February 11, 2015

MEMORANDUM

TO: Jayanth Banavar  
Dean, College of Computer, Mathematical, & Natural Sciences

FROM: Elizabeth Beise  
Associate Provost for Academic Planning and Programs

SUBJECT: Proposal to Modify the Bachelor of Science in Astronomy (PCC log no. 14022)

The proposal to modify the Bachelor of Science in Astronomy has been administratively approved. A copy of the approved proposal is attached.

This change is effective Spring 2015. Please ensure that this change is fully described in the Undergraduate Catalog and in all relevant descriptive materials, including the undergraduate program's four-year plan (contact Lisa Kiely at likely@umd.edu for more information), and that all advisors are informed.

MDC/ Enclosure

cc: Gregory Miller, Chair, Senate PCC Committee  
Barbara Gill, Office of Student Financial Aid  
Reka Montfort, University Senate  
Erin Taylor, Division of Information Technology  
Pam Phillips, Institutional Research, Planning & Assessment  
Anne Turkos, University Archives  
Linda Yokoi, Office of the Registrar  
Cynthia Stevens, Office of Undergraduate Studies  
Robert Infantino, College of Computer, Mathematical, & Natural Sciences  
Stuart Vogel, Department of Astronomy
THE UNIVERSITY OF MARYLAND, COLLEGE PARK
PROGRAM/CURRICULUM/UNIT PROPOSAL

Please email the rest of the proposal as an MSWord attachment to pcc-submissions@umd.edu.

Please submit the signed form to the Office of the Associate Provost for Academic Planning and Programs, 1119 Main Administration Building, Campus.

College/School:
Please also add College/School Unit Code-First 8 digits: 01203000
Unit Codes can be found at: https://hypprod.umd.edu/Html_Reports/units.htm
Department/Program: 1300301
Please also add Department/Program Unit Code-Last 7 digits:

Type of Action (choose one):
X Curriculum change (including informal specializations)
□ Curriculum change for an LEP Program
□ Renaming of program or formal Area of Concentration
□ Addition/deletion of formal Area of Concentration
□ Suspend/delete program

Italics indicate that the proposed program action must be presented to the full University Senate for consideration.

Summary of Proposed Action:
The Department of Physics has changed the requirements for its undergraduate program. The Department of Astronomy agrees these changes will result in a more effective development of mid-level physics concepts and implementation of mathematics with computational skills into the curriculum. Since the astronomy curriculum requires the completion of several physics courses, the Department of Astronomy proposes to revise our undergraduate curriculum to reflect the changes in the physics curriculum. The proposed changes will better prepare our majors for graduate school and the workforce.

Departmental/Unit Contact Person for Proposal: Grace Deming

APPROVAL SIGNATURES - Please print name, sign, and date. Use additional lines for multi-unit programs.

1. Department Committee Chair: Eric McKee, 12/28/14
2. Department Chair: Stuart Vogel, 10/29/14
3. College/School PCC Chair: Robert Finn, 11/11/14
4. Dean: 
5. Dean of the Graduate School (if required): 
6. Chair, Senate PCC: Gregory Buetler, 12/8/14
7. University Senate Chair (if required): 
8. Senior Vice President and Provost: 

1/25/14
Changes to the Astronomy B.S. Requirements (10/28/14)

Please find attached a proposal to the PCC committee to change the requirements to obtain a B.S. in Astronomy. This proposal is in response to changes in the Physics course offerings and in the requirements to obtain a B.S. in “Physics – Professional Area of Concentration”, which were submitted to PCC for approval in Spring 2014. The current proposal was prepared by Ms. Grace Deming, Undergraduate Advisor for Astronomy, with assistance from Dr. Eric McKenzie, Undergraduate Director for Astronomy.
Information Required in Curriculum Change Proposals

1. Current (old) requirements. As shown in the catalog, plus additional materials, if any, prepared by the Department or College and distributed to current students.

