Current Listing of Undergraduate Physics Research Projects

The following is a list of specific undergraduate research projects available either during the academic year as Phys 195 / thesis projects or as paid summer research opportunities. Note that additional projects beyond this list are also possible. Students are encouraged to contact individual faculty members for additional information.

Project title(s): Computer simulations of the mechanics of cytoskeletal structures and image analysis from microscopy data
Faculty member: Kinjal Dasbiswas, kdasbiswas@ucmerced.edu
Research area: Soft matter & biophysics
Experiment/Simulation/Theory: Theory/Computation
Term available: Summer 2022 or academic year
Project description: The cell cytoskeleton is the structural framework of animal (including human) cells that is made of networks and bundles of filaments (actin) associated with molecular motors (myosin). Together, actin and myosin generate mechanical forces that enable cells to move, divide or contract such as when you flex your muscles. Recent microscopy experiments reveal that these constituent parts can be organized by motor forces into ordered structures, that resemble phases of condensed matter such as liquid crystals. By modeling force transmission through the cytoskeleton represented as a network of springs, we aim to show how elastic interactions enable such ordering. This is very different from the ordering that happens in equilibrium phase transitions in nonliving materials. You can work with graduate students who develop computer simulations and with experimental data obtained from collaborators.

Project title(s): The physics of coronavirus self-assembly; The physics of collective cell migration
Faculty member: Ajay Gopinathan, agopinathan@ucmerced.edu
Research area: Soft matter & biophysics
Experiment/Simulation/Theory: Simulations and theory
Term available: Summer 2022 or academic year
Project description:

Project 1: The physics of coronavirus self-assembly**.** Simple analytics and computer simulations of the assembly of coronavirus proteins to form a mature viral particle. This will be part of a multi-campus collaboration with experimentalists and other theorists.

Project 2: The physics of collective cell migration. Computer simulations of agent based models of collective migration of cancer cells and during vascular development. More details on our

research (gopinathanlab.ucmerced.edu) and also be part of the Center for Cellular and Biomolecular Machines (ccbm.ucmerced.edu)

Project title(s): Shear of granular materials with pinned disorder; Clogging of suspension flow
Faculty member: Brian Utter, brianutter@ucmerced.edu
Research area: Soft condensed matter
Experiment/Simulation/Theory: Experiment
Term available: Summer 2022 or academic year
Project description: Openings for both summer research and Phys 195 projects beginning in fall 2021 are available. For general information and videos/images, see https://sites.ucmerced.edu/utter/research. Note that Professor Utter's lab focuses exclusively on undergraduate research. Interested students are encouraged to reach out to Prof. Utter directly.

Project 1: Granular shear within networks of pins: Shear of granular materials is an example of a complex system, where simple, frictional interactions of many particles lead to complex responses of the material, for instance sudden jamming and avalanching behavior. In this project, we will perform experiments using photoelastic grains to visualize forces under shear. We will introduce fixed pins as a source of imposed structural order to understand the stress and flow response. Potential applications include designer materials, with tunable rheological properties. This project involves the collaboration of colleagues working on related experiments and simulations. Positions beginning in summer or fall may be available. Relevant paper: https://journals.aps.org/pre/abstract/10.1103/PhysRevE.96.022903

Project 2: Clogging of suspension flows: Clogging is the sudden arrest of particle flow, for instance in sand flowing through an hourglass. In this project, we will study the clogging of bidirectional flow, where light and dense particles in suspension pass through each other in a channel. Despite it's simplicity, there are many intriguing questions about the interaction of grains and stability of the structures formed. Experiments will characterize the jamming probabilty and stability of clogs formed. Related experiments on clogging through millifluidic channels may also be possible. Work is in collaboration with a colleague working on similar flows in in simulations of pedestrian motion. Relevant paper: https://arxiv.org/abs/2003.06102

Project title(s): Molecular motor biophysics
Faculty member: Jing Xu, jxu8@ucmerced.edu
Research area: Biophysics
Experiment/Simulation/Theory: Numerical or experiment
Term available: Summer 2022 or academic year
Project description: http://xulab.ucmerced.edu/, project specifics will be matched to student preparation and interest.