Introduction & Résumé

Physics is beautiful, and the purpose of this course is to partly reveal the beauty that physicists have discovered over the past century. These discoveries are deep and revolutionary, but while “revolutions in physics” may usually be associated with Albert Einstein or perhaps Erwin Schrödinger (and his cat), the key player in this story is the little known Emmy Noether. Her discovery: fundamental physics is dictated by symmetry.

We will begin our discussion with what it means for something to be symmetric, whether a geometrical figure, an artistic design, or a musical score. After forming a concrete intuition about symmetry we will discuss what it means for mathematical equations and for space and time to be symmetric. Then we can discuss Noether’s penetrating insight that bridged symmetry and physics. Finally, inspired by Noether we will dig deeper and find how symmetry shapes our most fundamental and unifying theories of the universe.

Objectives

By the end of the course you will

- Understand symmetry.
- Understand the role symmetry (and its breaking) plays in fundamental physics.
- Be able to use qualitative and quantitative reasoning to explore some basic (but not trivial) physics.
- Catch a glimpse of the simplicity and unity of nature.

Prerequisites

All that is required is the willingness to engage in mathematical reasoning (this satisfies Q, after all). You will be doing some quantitative assignments that may require some high school level geometry, algebra, and trigonometry. We will review the requisite math as needed.

Who Should Take This Course?

You should take this course if you’re interested in exploring the simplicity and unity of nature. Or if you want to satisfy NA and Q.

Books & Readings

The principle book for this course is:

- *Symmetry and the Beautiful Universe*, L. M. Lederman and C. T. Hill (the course’s namesake!).

According to one surfer-physicist, this highly symmetrical object (called E8) may unify all of physics.
This book is about what this course is about – symmetry in physics. The discussion is largely qualitative and not overly technical. We will fill in some technical details in class. I will provide some additional reading assignments in the form of journal articles or book excerpts throughout the term.

Specific reading assignments and due dates will be posted to Moodle throughout the term.

**Lecture & Participation**

Our class time will be used to discuss the readings and explore their content in greater depth, discussing both their qualitative and more technical quantitative aspects. Your continued attendance in class and participation in discussions will be crucial for maximizing your experience in this course.

**Assignments**

Homework assignments will have two aspects: 1) reading responses and 2) problems. The reading responses will be short essay/journal format responses to the assigned readings. They are aimed at capturing your overall impression of the material as well as gauging your qualitative/conceptual understanding of the material. The problems will involve varying levels of mathematical and physical analysis of situations inspired by the readings and lectures.

**Exams**

There will be two take-home exams: a midterm and a final. Exams will be approximately 75% qualitative and 25% quantitative.

**Final Paper**

Your Final Paper will be a sort of capstone to this course. The purpose of the project is to explore symmetry as it relates to something you find interesting. You can choose to explore a topic from the course in greater depth or something not covered at all, about physics or not.

**Grades**

Your class grade will be determined by:

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<thead>
<tr>
<th>Component</th>
<th>Percentage</th>
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<tbody>
<tr>
<td>Participation</td>
<td>10%</td>
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<tr>
<td>Assignments</td>
<td>50%</td>
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<tr>
<td>Midterm Exam</td>
<td>15%</td>
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<tr>
<td>Final Exam</td>
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<tr>
<td>Final Paper</td>
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<td>Total</td>
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**Accommodations**

If you require accommodations, please see Rick Webb (@webb@haverford.edu, 610 896-1290) in the Office of Disabilities Services as soon as possible. Then come see me so we can make whatever arrangements are necessary.