The following are the current (old) requirements for the B. S. in Astronomy:

**Required Basic Astronomy Courses (13 credits):**
- ASTR 120  Astrophysics I: The Solar System (3 credits)
- ASTR 121  Astrophysics II: Stars and Beyond (4 credits)
- ASTR 310  Observational Astronomy (3 credits)
- ASTR 320  Theoretical Astrophysics (3 credits)

**Advanced Astronomy Courses (6 credits):**
Any two 400 level Astronomy courses are required:
- ASTR 410  Radio Astronomy Techniques (3 credits)
- ASTR 415  Computational Astrophysics (3 credits)
- ASTR 421  Galaxies (3 credits)
- ASTR 422  Cosmology (3 credits)
- ASTR 430  The Solar System (3 credits)
- ASTR 450  Orbital Dynamics (3 credits)
- ASTR 480  High Energy Astrophysics (3 credits)
- ASTR 498N  Stellar Evolution (3 credits)

**Optional Astronomy Seminars**
- ASTR 288C  Astronomy Research Techniques (2 credits)
- ASTR 288M  Current Events in Astronomy Research (1 credit)

**Required Introductory Physics Courses (14 credits):**
- PHYS 171  Mechanics and Relativity (3 credits)
- PHYS 174  Laboratory Introduction (1 credit)
- PHYS 272  Fields (3 credits)
- PHYS 273  Waves (3 credits)
- PHYS 275  Laboratory--mechanics, heat and fields (2 credits)
- PHYS 276  Laboratory--electricity and magnetism (2 credits)

*Also accepted with consent of advisor: PHYS 161, 260, 261, 270, 271 (11 credits)*

**Advanced Physics Courses (11 credits):**
- PHYS 374  Theoretical Methods (4 credits)
- PHYS 401  Quantum Mechanics I (4 credits)
- PHYS 404  Statistical Thermodynamics (3 credits)

**Mathematics Courses (18 or 19 credits):**
- MATH 140  Calculus I (4 credits)
- MATH 141  Calculus II (4 credits)
- MATH 241  Calculus III (4 credits)
- MATH 246  Differential Equations (3 credits)
- MATH 461 or 240  Linear Algebra (3 or 4 credits)
Total Credits Required for the Astronomy Major = 62 or 63 credits
Grades in all of the above required courses must be C- or better.

2. Proposed (new) requirements

The following are the proposed new requirements for the B. S. in Astronomy:

Required Basic Astronomy Courses (13 credits):
- ASTR 120 Astrophysics I: The Solar System (3 credits)
- ASTR 121 Astrophysics II: Stars and Beyond (4 credits)
- ASTR 310 Observational Astronomy (3 credits)
- ASTR 320 Theoretical Astrophysics (3 credits)

Advanced Astronomy Courses (6 credits):
Any two 400 level Astronomy courses are required:
- ASTR 410 Radio Astronomy Techniques (3 credits)
- ASTR 415 Computational Astrophysics (3 credits)
- ASTR 421 Galaxies (3 credits)
- ASTR 422 Cosmology (3 credits)
- ASTR 430 The Solar System (3 credits)
- ASTR 450 Orbital Dynamics (3 credits)
- ASTR 480 High Energy Astrophysics (3 credits)
- ASTR 498N Stellar Evolution (3 credits)

Optional Astronomy Seminars
- ASTR 288C Astronomy Research Techniques (2 credits)
- ASTR 288M Current Events in Astronomy Research (1 credit)

Required Introductory Physics Courses (17 credits):
- PHYS 165 Introduction to Programming for the Physical Science (For students with experience with computer programming this course can be replaced by PHYS 474 Computational Physics or ASTR 415 Computational Astrophysics (3 credits)
  If students complete ASTR 415 for this requirement, it cannot be counted as an advanced astronomy course (400-level course) requirement.
- PHYS 171 Mechanics and Thermal Physics (3 credits)
- PHYS 174 Physics Laboratory Introduction (1 credit)
- PHYS 272 Fields (3 credits)
- PHYS 273 Waves (3 credits)
- PHYS 275 Experimental Physics I: Mechanics, Heat and Fields (2 credits)
- PHYS 276 Experimental Physics II: Electricity and Magnetism (2 credits)
  Also accepted with consent of advisor: PHYS 161, 165, 260, 261, 270, 271 (14 credits)

Supporting Mathematics/Mathematical Methods Courses (15 credits):
- MATH 140 Calculus I (4 credits)
- MATH 141 Calculus II (4 credits)
- MATH 241 Calculus III (4 credits)
- PHYS 274 Mathematical Methods for Physics I (3 credits)
  Completion of both MATH 246 and either 240 or 461 will be accepted in place of PHYS 274.
Advanced Physics Courses (13 credits):
  PHYS 371  Modern Physics (3 credits)
  PHYS 373  Mathematical Methods for Physics II (3 credits)
  PHYS 401  Quantum Mechanics I (4 credits)
  PHYS 404  Statistical Thermodynamics (3 credits)

Total Credits Required for the Astronomy Major = 64 credits

Grades in all of the above required courses must be C- or better.

