Potential Career Tracks Associated With the APS Undergraduate Major

This document is an outline of the various career paths that recent APS graduates have taken. We encourage all majors to read these descriptions EARLY in their careers so that you can understand your options and the actions you need to take to prepare yourselves for them. We strongly encourage you to discuss these career options with your APS faculty mentors at each semester's meeting and to regularly review your progress along the lines described below. The career options we described below are not meant to be all-inclusive:

1.) Professional Research and College-level Teaching

For professional research jobs and college teaching in astrophysics, astronomy and planetary sciences, a PhD is almost certainly required. Some junior college teachers only have Masters' degrees, but in our field, even this is rare. To pursue this career track, the preparation that you will need here at CU is:

- Astrophysics/Physics track or
- Physics Plan 1 or
- Double major in Physics and Astrophysics/Physics.

If the former, it is recommended that you take a couple of extra upper division Physics courses to enhance your general physics understanding and prepare you for the Physics Graduate Record Exams (GREs). The additional recommended courses are:

- PHYS 4230 Thermodynamics & Statistical Mechanics (3) and/or
- PHYS 4410 Quantum Mechanics & Atomic Physics 2 (3)

We strongly recommend that you obtain some research experience while you are still an undergraduate. There are a variety of ways to accomplish this, including laboratory assistant jobs with LASP, CASA or JILA, research with individual APS faculty or researchers, and doing an undergraduate Honors Thesis. You should consider competing for and attending a summer UROP (Undergraduate Research Opportunities Program) between your junior and senior years (watch for announcements on the bulletin board outside the APS Department office).

A successful research or CASA/LASP/JILA job opportunity will require some computer programming skills. If you do not already have programming skills, we recommend that you take either our Maymester (or occasional Fall semester) Introduction to the IDL programming

language (ASTR 2600) and/or ASTR 3800 Scientific Data Analysis & Computing (3) [requires Calculus III], which is offered each Spring semester.

Doing an Honors thesis requires a minimum GPA of 3.3 and declaring your intention to conduct Honors thesis research by the Spring semester of your junior year. You then have the summer between your junior and senior years, the Fall term of your senior year and the first two months of your last semester here to complete the Honors Thesis. Graduating with Honors in the Fall requires a modification of the above schedule. Those doing an honors thesis should contact the APS Department Honors representative for full details.

We recommend that you plan on taking the Physics GREs twice to help you obtain a decent score. To ensure entry into a quality graduate program (top 15) requires a minimum score of ~50% on the advanced Physics exam and > 90% on the three GRE general exams.

Out of the ~10 Astrophysics/Physics track students that graduate each year from this program, 2--3 go on to graduate school. This means that to obtain entry to a good graduate program requires more As than Bs in your Physics, APS and Math courses. Graduate school is typically 4-6 years in length and that is where the real competition for research and teaching job begins. Recent graduates of our program obtained admission to graduate programs at UC Berkeley, U of Maryland, U of Washington, Washington U. in St. Louis, U of New Mexico, UC Santa Cruz, U of Wyoming and Caltech to name a few.

Students of Planetary Sciences can pursue an alternative academic track by majoring or minoring in Geology. For students of planetary surfaces, further advanced coursework in Geology could be substituted for the further advanced coursework in Physics that is recommended above. Alternately, planetary science students may wish to major in Geology and minor in Astronomy or double major in Geology and APS (General Astronomy).

2.) Technical Jobs in Industry

Higher level technical jobs in the aerospace industry, national laboratories and observatories, or other high-tech or computer software company may require both the physical understanding of the Astrophysics/Physics track, although General Astronomy majors can compete for similar jobs in some circumstances. The Physics Plan 1 and Physics Plan 2 (Astrophysics) curricula are similar preparation for technical industry jobs to the Astrophysics/ Physics track in APS. Recent graduates from our program have obtained jobs at Ball Aerospace Corp., small technical and computer firms in the Boulder/Denver area, as well as observing specialist positions at the Sloan Digital Sky Survey Telescope, Apache Point Observatory and at the Large Binocular Telescope.

