Physics Senior Thesis

November 25, 2014

http://www.physics.oregonstate.edu/WIC
Physics Major Timeline

• Junior Year
  – Paradigms
  – Electronics Lab
  – Math Methods Capstone

• Senior Year
  – Capstones (EM, Mech, QM, Thermo, Optics)
  – Senior Thesis
  – Job / Grad School
Physics Major Curriculum

<table>
<thead>
<tr>
<th></th>
<th>PH 411</th>
<th>3</th>
<th>PH 412</th>
<th>3</th>
<th>PH 415/464</th>
<th>3</th>
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<tbody>
<tr>
<td>JUNIOR</td>
<td>PH 320</td>
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<td>PH 424</td>
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<td>PH 421</td>
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<td>PH 365</td>
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<td><strong>PH 403</strong></td>
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<tr>
<td>SENIOR</td>
<td>PH 431</td>
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<td>PH 435</td>
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<td>PH 481</td>
<td>4</td>
<td>PH Elective</td>
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</tbody>
</table>
Graduate School

• Physics, Applied Physics, Engineering, ...
• M.S., Ph.D.
• Research Experience as UG
• Letters of Recommendation (3+)
• Personal statement
• GRE
  – General: Computer based, anytime
  – Physics: paper-based: September, October, April
  – GRE seminar Spring term
• Finance: TA/RA, Fellowship (NSF, DOE, etc)
Graduate School Info

• GRE: www.ets.org/gre
• AIP info: www.gradschoolshopper.com
• GradSchools.com www.gradschools.com
• www.princetonreview.com/grad
• www.petersons.com
• http://graduate-school.phds.org/
Graduate School Timeline

• GRE
  – General: Computer based, anytime
  – Physics: paper-based: **September, October, April**

• Applications due: Jan 1 approx

• Letters of Recommendation (3+, 4 weeks notice)

• Fellowship apps

• Acceptance date: Feb, March approx

• Visit campuses: March, April

• Decision date: 15 April
  • http://www.cgsnet.org/students
Jobs

• Oregon: HP, Intel, InFocus, ESI, Solar World…
• Washington: Boeing, Microsoft, Yahoo, …
• California: Silicon Valley, LA Aerospace, …

• Career Fair: http://oregonstate.edu/career/career-fairs
  – February 18, 2015  CH2M Hill Alumni
  – February 19, 2015  CH2M Hill Alumni
  – April 22, 2015  CH2M Hill Alumni

• Physics career info:  http://www.aps.org/careers/
Status of Physics Bachelor’s One Year After Degree, Classes 1995 through 2012

http://www.aip.org/statistics
Knowledge and Skills Regularly Used by Physics Bachelor’s Employed in the Private Sector, Classes of 2009 & 2010 Combined

<table>
<thead>
<tr>
<th>Skill</th>
<th>Employment in Engineering</th>
<th>Employment in Computer Science or Information Technology</th>
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</thead>
<tbody>
<tr>
<td>Solve Technical Problems</td>
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<tr>
<td>Work on a Team</td>
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<td>Technical Writing</td>
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<td>Knowledge of Phys. or Ast.</td>
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<tr>
<td>Perform Quality Control</td>
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<tr>
<td>Use Specialized Equip.</td>
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<tr>
<td>Design &amp; Development</td>
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<td>Programming</td>
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<td>Manage Projects</td>
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<tr>
<td>Work with Customers</td>
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<tr>
<td>Advanced Math</td>
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<tr>
<td>Simulation or Modeling</td>
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<td>Computer Admin.</td>
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<tr>
<td>Manage People</td>
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<tr>
<td>Manage Budgets</td>
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</table>

Percentages represent the physics bachelor’s who chose "daily", "weekly", or "monthly" on a four-point scale that also included "never or rarely".

http://www.aip.org/statistics
Typical Starting Salaries for Physics Bachelor’s Classes of 2009 & 2010 Combined

Employer
- Private Sector STEM
- Civilian Govt. incl. Natl. Labs
- Private Sector non-STEM
- Active Military
- High School Teachers
- College or University

Typical Salaries (in thousands of dollars)

Figure includes only bachelor’s in full-time, newly accepted positions.