3. Identification of and rationale for the changes

   a) A programming course requirement, PHYS 165, PHYS 474 or ASTR 415, has been
      added. As programming skills has become increasingly important to all STEM fields, addition of
      a programming course requirement will better prepare our graduates for technical careers or
      graduate study. The acceptance of PHYS 165 or an upper level computational course, PHYS 474
      or ASTR 415, will accommodate students who need an introductory course and also those
      students who already have developed programming skills will learn new applications.

   b) PHYS 171 has already been changed from Mechanics and Relativity to Mechanics and
      Thermal Physics. Thus, relativity will be presented in PHYS 371.

   c) Changes in the mathematics sequence include the elimination of MATH 240 and 246;
      and the change in the advanced physics sequence includes the elimination of PHYS 374. Physics
      has discontinued PHYS 374 which is currently required for the B. S. in Astronomy. The
      Department of Physics has developed three new physics courses to replace MATH 240, 246 and
      PHYS 374. PHYS 274 and 373, Mathematical Methods for Physics I and II, will better prepare
      our students for success in the 400-level advanced physics courses required for the B. S. in
      Astronomy. In addition, PHYS 371, Modern Physics, will introduce relativity (with 4-vectors),
      elementary particles, nuclear physics, and cosmological physics. PHYS 371 will present exciting
      contemporary topics from later 20th and early 21st centuries. About 50% of our astronomy majors
      double major in physics and will take several additional 400-level advanced physics courses.
      Completion of PHYS 371 will better prepare our students for the topics presented in these
      advanced physics courses.

4. A sample program under the proposed requirements.

Show how a typical student would progress through the proposed program year by year.
Attention should be paid to course prerequisites to ensure that students can actually follow
the prescribed program. A table illustrating the semester by semester breakdown of credits
is useful.
### FIRST YEAR

<table>
<thead>
<tr>
<th>Course</th>
<th>Credits</th>
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<tbody>
<tr>
<td>ASTR 120 (DSNS)</td>
<td>3</td>
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<tr>
<td>ENGL 101 (FSAW)</td>
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<td>MATH 140 (FSMA/AR)</td>
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</tr>
<tr>
<td>GenEd (SCIS/DSHU)</td>
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</tr>
<tr>
<td>GenEd (DSHS)</td>
<td>3</td>
</tr>
<tr>
<td>ASTR 121 (DSNL)</td>
<td>4</td>
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<td>MATH 141</td>
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<td>PHYS 174</td>
<td>1</td>
</tr>
<tr>
<td>GenEd (SCIS/DSHS)</td>
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**Total** = 16

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### SECOND YEAR

<table>
<thead>
<tr>
<th>Course</th>
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<tr>
<td>MATH 241</td>
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<td>PHYS 272</td>
<td>3</td>
</tr>
<tr>
<td>PHYS 275</td>
<td>2</td>
</tr>
<tr>
<td>ASTR 288C (optional)</td>
<td>2</td>
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<tr>
<td>GenEd (DVUP)</td>
<td>3</td>
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<td>PHYS 273</td>
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</tr>
<tr>
<td>Elective</td>
<td>3</td>
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<tr>
<td>ASTR 288M (optional)</td>
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**Total** = 15-17

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### THIRD YEAR

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<tbody>
<tr>
<td>PHYS 165</td>
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</tr>
<tr>
<td>PHYS 371</td>
<td>3</td>
</tr>
<tr>
<td>PHYS 373</td>
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</tr>
<tr>
<td>ASTR 320</td>
<td>3</td>
</tr>
<tr>
<td>PHYS 401</td>
<td>4</td>
</tr>
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<td>ENGL 393 or 390 (FSPW)</td>
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<tr>
<td>Elective</td>
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**Total** = 15

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### FOURTH YEAR

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<td>ASTR 4**</td>
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<tr>
<td>PHYS 404</td>
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</tr>
<tr>
<td>GenEd (DSSP non-major)</td>
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</tr>
<tr>
<td>Elective</td>
<td>3</td>
</tr>
<tr>
<td>Elective</td>
<td>3</td>
</tr>
<tr>
<td>Elective</td>
<td>3</td>
</tr>
</tbody>
</table>

**Total** = 15

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ASTR4** — any advanced astronomy course (2 are required)

A minimum of 120 credits is required for graduation. A grade of C- or better must be earned in all courses that are required for the major.

