

Class meetings: TR 2:00 – 5:30 PM, Lind Hall, Room 207

Instructor: Dr. Michael R. Braunstein, Assoc. Prof. of Physics

Office: Lind Hall, 203D Office Phone: (509) 963-2761 email: braunst@cwu.edu

Office hours: 9:30 AM - 10:30 AM TR, Noon - 1:00 PM W; knock if my office door is closed. Scheduled appointments are suggested for times other than these.

Co / Pre - requisites: Physics 318, Physics 331

Course content: The course will consist of introductions to experimental methods in physics, laboratory work on modern physics experiments introduced with appropriate content, and shop work.

Text: **Experimentation, An Introduction To Measurement Theory and Experiment Design**, 3d Edition, D.C. Baird.

Lab reports: The primary means for assigning a grade in the course will be by evaluation of written lab reports, presentations and poster presentations. Deadlines for these assignments will be determined by the instructor and announced in class. Chapter 7 of the text describes the requirements of a written lab report and those guidelines will be used for written reports in this course.

Late assignments: Late (appropriate) assignments will STRICTLY be assessed grade deductions of 25% for each 24 hour (work day) period following the assignment deadline. Students will be given a single 24 hour (work day) “late grace” for one (appropriate) assignment of their choice.

**Final Exam: Tuesday, March 14, 2:00 - 4:00 PM.**

Attendance: Students are expected to attend each class meeting. It has proven extremely difficult for students to complete the assigned exercises without diligent regular effort during the scheduled course meetings. It is also expected that additional time outside the assigned class meeting times may be necessary for students to complete the course requirements.

Cheating: Cheating absolutely will not be tolerated. **Any** instance of cheating will result in a grade of F for the entire course. This policy on cheating includes, but is not limited to, such acts as copying assignments, plagiarizing material, using unauthorized resources on exams, tests or quizzes, copying from others on exams, tests, or quizzes, and submitting the work of another as ones own. In addition, students should familiarize themselves with CWU's policy on academic integrity; instances of cheating can result in additional disciplinary action.

Your course grade will be assigned based on an evaluation of your work in the following areas and according to the weights assigned below:

Lab Reports:	65%
Presentation/Poster:	20%
Homework, Lab Quizzes, Final Exam:	15%

and assigned a letter grade as follows:

Grade	% of total possible points		
A	92-100	D+	68-70
A-	90-92	D	62-68
B+	88-90	D-	60-62
B	82-88	F	Below 60
B-	80-82		
C+	78-80		
C	72-78		
C-	70-72		

Note: **The instructor reserves the right to alter the listed weights and to curve the final grades.**

## Course Goals

Students will:

1. Develop ability to apply the scientific process to understand fundamental physical systems of intermediate and advanced complexity.
2. Develop ability to apply specific skills, knowledge areas, and resources associated with scientific experimentation and measurement including experimental design and techniques, uncertainty analysis, report writing and presentation, and use of apparatus of intermediate and advanced complexity.
3. Develop ability to understand the relationship between physical systems and their analytical descriptions.
4. Develop ability to carry out independently designed and performed experimental studies.

FAST X-RAY PICTURES OF SAND JETS. Granular materials---possessing both solid-like and liquid-like characteristics---exhibit much strange emergent behavior even in the simplest of experiments. When, for example, a heavy sphere is dropped into a bed of sand, what happens, if you look carefully enough, can still surprise seasoned researchers. Heinrich Jaeger of the University of Chicago and his colleagues watched the jets kicked up by the sphere: they used high speed video and ordinary light to view the outside of the jets and high-speed radiography (the x rays supplied by the Advanced Photon Source at Argonne) of the jet interior. The impact kicked up a bizarre two-tiered jet structure: a thick shaft at the bottom and, projecting up out of the top, a further and thinner shaft .

(see figures at <http://jfi.uchicago.edu/~jaeger/group/granular.html> ).

That the jets are so well collimated is a surprise: why doesn't the sand just fly out at all angles? In moving up in a sort of directed beam, with very little lateral motion, it seems to act like an ultracold gas (at least in the sideways direction). Another surprise is the twofold jet structure. The lower, thicker jet is surely sculpted by collisions between sand grains and air molecules since it gets progressively scantier until, at pressures close to vacuum, it goes away altogether, leaving only the thinner spiky jet. The jet interior pictures are unprecedented: taken with an exposure rate of 5000 frames per second, the x ray flux provided the equivalent of a 50-watt halogen lamp illumination---only at x-ray wavelengths. The x-ray pictures proved that air squeezed among the grains was the driving force in forcing up the thick stage of the jet formation, and not as one might have expected a force for dissipating the jet. (Royer et al., Nature Physics, December 2005; by the way, Nature Physics is a new journal that began publication in October 2005.)