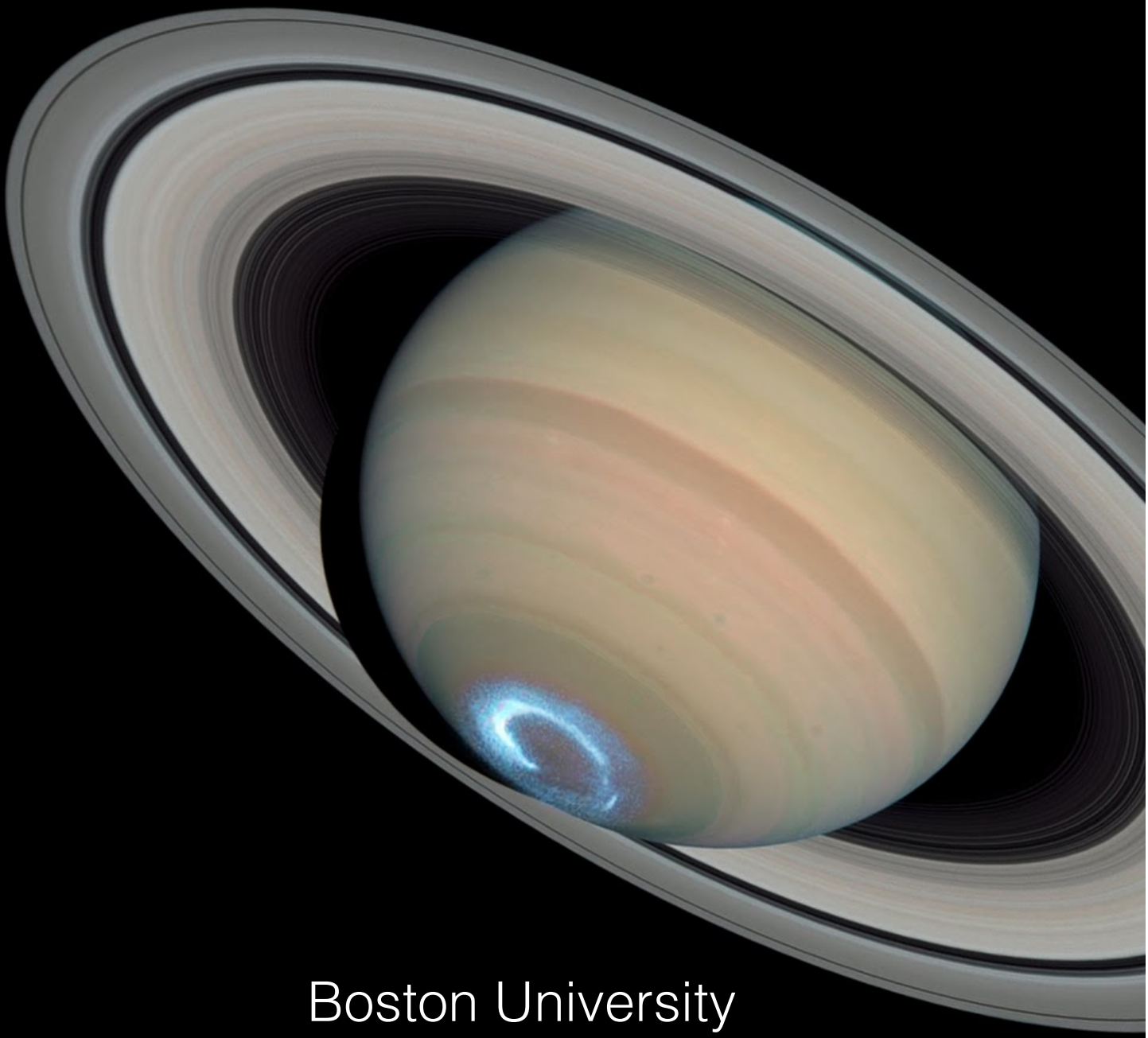

Boston University
Astronomy Department

Graduate Student Handbook
2013

Cover image: NASA, ESA, J. Clarke (Boston University), and Z. Levay (STScI)

Introduction

Welcome to the Astronomy Department at Boston University! This handbook has been written and compiled by graduate students, for you, fellow students and intrepid seekers of knowledge. Furthermore, its accuracy has been vetted by the Chair and the Director of Graduate Studies. Although procedures and rules may evolve, in this handbook, we've tried to lay out the requirements for graduation—coursework, examinations, etc.—as they stand now, for you, the incoming class of 2013. We've also included what we hope is some helpful advice about how things work around the department, things we wish we'd known coming in. Although we believe all the information in this handbook holds value, particularly important sections are underlined in the table of contents. We hope this will serve as a useful reference throughout your graduate career on the road to your PhD!

