IPRO 497-305 Syllabus – Spring 2015
Developing an Antimatter Gravity Interferometer

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Classes: TuTh 11:25 am – 12:40 pm, 050 TBC

Brief overview: The gravitational acceleration of antimatter on Earth has never been directly measured. We will develop apparatus that can be used to measure the gravitational acceleration of antimatter: in particular, of the neutral *muonium* atom, a hydrogen-like bound state of an antimuon with an electron. In future, this apparatus can be taken to a particle accelerator laboratory and placed in a muonium beam in order to carry out the gravity measurement. Since muonium lives for only 2.2 microseconds on average, its gravitational deflection is very small. Thus an atom-beam interferometer of unprecedented precision is required. Such an interferometer can be built using state-of-the-art nano-fabrication for gratings, precision machining of an optical bench out of single-crystal silicon, and sub-nanometer precision motion and control by optical feedback. The course goal is the preliminary design and modeling of such an instrument. (If the initial steps progress sufficiently quickly, prototyping may also be possible.)

Course objectives:

1. Design, prototype, and test diffraction gratings suitable for measuring gravitational acceleration of muonium
    a. Carry out finite-element modeling (FEM) to optimize grating internal support structure
    b. Build macroscopic grating model to verify geometry
    c. (If time permits; otherwise next semester) Build and characterize one or more prototype gratings at Argonne Center for Nanoscale Materials
2. Study and model interferometer mounting and alignment system
3. Carry out design and simulation studies of muonium gravity experiment as a whole

Grading: A combination of peer assessment, self-assessment, and instructor assessment (details TBD). Students will be graded not only on the quality and level of their own individual effort, but also on the participation and functioning of **all** of the students together as members of a team, and on the overall performance of the team. This includes the team's effectiveness in achieving the project goals in a quality fashion.

Important dates:

- **Jan 24** – Last day to add or drop a course, change sections, etc.
- **Week of Mar 2 or Mar 9 (date TBD)** – Mid-Term Review
- **Mar 16–20** – Spring Break
- **Mar 30** – Last day for official withdrawal
- **Apr 21** – Video due
- **Apr 24** – IPRO Day
- **Week of Apr 20 or Apr 27 (date TBD)** – Final review
- **Week of Apr 27 (date TBD)** – Closure & Feedback Session

Class attendance: All students are expected to attend all class sessions. Please notify the instructors by email before class if you must be late or absent. You remain responsible for whatever you miss.

Disability notice: Reasonable accommodations will be made for students with documented disabilities. In order to receive such accommodations, students must obtain a letter of accommodation from the Center for Disability Resources, located in 3424 S. State St., room 1C3-2 (on the 1st floor); phone: 312 567-5744; email: disabilities-at-iit.edu.