Students should consider taking the following courses to give themselves more practical, hands-on lab experience:

- ASTR/ASEN 2500 Gateway to Space (3)
- ASTR 3510 Observations and Instrumentation 1 (4)
- ASTR 3520 Observations and Instrumentation 2 (4)
- PHYS 4510 Optics (3)
- ASTR 5760 Astrophysical Instrumentation (3; graduate level)

Consider becoming involved in Space Grant College. This is an interdisciplinary (APS and Aerospace Engineering) program that promotes and develops hands-on skills in space hardware development. You would be working with engineering students in the design and fabrication of small spacecraft payloads. To begin this program, take ASTR/ASEN 2500 Gateway to Space (3).

Develop ample computer programming skills, which will serve you in obtaining a research job here at CU as an undergraduate and later in your job years. If you do not already have programming skills, we recommend that you take either:

- ASTR 2600 Computational Techniques, which is offered in Maymester (or occasional Fall semester), and/or
- ASTR 3800 Scientific Data Analysis & Computing (3) [requires Calculus III], which is offered each Spring.

Develop ample proposal writing skills, which will serve you in many types of technical jobs, which need people who can understand the requirements of program announcements and announcements of research opportunities and respond to them with clear, cogent and precise prose. Good writing skills should be cultivated early and often in your CU career, perhaps starting with the CU Writing Program.

We recommend that you obtain some research experience while you are still an undergraduate. There are a variety of ways to accomplish this, including laboratory assistant jobs with LASP, CASA or JILA or projects with individual APS faculty or researchers. If you are aiming for industry, a job in one of CASA/LASP/JILA labs would be a good choice. Semi-independent research work is also available during the school year and is facilitated by the ASTR 4840/independent study or a departmental honors thesis.

3.) K-12 Teaching

The APS Department's General Astronomy track was developed to facilitate student involvement and accreditation in K-12 teaching here in Colorado, so students preparing for K-12 teaching should take course requirements to fulfill the General Astronomy track with special attention given to the specific recommendations given below for the various K-12 levels. Recent APS graduates are now enrolled in Masters' education degree programs or have teaching jobs in the area (e.g., Lakewood, Boulder, etc).

All students preparing for K-12 teaching careers should consult with Education School advisors about Ed School requirements at your earliest convenience for the specific grade levels you are interested in.

All students preparing for K-12 teaching careers should obtain classroom teaching experience while here at CU. A joint program between several science departments (including APS, Physics, the Biologies and Applied Mathematics) and the Education School seeks to provide science teacher training while you are here at CU. Stipends are available for classroom work by ``peer learning instructors'' (a.k.a. ``learning assistants'' or ``undergraduate TAs'') in our introductory classes for non-majors. Watch for announcements about this program and ask your mentor if you want to become involved.

3.1 High School Teaching

Physical Science teaching at the High School level will require you to teach Physics, and possibly Chemistry, in addition to Astronomy, if the school where you teach offers Astronomy (not all do). Therefore, a solid background in Physics is required, which could include either:

- Astrophysics/Physics APS degree track OR
- General Astronomy track with the following courses minimally required:
    - PHYS 2130 General Physics 3 (3) [requires Calculus III] or
    - PHYS 2170 Foundations of Modern Physics (3) [requires Calculus III]
    - (+ we suggest: PHYS 2150 Experimental Physics (1) [Taken with PHYS 2170])
    - Calculus III in either Math or Applied Math Departments
    - Chemistry 1111/1131 (10)

Either emphasis within APS is appropriate: Planetary Science or Stars and Galaxies.

3.2 Middle School Teaching

In Colorado the Middle School requirement for physical science is called ``Earth and Space Science''. Therefore, the most appropriate concentration area in APS is Planetary Science. The General Astronomy track is adequate for this career goal.

Your other science sequence should be taken in Geology. You should also take at least one weather and/or climate course from the Atmospheric & Oceanic Sciences Dept. like:

- ATOC 1050: Weather and the Atmosphere (3)
- ATOC 1060: Our Changing Environment: El Nino, Ozone and Climate (3)
- ATOC 1070: Weather and the Atmosphere Laboratory (1)

While this career goal does not specifically require you to take Calc III and Physics III, you will have a greater choice of upper division coursework in APS if you do. Otherwise, for your sophomore level APS requirement take either:

- ASTR 2500 (ASEN 2500) Gateway to Space (3) {check availability}! OR
- ASTR 2600 Computational Techniques (3) during Maymester (or occasional Fall semester)

3.3 Primary Grade Teaching

It is wonderfully laudable for you to consider teaching at this level with a science background because you could easily find yourself as the resource person in science for your entire school.