Typical salaries are the middle 50%, i.e. between the 25th and 75th percentiles. STEM refers to positions in natural Science, Technology, Engineering, and Math.

http://www.aip.org/statistics
Initial Employment Sectors of Physics Bachelor’s, Classes of 2009 & 2010 Combined

Private Sector: 53%

- College & University: 13%
- High School: 11%
- Civilian Gov’t, National Lab: 10%
- Active Military: 8%
- Other: 5%

http://www.aip.org/statistics
Field of Employment for Physics Bachelor’s in the Private Sector, Classes of 2009 & 2010 Combined

- Non-STEM: 26%
- Engineering: 32%
- Computer or Information Systems: 21%
- Other STEM: 16%
- Physics or Astronomy: 5%

STEM refers to natural Science, Technology, Engineering, and Mathematics.
http://www.aip.org/statistics
Senior Thesis

- OSU Baccalaureate Core
- Writing Intensive Course (WIC)
- Major specific
- Physics majors: PH 403 (3) thesis
- Take with you in job interviews!
Senior Thesis Requirements

- Physics Research - PH 401 or PH 410 can be used if credit is needed
- Writing Intensive Course (WIC)
  - PH 403 Thesis
  - 1 unit Fall term of Senior year
  - 1 unit Winter term of Senior year
  - 1 unit Spring term of Senior year
- THESIS -- Presentation
OSU WIC Guidelines

• http://wic.oregonstate.edu/wic-thesis-option
• The thesis must be written in the student's major, or in the case of a student with an interdisciplinary major, in a subject area relevant to the major.
• Students in a major who are writing a thesis will meet together regularly in a group, with faculty leadership, to discuss and demonstrate understanding of issues related to writing in the discipline; to discuss and demonstrate familiarity with a variety of types of writing used by those working in the field (for example, writing done for various audiences); and to participate in peer review of ongoing drafts of writing projects in the major.
• The person leading the thesis writing group will be a faculty member in the discipline rather than a graduate teaching assistant.
• Students writing a thesis will gain experience in the steps involved in the process of writing a large document over time. Documents in the process might include: thesis proposal or project description, update memos to the committee or faculty mentor, literature review, drafts of required thesis sections on which the student received feedback, a whole draft with feedback, and a final polished version.
OSU WIC Guidelines (contd)

- Thesis writers will receive instruction in revising their writing and will perform significant revision of their writing.
- Thesis writers will have opportunities (perhaps in the thesis writing group) to use informal, minimally graded or ungraded writing as a mode of learning and understanding content.
- Thesis writers will write at least 2000 words of polished writing that has gone through revision in response to feedback, and a total of 5000 words including drafts. Graphics are not included in the word count. Drafts to prepare for an oral presentation can also be counted in the 5000 words.
- Thesis writers will demonstrate in their thesis the ability to integrate and document information from outside sources.
- Students receiving WIC credit in a thesis option will take a minimum of three hours of thesis/research credit.
- It is recommended that at least one person in a department offering a WIC thesis experience have taken the WIC Seminar in order to be familiar with current research and pedagogies for helping students become better writers.
RESEARCH

Verify data

Create data

Analyze data

Design data creation mechanism
Create data

Verify data

Analyze data

Design data creation mechanism

Record whole process
Is there a scientific method??
Research Options

• OSU Physics Faculty
• OSU Faculty in other departments
  • Engineering
  • Oceanography
  • Chemistry
  • Biophysics/biochemistry
  • Soil science
  • ………

• Internships
• REU
• Research Experience for Undergraduates
  – 8-10 weeks (Early start?? See me)
• NSF
  http://www.nsf.gov/crssprgm/reu/
  http://www.nsf.gov/crssprgm/reu/list_result.cfm?unitid=69
  – Stipend + Expenses (housing, travel)
• OSU URISC $$$
  http://oregonstate.edu/research/incentive/urisc
  http://oregonstate.edu/students/research/
Internships

