uscdornsife.usc.edu/secure/JEP/) since spaces are limited.
3) I sometimes offer other extra credit assignments such as optional homework assignments or IMAX movies related to course topics. Feel free to make suggestions if you think of something during the semester.

Grading for exams, labs, and the course is on a curve. Typically at the end of the course at least 50% of students will get A's and B's. At the end of the course, students falling on the boundary between two grades are eligible (at my discretion) to receive the higher grade based on the following: (1) showing continued improvement in midterm scores, (2) repeated class participation, and (3) regular and collegial participation in labs.

**Scott Paterson:** Office Hours: 8:30-9:20 and 11:00-12:00 am, Tues/Thurs or by appointment.
Office: ZHS-307, phone: 213-740-6103; email: paterson@usc.edu

Students requesting academic accommodations based on a disability are required to register with Disability Services and Programs (DSP) each semester. A letter of verification for approved accommodations can be obtained from DSP when adequate documentation is filed. Please be sure the letter is delivered to me as early in the semester as possible. All DSP students are expected to remind me in advance regarding special arrangements needed for midterm exams. DSP is open Monday-Friday, 8:30-5:00. The office is in 3601 Watt Way, Grace Ford Salvatori Hall, 120, the phone number is (213) 740-0776, and email is ability@usc.edu.

**Statement on Academic Integrity**

USC seeks to maintain an optimal learning environment. General principles of academic honesty include the concept of respect for the intellectual property of others, the expectation that individual work will be submitted unless otherwise allowed by an instructor, and the obligations both to protect one's own academic work from misuse by others as well as to avoid using another's work as one's own. All students are expected to understand and abide by these principles. *SCampus*, the Student Guidebook, (www.usc.edu/scampus or http://scampus.usc.edu) contains the University Student Conduct Code (see University Governance, Section 11.00), while the recommended sanctions are located in Appendix A.

**Emergency Preparedness/Course Continuity in a Crisis**

In case of a declared emergency if travel to campus is not feasible, USC executive leadership will announce an electronic way for instructors to teach students in their residence halls or homes using a combination of Blackboard, teleconferencing, and other technologies.

## Class Schedule

### The Beginnings of Science:

| | |
|---|---|
| Week 1 (Aug. 23) | Introduction to course & meet your crazy professor |
| Week 1 (Aug. 25) | Topic 1: What is Science? |
| Week 2 (Aug. 30) | Topic 2: How Do We 'Do' Science? |
| Week 2 (Sept. 1) | Topic 3: The Origin of Science in Ancient Greece |
| Week 3 (Sept. 6) | Topic 4: Ancient Greek Science – 500 Years After its Beginnings |
| Week 3 (Sept. 8) | Topic 5: The Development of Theories and Paradigms |
| Week 4 (Sept. 13) | Topic 6: The Scientific "Dark Ages"? |
| Week 4 (Sept. 15) | Lecture "catch up" and/or review for midterm |
| Week 5 (Sept. 20) | **First Midterm Exam** (Topics 1-6) |

### Scientific Revolutions:

| | |
|---|---|
| Week 5 (Sept. 22) | Topic 7: The First Revolution - Astronomy of Copernicus/Galileo |
| Week 6 (Sept. 27) | Topic 8: The Second Revolution - Motion from Galileo to Newton |
| Week 6 (Sept. 29) | Topic 9: The Nature of Light and the Special Theory of Relativity |
| Week 7 (Oct. 4) | Topic 10: The General Theory of Relativity |
| Week 7 (Oct. 6) | Topic 11: Changing Views on the Nature of Matter |
| Week 8 (Oct. 11) | Topic 12: The Bohr Atom: The First New Paradigm for Matter |
| Week 8 (Oct. 13) | Topic 13: A Quantum Mechanical View of Matter |
| Week 9 (Oct. 18) | Topic 14: The Double-Slit Experiment, Causality, and Schroedinger's Cat |
| Week 9 (Oct. 20) | Lecture "catch up" and/or review for midterm |
| Week 11 (Oct. 25) | **Second Midterm Exam** (Topics 7-14) |