Electives and GenEd courses may be combined to complete requirements for a minor. A double major with physics is possible by completing 6 additional physics courses.

5a. A list, table or chart showing the prerequisite structure of all required or optional courses appearing in the new requirements.
<table>
<thead>
<tr>
<th>Course</th>
<th>Description</th>
<th>Req.</th>
<th>Prerequisites or Dept. Permission</th>
<th>Pre/Co-req.</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASTR 120</td>
<td>Astrophysics 1</td>
<td>Y</td>
<td>Math 115 or higher</td>
<td>none</td>
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<td>ASTR 121</td>
<td>Astrophysics 2</td>
<td>Y</td>
<td>ASTR120</td>
<td>none</td>
</tr>
<tr>
<td>ASTR 288C</td>
<td>Astronomy Research Techniques</td>
<td>N</td>
<td>Permission of dept.</td>
<td>none</td>
</tr>
<tr>
<td>ASTR288M</td>
<td>Current Events in Astronomy Research</td>
<td>N</td>
<td>Permission of dept.</td>
<td>none</td>
</tr>
<tr>
<td>ASTR 310</td>
<td>Observational Astr.</td>
<td>Y</td>
<td>ASTR 121, PHYS 171</td>
<td>none</td>
</tr>
<tr>
<td>ASTR 320</td>
<td>Theoretical Astrophysics</td>
<td>Y</td>
<td>ASTR 121, PHYS 273</td>
<td>none</td>
</tr>
<tr>
<td>ASTR 410, 415, 421, 430, 498N</td>
<td>400 level courses</td>
<td>Y, any two 400 level</td>
<td>ASTR 121, PHYS 273</td>
<td>none</td>
</tr>
<tr>
<td>ASTR 422, 450, 480</td>
<td>400 level courses</td>
<td>Y, any two 400 level</td>
<td>ASTR 121, PHYS 273</td>
<td>ASTR 320</td>
</tr>
<tr>
<td>MATH 140</td>
<td>Calculus 1</td>
<td>Y</td>
<td>MATH 115 or math placement</td>
<td>none</td>
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<tr>
<td>MATH 141</td>
<td>Calculus 2</td>
<td>Y</td>
<td>MATH 140</td>
<td>none</td>
</tr>
<tr>
<td>MATH 241</td>
<td>Calculus 3</td>
<td>Y</td>
<td>MATH 141</td>
<td>none</td>
</tr>
<tr>
<td>PHYS 165</td>
<td>Programming for P.S.</td>
<td>Y</td>
<td>PHYS 171, 161 or 141</td>
<td>none</td>
</tr>
<tr>
<td>PHYS 171</td>
<td>Mechanics</td>
<td>Y</td>
<td>MATH 140 and HS physics</td>
<td>MATH 141</td>
</tr>
<tr>
<td>PHYS 174</td>
<td>Intro. Lab</td>
<td>Y</td>
<td>none</td>
<td>MATH 140</td>
</tr>
<tr>
<td>PHYS 272</td>
<td>E &amp; M</td>
<td>Y</td>
<td>PHYS 171, MATH141</td>
<td>MATH 241</td>
</tr>
<tr>
<td>PHYS 273</td>
<td>Waves</td>
<td>Y</td>
<td>PHYS 272, MATH 241</td>
<td>PHYS 274</td>
</tr>
<tr>
<td>PHYS 274</td>
<td>Math. Methods 1</td>
<td>Y</td>
<td>PHYS 272, MATH 241</td>
<td>PHYS 273</td>
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<tr>
<td>PHYS 275</td>
<td>Mechanics Lab</td>
<td>Y</td>
<td>PHYS 174, PHYS 171 or 161</td>
<td>PHYS 272</td>
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<td>PHYS 276</td>
<td>E &amp; M Lab</td>
<td>Y</td>
<td>PHYS 272, 275</td>
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</tr>
<tr>
<td>PHYS 371</td>
<td>Modern Physics</td>
<td>Y</td>
<td>PHYS 273</td>
<td>none</td>
</tr>
<tr>
<td>PHYS 373</td>
<td>Math. Methods 2</td>
<td>Y</td>
<td>PHYS 273, 274</td>
<td>none</td>
</tr>
<tr>
<td>PHYS 401</td>
<td>Quantum 1</td>
<td>Y</td>
<td>PHYS 371</td>
<td>PHYS373</td>
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<tr>
<td>PHYS 404</td>
<td>Thermodynamics</td>
<td>Y</td>
<td>PHYS 273</td>
<td>None</td>
</tr>
</tbody>
</table>