- http://www.science.oregonstate.edu/node/111
- http://science.energy.gov/wdts/suli/
- http://www.energy.gov/scholarships&internships.htm
PH 403 Activities

• PH403 (Thesis) concerns the writing aspect of the research, and students enroll in 1 unit of PH403 in each of Fall, Winter and Spring of the senior year.
• You will need permission from the Physics office to register.
• These three total credits satisfy the OSU Writing Intensive Course (WIC) requirement of the OSU Baccalaureate Core requirement.
• Students meet weekly as a group to write, critique, and revise their writing.
• They also discuss and write about issues relating to ethics, types of science writing, and logical presentation of ideas.
• In Winter and Spring, activities focus on the thesis itself, including significant time devoted to the writing and revision of the thesis.
• Steady progress and continual peer and advisor review are expected throughout.
• A typical thesis is about fifteen to twenty pages, or about 3,000 to 5,000 words.
• The goal is to have the thesis ready by week 8 of Spring term.
• After this, class time is devoted to preparing 10-minute oral presentations, the standard at physics conferences.
• In the final week of Spring term, there is a mini-conference where students give oral presentations on their projects to the department.
Transcript notation: OSU now offers students who complete a research or creative project with an OSU professor the opportunity to get this notated on their official transcript.

http://oregonstate.edu/students/research/
Senior Thesis Outline

1 Title, abstract, PACS.
2 Introduction: Why is topic important? How does it relate to the real world? How does it add to our knowledge base?
3 Previous work: survey of what has been done before.
4 Methods: description of theory, equipment, computational tools, etc.
5 Results
6 Discussion: What do the results mean? How do they relate to previous work?
7 Conclusion: What have we learned? What should be done next?
8 Bibliography
Recent OSU Physics Theses

- Measuring acoustic response functions with white noise
- Generation of high-energy terahertz radiation through optical rectification using tilted pulse fronts in LiNbO$_3$
- Neutron Capture Cross Sections, Resonance Integrals and Half-lives of Barium Isotopes
- Applied computing techniques for holographic optical tweezers
- Characterization of BaCuSF Thin Films Grown in Excess Copper by Pulsed Laser Deposition
- Optical Measurements of P-Type Thin Film Semiconductors
- Simulated Radial Compression of Carbon Nanotubes
- Interactions of narrow band multi-cycle THz pulse with microcavity quantum well
<table>
<thead>
<tr>
<th>Name</th>
<th>Title of Presentation</th>
<th>Advisor</th>
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<tbody>
<tr>
<td>Daniel Gluck</td>
<td>High-Resolution Spectroscopy and Abundance Analysis of Very Metal Poor Red-Giant Stars</td>
<td>Rhee</td>
</tr>
<tr>
<td>Patrick Gollmann</td>
<td>Fouling Prevention by Electrically Charged Thin Film Composite Forward Osmotic Membranes/a&gt;</td>
<td>Farr/Sun</td>
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<tr>
<td>Bradley Hermens</td>
<td>Adaptive Choronomagry Using a Digital Micromirror Array</td>
<td>Hetherington</td>
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<tr>
<td>Alec Holmes</td>
<td>First principles study of finite temperature phase stability in (Cu,Ag,Au)In2 and Al2Cu alloys</td>
<td>Schneider</td>
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<td>A Comparison of Material Characterization</td>
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<tr>
<td>Aaron Kratzer</td>
<td>Techniques: Spectroscopic Ellipsometry and Reflection Spectroscopy on Zinc Sulfide</td>
<td>Tate/McIntyre</td>
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<tr>
<td>MacKenzie Lenz</td>
<td>Nonlinear Terahertz Spectroscopy of Vanadium Oxide</td>
<td>Lee</td>
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<tr>
<td>Paho Lurie-Gregg</td>
<td>The contact value approximation to the pair distribution function for an inhomogeneous hard sphere fluid</td>
<td>Roundy</td>
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<tr>
<td>Cord Meados</td>
<td>Force Measurements measured from Reflection in an Optical Tweezer</td>
<td>McIntyre</td>
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<tr>
<td>Name</td>
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<td>Jordan Pommerenck</td>
<td>Characterization of super-low frequency electromagnetic fields produced by an undersea transmission cable in a homogeneous fluid</td>
<td>Yokochi</td>
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<tr>
<td>Grant Sherer (Honors College)</td>
<td>Examining Upper-Division Thermodynamics Using the Actor Oriented Transfer Framework</td>
<td>Manogue</td>
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<tr>
<td>Harsukh Singh</td>
<td>The Effect of Inhomogenous Surface Temperature Distribution on Collagen Growth</td>
<td>Sun</td>
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<tr>
<td>Rodney Snyder (Honors College)</td>
<td>Electrical and Thermal Properties of Silicon and Tetrahedrite</td>
<td>Tate</td>
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<tr>
<td>Dustin Swanson</td>
<td>Effects of impurities and contact resistance in graphene field effect transistors</td>
<td>Minot</td>
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<tr>
<td>Mattson Thieme</td>
<td>Low temperature microscopy of organic optoelectronic materials</td>
<td>Ostroverkhova</td>
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<tr>
<td>Kyle Thomas</td>
<td>Fibroblast Morphology During Trypsinization</td>
<td>Sun</td>
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<tr>
<td>Heather Wilson (2014 WIC Culture of Writing Awardee)</td>
<td>Real-time monitoring of chemical reactions with carbon nanotube field-effect transistors</td>
<td>Minot</td>
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<tr>
<td>Rene Zeto</td>
<td>Testing the model for Min D protein oscillations in Escherichia coli</td>
<td>Roundy</td>
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OSU Physics Faculty