The General Astronomy track is adequate for your needs. Like preparation for Middle School, you do not need to take PHYS III and Calculus III, and so should take:

- ASTR 2600 Computational Techniques (3) during Maymester (or occasional Fall semester) OR
- ASTR 2500 (ASEN 2500) Gateway to Space (3) {check availability}!

Unlike Middle School preparation you have more choice in the other science courses you can take to meet the General Astronomy degree requirement.

Take advantage of the Fiske Planetarium while you are here at CU. You can even consider doing practicum work at Fiske developing learning modules and outreach projects in conjunction with the Fiske staff.

4.) Informal Education and Public Outreach (E/PO) and Science Writing

For this general area of career goals, we recommend either the Astrophysics track or the General Astronomy Track with a preparation level equivalent to the requirements for a High School Teacher (see above). In educating and writing for the general public, it is important to have as strong an astronomy and physics background as possible. This will also help you understand the scientific results you are presenting as well as allow you to converse knowledgably with the scientists who make the discoveries. Recent graduates of our program have taken planetarium jobs and E/PO positions at the Denver Museum of Nature and Science (Gates Planetarium), LASP and the Space Sciences Institute (Cassini Mission).

Specifically, if you choose the General Astronomy track, it is highly recommended that you choose to fulfill your sophomore level requirements with either:

- Physics 2130 General Physics (3) or
- Physics 2170 Foundations of Modern Physics (3)

and choose your ``other lab science'' in coordination with your area of concentration within our department; e.g., if ``Stars & Galaxies'' choose a Chemistry sequence; if ``Planetary Sciences'' choose either a Geology sequence (for planetary surfaces), a Biology sequence (for astrobiology), or an Atmospheric Sciences sequence (for atmospheres and climate change).

- Consider taking: ASTR 4800 Space Science Policy (3)

Take advantage of the presence of Fiske Planetarium here on campus. Early in your career you can become familiar with workings at Fiske either by volunteering or taking work-study positions. Later, Fiske offers opportunities to present K-12 Star Theatre, hands-on laboratory and outreach programs that will assist you in honing teaching skills. Development of learning modules and new Star Theatre shows is also possible independently with the Fiske staff.

Course work for you to consider outside our department which will enhance your preparation for E/PO and Science Writing by expanding your knowledge of the scientific method and your communications and writing skills:

- PHIL 1400 Philosophy and the Sciences (3)
- HIST 4040 The History of Space Exploration and Defense (3)
- PHYS 3050 Writing in Physics (3)
- ENVS 3020 Advanced Writing in Environmental Studies (3)
- WRTG 3030 Writing on Science and Society (3)
- WRTG 3035 Technical Communication and Design (3)
- JOUR 4872/ENVS 4800 Science & Environmental Journalism (3)
- COMM 3320 Persuasion in Society (3)

5.) Science, Energy and Space Science Policy

For this general career goal area, we recommend either the General Astronomy Track with a preparation level equivalent to the requirements for a High School Teacher or the Astrophysics/Physics track. General scientific knowledge, public policy knowledge AND good writing and speaking skills are required for this career goal. Recent graduates of our program have gone on to Masters' degree programs in science and public policy and energy policy.

Specifically, if you choose the General Astronomy track, it is highly recommended that you choose to fulfill your sophomore level requirements with either:

- Physics 2130 General Physics (3) or
- Physics 2170 Foundations of Modern Physics (3)

Take ASTR 4800 Space Science: Practice & Policy (3) in our department and consider taking one or more of the following science policy courses in other disciplines:

- PSCI 2101 Intro to Public Policy Analysis (3)
- ATOC 4800 Policy Implication of Climate Controversy (3)
- ENVS 4100 Topics in Environmental Policy (3)
- PHYS 3000 Science and Public Policy (3)

as well as courses offered by staff in the Center for Science and Technology Policy Research like:

- ENVS 4800 Making Decisions in a Complicated World (3)
- ENVS 5000 Policy, Science and the Environment (3)

Enhance your communications skills by taking one or more of the following writing or communications courses:

- PHYS 3050 Writing in Physics (3)
- ENVS 3020 Advanced Writing in Environmental Studies (3)
- WRTG 3030 Writing on Science and Society (3)
- WRTG 3035 Technical Communication and Design (3)
- JOUR 4872/ ENVS 4800 Science & Environmental Journalism (3)
- COMM 3320 Persuasion in Society (3) or COMM 3340 Political Communication (3)