### Science's Ever Changing View of Our Universe:

| | |
|---|---|
| Week 11 (Oct. 27) | Topic 15: Measuring Time: Changing Ideas about the Age of Objects in Our Universe |
| Week 12 (Nov. 1) | Topic 16: Earth: The Change from Static to Dynamic Views of Earth Evolution |
| Week 12 (Nov. 3) | Topic 17: The Plate Tectonics Paradigm Shift |
| Week 13 (Nov. 8) | Topic 18: Big Bang, A New Dynamic Universe |
| Week 13 (Nov. 10) | Topic 19: Black Holes, QM, and the Universe |
| Week 14 (Nov. 15) | Topic 20: Chaos Theory: A Chaotic Paradigm Shift in progress |
| Week 14 (Nov. 17) | Topic 21: Fractals in the Universe around us. |
| Week 14 (Nov. 22) | Topic 22: 20$^{th}$ Century Science and class summary |
| Week 15 (Nov. 24) | THANKSGIVING (enjoy your quantum turkeys) |
| Week 15 (Nov. 29) | Topic 23: 21$^{st}$ Century Science: the future and/or review for midterm |
| Week 16 (Dec. 1) | **Third Midterm Exam** (Topics 15-23) |

## Reading Assignments

Topic 1: Wolpert, Ch 1, 2; Dewitt, Ch.1-2;
Topic 2: Wolpert, Ch. 3; Dewitt, Ch. 3-8;
Topic 3: Wolpert, Ch. 4-7; Dewitt, Ch. 9-13.
Topic 4: Dewitt, Ch. 9-13
Topic 5: None required: Optional – Kuhn, T., "The Structure of Scientific Revolutions"
Topic 6: None required
Topic 7: Hawking, Ch. 1; Dewitt, Ch. 14-18.
Topic 8: Dewitt, Ch. 19-21
Topic 9: Gribbin, Ch. 1; Dewitt, Ch. 22-23; Gammow/Stannard, Ch. 1-2.
Topic 10: Hawking, Ch. 2; Gammow/Stannard, Ch. 2-5.
Topic 11: Gribbin, Ch. 1- 3.
Topic 12: Gribbin, Ch. 4; Gammow/Stannard, Ch. 8-9.
Topic 13: Gribbin, Ch. 5-7; Hawking, Ch 4, 5; Gammow/Stannard, Ch. 9-12, optional 13-16.
Topic 14: Dewitt, Ch. 24-29; Gribbin, Ch. 8-11.
Topic 15: Hawking, Ch. 1-3; Gammow/Stannard, Ch. 4-5.
Topic 16: Hawking Ch. 1; optional - any intro geology text
Topic 17: None required; optional - any intro geology text
Topic 18: None required; optional - any intro geology text
Topic 19: Hawking, Ch. 6-9; Gammow/Stannard, Ch. 7.
Topic 20: Wolpert, Ch. 8, 9.
Topic 21-22: None required: optional Gleick, J. "Chaos - Making a New Science" Ch. 1-11.
Topic 23: Gribbin-epilogue; Hawking, Ch. 10-11; Gammow/Stannard, Ch. 13-16.

## Sources for Readings

Gamow, G., and R. Stannard, the New World of Mr Tompkins, Cambridge University Press, 1999.
Gribbin, J., In Search of Schrodinger's Cat, Bantam Press, 1984.
Hawking, S., A Brief History of Time (tenth anniversary edition), Bantam Press, 1996.
Wolpert, L., The Unnatural Nature of Science, Harvard University Press, 1992.
Dewitt, R., Worldviews, Blackwell Publ., 2004.

Web and Wiki: lots of great information on these topics plus many videos. But be careful to cross check this information with materials presented in class.