Live long and prosper!

—the grad students

Getting Started

The following is a quick, condensed overview of what you'll need to do when you arrive on campus. If anything's confusing or for more info, follow the links to the other sections of the handbook. Alternatively, feel free to skip ahead to **The Astronomy Department** and start reading from there.

Upon arrival, you will need to (1) find your desk, (2) obtain keys, (3) obtain a BU identification card, (4) open a computer account, (5) schedule an advising appointment, (6) fill out a Graduate Student Contract, and (7) complete your payroll paperwork.

Your desk: You will be assigned a desk in one of the graduate student offices. Please check with the department's Observatory Manager (Quinn Sykes) for your assignment. Most first-year students are assigned desks in the Teaching Fellows office (CAS 524), but if you are a Research Assistant, you may be assigned to another office. In addition, you will get a work computer. This will be set up by one of the computer Systems Managers (David Bradford and Jeff Sanborn). Don't forget to ask about setting up access to printers on your computer (ask specifically for double-sided).

Your keys: Keys should be obtained from the Observatory Manager. You will get a submaster key that will open various doors around the department, including the TF office, the observatory storage room, and Room 413 (a conference room). If your office requires another key, or if you are working with a professor and need access to labs or other rooms, the Observatory Manager, CSP, or IAR staff will issue you the appropriate keys. Specifically, you might also want to ask for keys that open CAS 500 and CAS 502. Upon obtaining your BU ID card (see below), Quinn will also add your card to the swipe database so it can open the department office, the kitchen, the observatory, Room 606 (a computer lab), and the library. If you ever need to replace your ID, tell Quinn so he can update the departmental card-swipes (the university card swipes will be automatically updated with the issuance of the new ID, but not those managed by the Astronomy Department.)

BU Identification: BU identification cards can be obtained by going to the Terrier Card office in the basement of the George Sherman Student Union Building (775 Commonwealth Ave). You will have a photo ID made and be assigned a BU identification number. The room will be clearly marked; just follow the signs. If you damage it to the point that it no longer works in card swipes or lose it, you can get a new one at the same location. If you are replacing a damaged ID, bring it with you and you will not have to pay for a new one. If you have lost your ID, replacement fees "start at $30," according to the form.

Computer Account: You will need to set up an account on Kerberos, the standard BU campus-wide network, in order to access Student Link (bu.edu/studentlink), email, and

other BU online services. Information Services & Technology (IS&T) should contact you during the summer with instructions on how to do this. You may have already set up a Kerberos account as part of your application to BU. Boston University now uses Microsoft Exchange for email. Instructions for setting up email, and whom to contact if you have trouble with your Kerberos (bu.edu/tech/accounts/kerberos) and Exchange accounts can be found on the IS&T website. You can also find instructions for mail forwarding here if you want to forward your BU email to a different account. Also make sure to sign up for appropriate mailing lists (astrowiki.bu.edu/Mailing Lists) on the Department's AstroWiki (astrowiki.bu.edu). These lists are the best way to get information about seminars, journal club, and other department events. At the minimum you should sign up for [announce], [grad], and either [CSP] or [IAR] (or both). For more information, see **The Astronomy Department > Department Facilities > Computer Facilities** section of this handbook.

Advising: Contact the Director of Graduate Studies (DGS; currently Meers Oppenheim) for an initial advising appointment. You should already be registered for the basic first-year Astronomy classes, and you can check on your schedule through Student Link once you have a username and login. You should still meet with the Director of Graduate Studies to discuss your proposed plan of study. Every semester the DGS meets with the grads to discuss the next semester, but of course you should feel welcome to meet more frequently. For more information about course registration, see the **Academics > Registration** section of this handbook.

Graduate Student Contract: Before every academic year begins, each graduate student is required to fill out a contract detailing their financial aid arrangements. If you are going to be a Research Assistant, this form will need to be signed by the Principal Investigator of the grant you will be working under; if you are going to be a Teaching Fellow, this form needs to be signed by the Chair. The Department Administrator can provide you with this form. For more information about the ever-important topic of funding and where it comes from, see the **Department Duties > Funding** and **Research in the Astronomy Department > Funding, again** sections of this handbook.

