The Elegant Mind Club: Undergraduate Biophysics Research Lab at UCLA to Explore the Minds of *C. elegans*

ETTA D'ORAZIO, ANGELA ROSE DAVID, ANGELA DU, Javier Carmona, Rebecca Huang, Suying Jin, Blake Madruga, Phat Mai, Steve Mendoza, Trudy Tan, Joseph Thatcher, Sonya Watson, Amanda Yamada, and Katsushi Arisaka

UCLA, Elegant Mind Club @ Department of Physics and Astronomy

http://www.elegantmind.org

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INTRODUCTION

The Elegant Mind Club studies *Caenorhabditis elegans*, a simple yet behaviorally insightful organism, to provide undergraduate students across STEM disciplines the unique opportunity to design and manage their own research methods and carry out experiments in a laboratory setting, allowing them to explore the nature of scientific research.

With a relatively simple nervous system, consisting of 302 neurons, stereotyped motor behavior, and method of cultivation, the nematode *C. elegans* is an ideal model organism to study neuroscience and biophysics.

GOALS

To provide students with the environment and resources to:

- Take ownership of a research experiment from hypothesis to publication, utilizing peer-reviewed publications and online resources including WormBook, WormAtlas, and the Caenorhabditis Genetics Center to generate their own procedures from the leading methods.
- Independently maintain, culture, and prepare live *C. elegans* samples for their own experiment. Direct involvement with the biological samples teaches students the discipline of working with chemicals and maintaining a sterile working environment.
- Design and innovate specialized hardware, encouraging students to strive for the most controlled and reproducible system for their experiment. This promotes individual problem-solving.
- Apply MATLAB and associated software to conduct data analysis for biophysical characteristics and neuronal imaging.

LAB MEMBERS

Since summer of 2013, we have recruited new members every quarter through the Physics 89HC lab honors program. Students undergo intensive quarter-long trainings in laboratory protocol, hardware design and assembly, and the neurophysics of *C. elegans*. Students who return for the follow quarter lab course are tasked with designing their own experiments.

Fig. 1 Elegant Mind Club Physics 89 Winter 2017 Honors Students, Undergraduate, and Graduate Research Assistants, with Principle Investigator Dr. Katsushi Arisaka (front, right).

BEHAVIORAL EXPERIMENTS

After proposing a project and consulting empirical sources, students assemble the appropriate apparatus for the experiment. As of now we have built systems for imaging worms under the absence of external stimuli, electric field, magnetic field, infrared laser, thermal gradients, and blue light stimulation. We have also developed several advanced freely-moving realtime worm-tracking microscope capable of imaging neural activities in 2D and 3D.

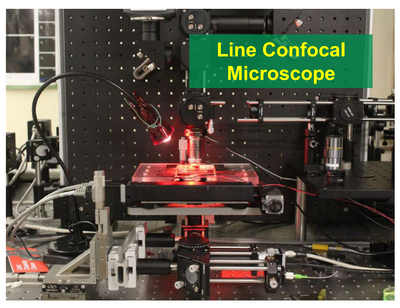

Fig. 2 Line Confocal Microscope, featuring attachments for blue light (405nm), infrared, and electric field stimulations. Also equipped to observe neuronal dynamics via immobilized or motile specimens.

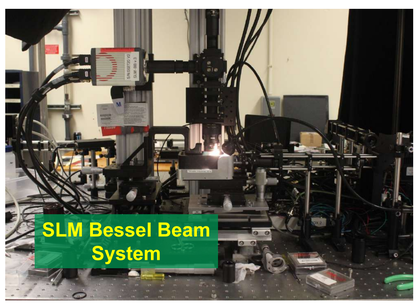

Fig. 3 SLM-Bessel Beam System enables high precision rapid z-scanning in four dimensions, allowing observation of active neural dynamics in the nerve ring of *C. elegans*.

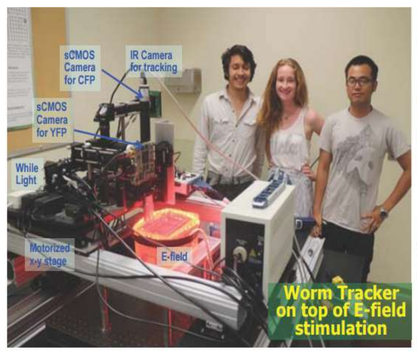

Fig. 4 A worm-tracking microscope tracks the center of mass of a worm in high resolution. The system is equipped with a sCMOS camera for CFP/YFP imaging.

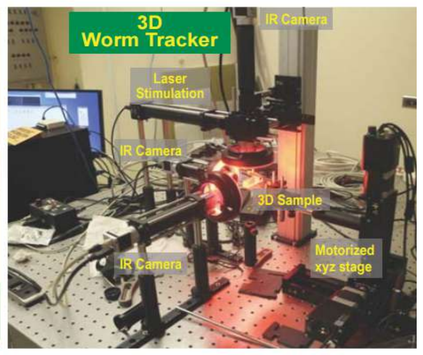

Fig. 5 The 3D worm tracking microscope synchronizes three objectives in x, y and z planes to generate an image of a worm navigating a gelatin medium in a 30mm^3 cuvette.

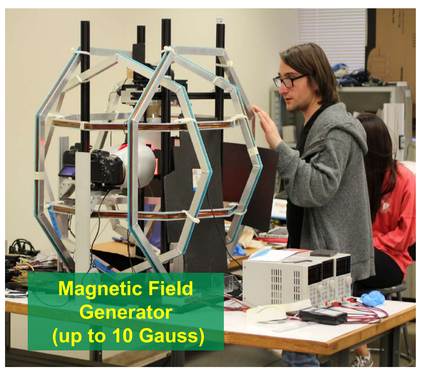

Fig. 6 The Helmholtz coil copper chamber images a cube cuvette sample in three dimensions via three orthogonal Canon cameras.

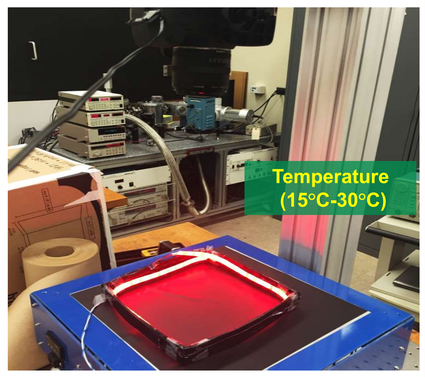

Fig. 7 A thermal gradient generated from a Peltier device. Samples are time-lapsed via a Canon EOS 60D camera.

OUR LAB FACILITIES

Our laboratory is composed of six rooms in Knudsen Hall, UCLA.

Central Lab Knudsen 4-173

- Meetings, lectures, discussions, and article presentations
- New member training
- Data analysis

Data Lab Knudsen 4-173A

- Nine PC rigs built and customized by students
- Image processing
- MATLAB and LabVIEW software coding and data analysis

Behavior Lab Knudsen 4-162

- Houses magnetic field, electric field, thermal plate, and free motion systems
- Undergraduate experimental systems workshop

Biology Lab Knudsen A-154

- Incubation of *C. elegans* cultures
- Sample preparation for all experiments
- Biological & chemical stock

Tracker Lab Knudsen 4-166

- Development of real-time worm-tracking microscopes
- Observation of neural activities under various external stimulations.

Microscope Lab

Knudsen B-171

- Development of advanced microscopes for 2D and 3D imaging
- Light field microscopy of neural structures
- 3D scanning of zebrafish and mouse brains.