

Course Outline: Honors Seminar (Physics 89) and Special Physics 6C Lab (G13)

Outline:

- This course is specifically designed for highly motivated life science majors in Physics 6C in Winter 2014 to explore **the physics behind life's dynamical behavior**, in conjunction with a newly developed **6C Lab (G13)**.
- Through this class, we will study behavior of a simple model animal called **C. elegans** that has only 302 neurons. Emphasis is given to the physics in the environment of C. elegans and human beings, as well as their/our neural networks that make sensible, prompt decisions for their/our survival.
- 15 - 20 students per each seminar are expected.

Instructor:

- Katsushi Arisaka, Professor of Physics & Astronomy
- Knudsen 4-146, (310) 825-4925, arisaka.6b@gmail.com

Course Homepage:

- Public homepage: <http://home.physics.ucla.edu/~arisaka/home/Teaching/Physics89C/>
- Our own homepage: <http://home.physics.ucla.edu/~arisaka/elegans/>
 1. This page is password protected (ID = elegans, PW = elegans)
 2. Please navigate the sites as much as you like in advance.

Weekly Meetings:

- Tentatively scheduled on

Sem. 1:	Thursday at 10:00 – 10:50 am
Sem. 2:	Thursday at 11:00 – 11:50 am
- Location: **Knudsen 4-134**
- The first meeting is on **Thursday, January 9**.

Associated Special 6C Lab (G13):

- In conjunction with Physics 6C/89, a special 6C Lab (G13) is scheduled.
- This lab focuses on behavior experiments with **C. elegans**. Nematode samples are observed under various stimulations (such as electric and magnetic fields, UV lights, motion and temperature).
- Once you register for Physics 89, you are requested to register 6C Lab (G13) as well, instead of the normal 6C Labs (G1 – 12).
- This special 6C Laboratory (G13) is located in **Knudsen 4-162**, open to you anytime from Monday-Friday, 9 am until 6 pm.
- You are expected to spend at least 5 hours per week, and hopefully $\sim >10$ hours per week in the lab. Therefore, your strong commitment to this course is anticipated.
- We are going to form five sub-groups, depending on the various stimulations, at the beginning of the 2nd week.

Teaching Assistant:

- Lead TA:
 1. Hector Garcia, hectorgarcia@physics.ucla.edu
- Assistant for biology:
 1. Peter Pellionisz, peterpellionisz@mac.com
 2. Neha Agarwal, neha227@gmail.com
 3. Bobby Vanmali, bvanmali@ucla.edu
- Technical Assistant:
 1. Timothy Sherry, timrsherry@ucla.edu
 2. Blake Madruga, blakemadruga@gmail.com
 3. Steve Mendoza, steve123er@gmail.com

Specific Aims:

- This course is specifically designed for highly motivated life science majors in 6C to understand the fundamental physics behind life's dynamical behavior.
- Topics include:
 - *Sensory inputs and environment:*
 1. *Vision*
 2. *Hearing*
 3. *Electric and magnetic fields*
 4. *Mechanical stimulations: Touch, Pain*
 5. *Temperature*
 - *Decision making by neural networks in Brain*
 1. *Nature vs. nurture*
 2. *Adaptation: Memory and Learning*
 3. *Conscious and unconscious behaviors*
 - *Motions and behavior*
 1. *Muscles*
 2. *Navigation*
- We are going to use *C. elegans* as a model animal. If time permits, we also study *Drosophila* and Zebrafish, using the identical setups.
- Participants will learn direct application of basics concepts from Physics 6A/6B/6C to biological systems listed above.
- Furthermore, you will learn advanced skills on today's professional lab environments, including
 - Computer programming (MatLab, MicroManager, ImageJ, LabView...)
 - Operation of advanced microscopes and CMOS cameras.
 - Professional optical design (ZeMaX) and mechanics design (SolidWorks)
 - Data analysis and statistical treatment
 - Professional writing of scientific papers
 - Professional oral presentations

Proposed Activities:

- The program will consist of the following, related to the topics mentioned above.
 - Weekly lecture by Arisaka and informal discussion (one hour per week)
 - Special 6C lab (G13) (> 5 hours per week)
 - A few reading assignments and written reports (~ 1/2 page report each)
 - End-of-Course Oral presentation at our own conference (will be scheduled in early April.)

- You will get one unit of honors credit, as well as full credit of 6CL (i.e. 15% of Physics 6C score for the course grade).

Reference:

- Feynman's Lectures on Physics (Copy will be provided.)
- Recommended books (see below).
- Recent articles from scientific magazines, related to neuroscience and C.elegans

Reading Assignments:

You are strongly encouraged to read two of the following books, one by February 3rd (Mon), and the other by March 3rd (Mon). Write a short (~1/2 page) book review. As for the first book, I strongly encourage you to read **I of the Vortex: From Neurons to Self** because it covers the central theme of this course extensively.

1. **I of the Vortex: From Neurons to Self**
by Rodolfo Llinas
\$16.29
2. **The Double Helix :
A Personal Account of the Discovery of the Structure of DNA**
by James D. Watson
\$11.20
3. **The Selfish Gene**
by Richard Dawkins
\$10.85
4. **Life Ascending: The Ten Great Inventions of Evolution**
by Nick Lane
\$16.95
5. **In Search of Memory: The Emergence of a New Science of Mind**
by Eric R. Kandel
\$18.95

Tentative Outline of Scientific Topics

<u>Week</u>	<u>Day</u>	<u>Topics</u>
1	January 9	Orientation, Origin and evolution of Universe
2	January 16	Origin and evolution of life
3	January 23	Origin of consciousness
<i>(First Midterm of 6C: Monday, January 27)</i>		
4	January 30	Environmental stimulation and sensors
5	February 6	Neural networks and decision-making
6	February 13	Group meeting by students
<i>(Second Midterm of 6C: Wednesday, February 19)</i>		
7	February 20	Advanced technique of high-speed Bio-imaging
8	February 27	Tour of CNSI
9	March 6	Progress report from students
10	March 13	Final Lecture: What is Life?

Mini Conference – Oral Presentation by students
Saturday, April 5 9 am – 5 pm
Sunday, April 6 9 am – 5 pm
