Proposal to the Academic Affairs Committee:
Astrophysics Concentration within the Physics Major
and
Astronomy Minor

v4.1 – January 7, 2016

Background and Motivation

Colby students have shown a strong interest in astrophysics, and we believe the concentration is long overdue. For instance, there are six recent (within the past decade) Colby graduates who are either currently pursuing or have recently completed PhDs in astrophysics, the highest number for any physics subfield among our majors. Likewise, enrollment in Astronomy courses at Colby has been high, even among non-science majors. AS342 had an enrollment of 19 students last spring, the highest of any 300-level physics or astronomy course. AS151 and AS172 are consistently overenrolled by factors of 2-3 (before pruning). Finally, we have recently secured funding for and have begun a project to upgrade the current observatory to house a research-grade 28-inch telescope, which will be the largest in New England. For all these reasons, we believe the time is right to offer both a concentration in astrophysics and an astronomy minor.

The primary goal we have for astrophysics is to better prepare students in our department for advanced research and graduate school. We have therefore designed the astrophysics concentration to point students to specific electives within the physics major, as well as include additional electives outside the department that will be useful to them should they want to pursue a career focused in astrophysics. Topics such as statistics and computer programming are becoming increasingly important in this field as the datasets astronomers work with become larger. Astrophysics truly has entered the domain of big data. Thus, we believe that our students would be best served by allowing them the option to take electives such as CS 231: Data Structures and Algorithms, CS 251: Data Analysis and Visualization, SC 212: Introduction to Statistical Methods, SC 321: Applied Regression Modeling, and MA 381: Mathematical Statistics I: Probability, in addition to the electives currently allowed for the physics major.

For the minor, our goal is to be more inclusive. We want to enable those who have an interest in the field but less of a desire to pursue the rigorous mathematical and computational work necessary for advanced studies to be able to learn the key concepts. For instance, someone interested in space science journalism may want to pursue a joint English major and astronomy minor. Or someone interested in classical civilizations may want to expand upon their understanding of the astronomical knowledge developed by those civilizations. Therefore, the minor is much more focused on astronomy with only the simplest physics and math needed to gain a basic understanding of the concepts. We believe that such a minor will have broad appeal among both science majors and non-science majors alike.

Below, please find our proposed requirements for:

1) Astrophysics Concentration within the Physics Major
2) Astronomy Minor
Requirements for the Physics Major with a Concentration in Astrophysics

Students should work closely with their advisors in selecting courses to fulfill the requirements for the concentration. Not all upper-level courses are offered every year. AS231 and one 300-level physics or astronomy course must be taken at Colby. All senior physics majors are required to participate in department colloquia by enrolling in Physics 401 and 402. For students electing the astrophysics concentration, Physics 415 should focus on a topic in astrophysics or a closely related field.

**Required Courses:** (unless exempted by advanced placement)

*Physics*
- 141 Foundations of Mechanics (or 143 Honors Physics)
- 145 Foundations of Electromagnetism and Optics
- 241 Modern Physics I
- 242 Modern Physics II
- 401-402 Senior Physics and Astronomy Colloquium
- 415 Physics and Astronomy Research (Physics 483-484 for students completing the honors major)

*Astronomy*
- 231 Introduction to Astrophysics
- 342 Galaxies and Cosmology

*Computer Science*
- 151 Computational Thinking

*Mathematics* – Choose three (unless exempted by advanced placement)
- 121 Single-Variable Calculus (or 161 Honors Calculus I)
- 122 Series and Multi-Variable Calculus (or 162 Honors Calculus II)
- 253 Linear Algebra
- 262 Vector Calculus
- 311 Ordinary Differential Equations

**Elective Courses:** Choose at least two. At least one must be a 300-level or higher physics or astronomy course.

*Astronomy*
- 335 General Relativity and Cosmology

*Computer Science*
- 231 Data Structures and Algorithms
- 251 Data Analysis and Visualization
Mathematics and Statistics

- SC 212 Introduction to Statistical Methods
- SC 321 Applied Regression Modeling
- MA 381 Mathematical Statistics I: Probability

Physics

- 311 Classical Mechanics
- 321 Electricity and Magnetism
- 332 Thermodynamics and Statistical Mechanics
- 338 Nuclear and Particle Physics
- 431 Quantum Mechanics

Requirements for the Honors Major with a Concentration in Astrophysics

In addition to fulfilling the requirements for the basic concentration in astrophysics, students must take three additional electives, two of which must be 300-level or higher physics or astronomy courses. In their senior year they must also take Physics 483 and 484 Independent Honors Project in the place of Physics 415. A written honors thesis is required. It is expected that students electing the astrophysics concentration will focus their honors thesis on a topic in astrophysics.
Requirements for the Minor in Astronomy

Students must take one of either AS151 or AS172, and the following required courses:

Astronomy
• 231 Introduction to Astrophysics
• 342 Galaxies and Cosmology

Physics
• 141 Foundations of Mechanics (or 143 Honors Physics)
• 145 Foundations of Electromagnetism and Optics

Mathematics
• 121 Single-Variable Calculus (or 161 Honors Calculus I, or 101 and 102 Calculus with Pre-calculus I and II)

Note: Students cannot fulfill the astronomy minor if electing to major in physics. Physics majors interested in astronomy should consider the astrophysics concentration.