5b. It may also be helpful to provide a table illustrating a sample schedule of course offering, semester by semester, to demonstrate that, with the available and anticipated faculty, enough courses will initially be offered to allow students to progress through their programs. The schedule should allow time for the necessary development of new courses.

PHYS 274 and 373 will be offered for the first time during Spring 2015. PHYS 371 will be offered for the first time during Fall 2015. Currently PHYS 165 is offered every fall semester. All of the remaining physics courses required for the astronomy major are offered every semester. ASTR 120 and 310 are offered every fall. ASTR 121 and 320 are offered every spring. Three to four advanced astronomy courses (400-level) are offered every year.

6. A list of any new courses: prefix, title, credits. New courses that have not yet been approved need not have specific numbers, but should be identified according to the desired
levels, such as 3**. "Selected" or "Special" topics courses should be avoided. If courses to be offered regularly in the new program are presently offered as "Selected" or "Special" topics, you should propose to make them permanent. Indicate new courses with an X. Indicate current courses that will be substantially modified as part of the program change with an M. Include a copy of the VPAC information describing these new or modified courses. It is your responsibility to insure that the new or modified course proposals are submitted to VPAC approval in a timely fashion.

PHYS 274, 371 and 373 have already been submitted by the Department of Physics and approved by VPAC.

7. A list of the courses being deleted from the program requirements.
   - MATH 246 Differential Equations
   - MATH 240 or 461 Linear Algebra
   - PHYS 374 Intermediate Theoretical Methods

8. Letters from any department(s) whose courses will be required or otherwise impacted. If the change in curriculum introduces a requirement (or recommendation) that majors take a course offered by another department, it is important to establish that such a requirement will not unduly burden faculty and resources elsewhere on campus. Attach a memorandum or letter from the Chair of the affected department indicating that it can handle the additional enrollment that the curriculum change will generate.

   We currently have 30 astronomy majors who are not physics majors. We anticipate that 10-15 of our astronomy majors will add physics as a second major during their 4th or 5th semester at the university. The change in proposed astronomy requirements will mean that the Department of Physics can expect 4-5 astronomy students who are not physics majors per semester in PHYS274, 371, and 373; and each fall they can expect 5-7 astronomy students who are not physics majors in PHYS165. We have attached a letter from the Chair of the Dept. of Physics indicating that they can accommodate these students.

9. It should be specifically acknowledged that students enrolled in the program prior to the effective date of any curriculum change may complete their program under the old requirements if they wish. The courses required must remain available, or suitable substitutions specifically designated. Further, if the proposed curriculum change affects articulation or transfer programs, the proposal should explain how currently-enrolled community college students will be able to complete their projected programs. Any necessary modifications to articulation agreements should be attached.

   PHYS 373 will be accepted for PHYS 374 if student has also completed MATH 246 and 240/461. PHYS 165 and 371 will be optional for students who are under the old requirements. Any transfer students who have completed MATH 246 and 240/461 will need to complete PHYS373, but not PHYS274.
October 28, 2014

Dear Colleagues,

The Department of Physics will accommodate Astronomy students needing to take the Physics courses outlined in the Astronomy PCC proposal.

If you have questions, please do not hesitate to contact me.

Sincerely,

A Baden

Dr. Andrew R. Baden
Professor and Chair
Department of Physics
drew@umd.edu