Payroll Documents: You should have received a letter informing you of the type of financial aid you have been awarded. If you are an RA, you will need to fill out a W-4, I-9, and Patent Policy Agreement. If you are a TF, you just need to fill out the W-4 and I-9. For the I-9 you will need to bring in a passport or a Social Security card. See the Department Administrator in Room 514 to fill out these forms on the first day of classes (or before, if possible). The Department Administrator or Graduate Student Advisor can help you find all of the correct forms. For more information on payroll and other money matters, see the **Academics > Financial aspects** section of this handbook.

Once you have your Kerberos account set up, you can find a lot of useful information at Student Link, including your class schedule, grades, transcript, any holds on registration, payroll information, etc. You can also set up direct deposit, pay fees, buy a discounted MBTA (subway and bus) semester pass, and update emergency contact information here.

Another minor item is to get a photo into the "Rogue's Gallery" opposite room 512. David Bradford is in charge of the cabinet, and will be happy to take a picture of you or you can provide one of your own. If you provide your own picture, it must be a full photo and not a thumbnail. With the large turnover associated with a University, this

lets everyone attach names to faces more easily. This, along with payroll documents, desk assignments, and keys are generally done during Orientation.

International students will want to become familiar with the services available to them through the International Students & Scholars Office (bu.edu/isso/index.html). If you have questions about your visa or your international status, this is the place to go.

Important locations

The Department of Astronomy is located in the College of Arts and Sciences (CAS) building, at 725 Commonwealth Ave., Boston, MA 02215. The Department occupies the 4th, 5th, and 6th floors. The Observatory is on the 7th floor. A few key rooms of note:

CAS 500: Conference room/Access Grid

CAS 502: Main Astronomy classroom

CAS 506: Research Support office: Center for Space Physics (CSP) and Institute for Astrophysical Research (IAR) main office

CAS 511: Computer System Managers' office (David Bradford, Jeff Sanborn)

CAS 514: Main department office (Dept. Administrator)

CAS 514A: Chair's office (Prof. Tereasa Brainerd)

CAS 517: Director of Graduate Studies' office (Prof. Meers Oppenheim)

CAS 520: Observatory Manager's office (Quinn Sykes)

CAS 521: Solar laboratory and undergraduate class laboratory

CAS 522: Lecture hall for most large Astronomy undergraduate classes

CAS 524: Teaching Fellows' office

CAS 606: Astronomy computer laboratory

CAS 601: Astronomy Library

CAS B4: Astronomy undergraduate class laboratory (in the basement of CAS)

The Astronomy Department

Organization

For all academic and scientific purposes, we are united under the common banner of the **Astronomy Department**. This is the academic entity that falls under the official umbrella of the Graduate School of Arts & Sciences (GRS) of BU. However, for administrative purposes—mostly related to the handling of grants—the Department has found it advantageous to establish three different "research centers" within the Department.

These are:

the **Center for Space Physics (CSP)**

the **Institute for Astrophysical Research (IAR)**

the **Center for Integrated Space Weather Modeling (CISM)**

The Center for Space Physics also bridges the College of Engineering and includes some students pursuing a degree in the Engineering program.

Each of these four entities associated with the department, including the Astronomy Department proper, have their own directors and administrators. Right now, these are:

Astronomy Department

Prof. Tereasa Brainerd, Chair
Prof. John Clarke, Associate Chair, Department Administrator
Prof. Meers Oppenheim, Director of Graduate Studies
Prof. Dan Clemens, Director of Undergraduate Studies
Prof. Paul Withers, Director of Graduate Admissions

Center for Space Physics

Prof. John Clarke, Director

Institute for Astrophysical Research

Prof. Alan Marscher, Director

IAR and CSP share the following research support staff:

Despina Bokios, Assistant Director
Zachary Grein, Financial Administrator
Alyson Savoie, Fiscal Administrator

Center for Integrated Space Weather Modeling
Prof. Jeffrey Hughes, Director
Kathy Nottingham, Administrator

If you are working as a Teaching Fellow (TF), your funding source will be the department; if you work as a Research Assistant (RA), your funding will be handled through one of the three research centers. Academic stuff such as class scheduling and grading are handled by the department; research stuff such as seminars, conferences, and grants are handled by the three research centers.

