

New Introductory Physics Major Course Sequence

- Motivation, Design and Implementation
- Preliminary Results

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The Gustavus Physics Major Curriculum

- Two “passes” through the subtopics of physics (1st -2nd and 3rd-4th year)
- Each subtopic only offered once in each pass
- Most courses meet five 50-minute periods per week
- Courses rotate regularly among all five tenured faculty members



Gustavus Physics Major Introductory Courses (1985-2010)

First Year Fall:

Classical Physics I – Classical Mechanics w/ lab

- Co-requisite math course = Calculus I (Differential calculus)

First Year Spring:

Classical Physics II – Various Topics w/ lab

- Fluids
- Vibrations, waves and sound
- Optics
- Thermodynamics
- Co-requisite math course = Calculus II (Integral calculus)



Gustavus Physics Major Introductory Courses (1985-2010)

Second Year Fall:

Classical Physics III – Electricity and Magnetism w/lab

- Electrostatics and Magnetostatics
- Electrodynamics
- Basic DC and AC Circuits
- Co-requisite math course = Calculus III (multivariable calculus)

Second Year Spring:

Modern Physics (no lab)

- Relativity and Quantum Physics
- Applications (atomic, molecular, nuclear, etc.)

Electronics (Spring Semester) w/lab

- Analog and Digital Topics

Mathematical Methods of Physics (0.5 course)

- Linear Algebra and Differential Equations

Motivations for Change

Primary

- Retention of student majors

Secondary

- IUPP philosophy
 - Rejection of purely historical order to physics topics
 - 20th-century physics is no longer “modern”
- Realization that semesters/units with a story/theme lead to more effective learning

Student Retention in the Major

10-year Averages 2001-2010

Finish 1st Semester – 36 students

Graduating Majors – 14 students

Student reasons reported for leaving:

- Major is difficult
- Like something else better

Faculty suspected reasons for students leaving:

- Students perceive their mathematical prowess is not as good as their peers
 - First semester math co-enrollments vary from Calculus 1 to Linear Algebra
- Students who had good high-school physics are bored by repeating mechanics right away in first semester
- Second semester is “scattered” with no coherent theme
- The “cool physics” waits until the 4th semester

The Solution?

Change the First Semester Course to Astrophysics!



Revised Gustavus Physics Major Introductory Courses (2011-)

First Year Fall:

The Cosmic Universe w/ lab

- 1D classical mechanics (kinematics and dynamics) and relativity
- Kepler's laws and orbital motion, gravitation
- Optics
- Basic thermodynamics ($PV=nRT$) and kinetic theory
- Basic atomic, molecular and nuclear physics
- Co-requisite math course = Calculus I (differential calculus)

First Year Spring:

The Mechanical Universe w/ lab

- **3D** classical mechanics with full use of vectors
- Fluids
- Vibrations, waves and sound
- Thermodynamics (work, heat engines)
- Co-requisite math course = Calculus II (integral calculus)



Revised Gustavus Physics Major Introductory Courses (2011-)

Second Year Fall:

The Electromagnetic Universe w/lab

- Electrostatics, Magnetostatics and Electrodynamics
- Basic DC and AC Circuits

Mathematical Methods of Physics (1.0 course)

- Multivariable calculus
- Linear Algebra
- Differential Equations

Second Year Spring:

The Quantum Universe (no lab)