- Prof. Tomasz Giebultowicz: Experimental Solid State Physics
- Prof. Matt Graham: Experimental Solid State Physics
- Prof. Henri Jansen: Theoretical Solid State Physics / Education
- Prof. David Lazzati: Theoretical Astrophysics
- Prof. Yun-Shik Lee: Experimental Atomic & Optical Physics
- Prof. Corinne A. Manogue: Physics Education Research / Octonians
- Prof. David H. McIntyre: Experimental Atomic & Optical Physics
- Prof. Ethan Minot: Experimental Solid State Physics
- Prof. Oksana G. Ostroverkhova: Experimental Atomic & Optical Physics
- Prof. Weihong Qiu: Experimental Biophysics
- Dr. Jae Rhee: Astronomy
- Prof. David J. Roundy: Theoretical Solid State Physics / Education
- Prof. Heidi Schellman (January 1): High Energy Physics
- Prof. Guenter Schneider: Theoretical Solid State Physics
- Prof. Bo Sun: Experimental Biophysics
- Prof. Janet Tate: Experimental Solid State Physics
- Prof. Michael Zwolak (on leave): Theoretical Physics
OSU Physics Research

• Learn about OSU Research at talks:
  • Colloquium: Monday 4:00 Weniger 149 or 116
    – Coffee/Tea/Cookies at 3:30 in Weniger 379
    – http://physics.oregonstate.edu/events-colloquia
  • Seminar: Wednesday 4:00 Weniger 304
    – http://physics.oregonstate.edu/events-SSO
Contacts

- Head Advisor: Henri Jansen, Weniger 301
- PH 403 Instructor: Janet Tate, Weniger 485
- Dept. Chair: Henri Jansen, Weniger 301
- Dept. Chair: Heidi Schellman, Weniger 301
Timeline, Action Items

• JR year Fall term: Gather info
  • JR year Winter term: Seek project
    – Apply for summer REU
    – Contact OSU profs
    – other …
  • JR year Spring term: Decide & Start
• JR-SR Summer: DO RESEARCH
• SR year Fall term: PH 403, research
• SR year Winter term: PH 403, research
• SR year Spring term: PH 403, finish