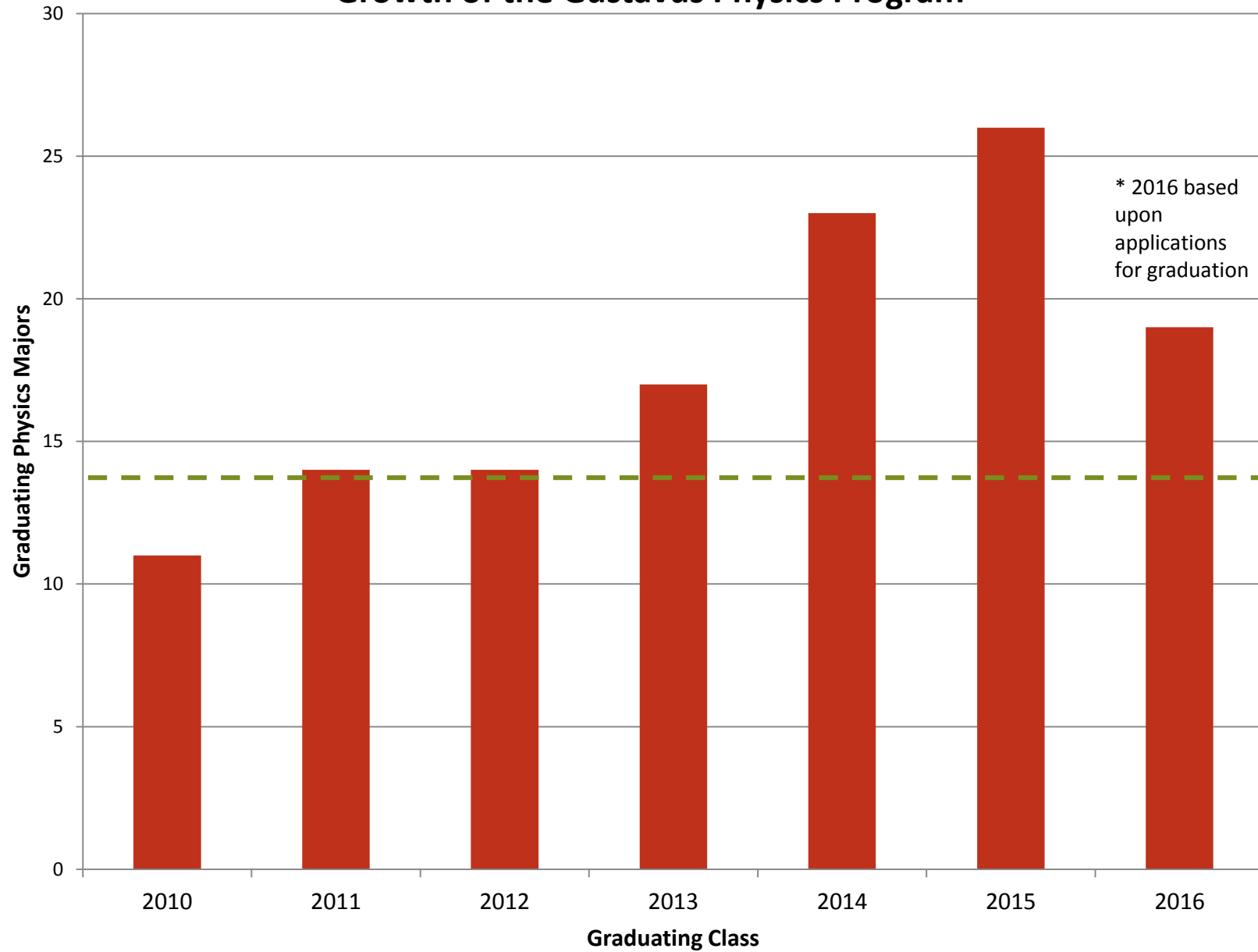
- Relativity and Quantum Physics
- Applications (atomic, molecular, nuclear, etc.)

Electronics w/lab

- Analog and Digital Topics



Growth of the Gustavus Physics Program



Outcomes- Based on Four Years of Data

The Good:

- Better Retention to 2nd Semester (and Beyond)
 - From 72% (2001-2010) to 78% (2011-2014)
 - 1st Semester to Graduation from 40% to 54%
- Students Have or Develop an Interest in Astrophysics
- More Interesting Topics in First Course
- More Coverage of Astrophysics/Cosmology
- Some Material Gets Covered Multiple Times

The Bad:

- Jumping Around in Textbooks – Reading Difficulties
- Math Maturity Level Lower in 2nd Course
- Shorter Time Covering Some Material

Conclusions:

- Possible to Interest Introductory Students in Astrophysics
- Astronomy Theme Holds Disparate Material Together
- Easy Switchover
- Seems to Work Well, But Need More Data

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