> As you may have noticed, **the functions of the Research Centers are purely bureaucratic.** They exist for administrative purposes only, as maintaining them as separate entities allows Principal Investigators (PIs) greater flexibility when applying for and administering grants. In reality, we collaborate across the entire department and any given member of the department can in principle have multiple projects funded by grants through any combination of the centers. Do not ascribe any greater significance to "divisions" between the Centers. As students, your primary affiliation lies with the *department* as a whole!

Who is here to help you

We get by with a little help from our friends

Your first and foremost lines of support are *us*—your fellow grad students. Yes, although we may be scattered around the department in various offices, we all lean on each other. Of course, you will form your own support networks—with your fellow classmates as you navigate the coursework and with your fellow research group members as you begin research. But don't forget about the rest of us! When it comes to questions like how to approach an old comps problem, or some annoying command that IDL is failing to compile, we were all first-years once and are happy to pass on whatever knowledge we succeeded in acquiring.

Do not be afraid to ask older graduate students for help. We are students for a reason—to learn. Also, remember there are no stupid questions! Face to face is the best way. You can also turn to the mailing lists; email grad@skynet.bu.edu for general questions to all grads, or codinghelp@skynet.bu.edu for programming questions. (For more info on the mailing lists, see the **Department Facilities > Computer Facilities > Email lists** section.)

Department assistance

For matters that require advice or assistance from the Department, the first person you should turn to is the Director of Graduate Studies (currently, Prof. Meers Oppenheim).

The next person to turn to is the Chair (currently, Prof. Tereasa Brainerd). If you have an issue that involves the Director of Graduate Studies (currently, Prof. Oppenheim), you should turn to the Chair, and vice versa.

For day-to-day logistical issues, the Observatory Manager (currently, Quinn Sykes), is primarily responsible for the condition of rooms and equipment around the department. An exception is computer equipment—they fall under the purview of the Systems Managers, David Bradford and Jeff Sanborn—and copy machines (the nearest staff can generally help). When you discover that something is broken or malfunctioning, please let the responsible party know about it. It is amazing how long something can be broken without it coming to our attention, so please don't assume we already know about the problem.

Other assistance

There are some organizations on campus that theoretically can help advocate on your behalf for larger issues with the university: The Graduate Women in Science and Engineering (GWISE) group (men are welcome to be involved, too!) and the Graduate Student Organization (GSO). For example, GSO got us health insurance many years ago! Both groups offer a number of social and professional development events throughout the year.

If all else fails and you are not sure where to turn, try the Ombuds' office. The ombudsperson can act as an impartial and confidential source of advise and can help direct you to resolution options. Their website (bu.edu/ombuds/about/frequently-asked-questions) has some good examples of when and why you would need such help.

Department Facilities

Classrooms

CAS 500

The outer part of 500 is the department's kitchen, available for your use. It consists of a refrigerator/freezer combo, a microwave, a coffee maker, a sink, and a toaster. Do not leave food in the refrigerators for an extended amount of time as it will be thrown out. Your BU ID will unlock the outer door; for the inner door, you need a separate key from Quinn. The inner part of 500 is the department's meeting and conference room. It is also used by CISM (the Center for Integrated Space Weather Modeling) for video conferencing and occasional small meetings. This should remain locked when not in use.

CAS 502

Room 502 is used as the Astronomy Department's classroom and CSP/IAR seminar room. Most graduate classes will be held there or in CAS 500.

CAS 521
Room 521, also known as the Solar Lab as it contains the solar telescope, is used by the TFs to teach the undergraduate astronomy day labs. This room should also remain locked when not in use.

CAS 522
Room 522 is a large classroom and is the only room on the fifth floor that is not exclusively used by the Astronomy Department. The 100 level undergraduate astronomy courses are often taught in 522. Teaching Fellows (TFs) will usually assist their professors in setting up demos, handing out tests, etc. in this room.

CAS 606
Room 606 is the computer lab. The outer portion serves as the control room for the 14" telescope on the roof, while the inner portion has a lab of about a dozen Windows machines (and a view of the Charles River). Classes that require use of computers, both on the graduate and undergraduate level, are taught here, and night labs using the 14" scope meet here as well. You will get swipe access on your BU ID. The outer portion of it also serves as the department server room and is therefore air conditioned continuously. If you're working or teaching a lab there and are freezing you can flip the switch near the window to turn it off, but remember to turn it back on before you leave!

CAS B4
Room B4 (in the basement) is used to teach undergraduate day labs and classes.

CAS 413
Apart from being a small classroom, this is an excellent room to hold small meetings, study for comps, or do problem sets together. Your submaster key works for it.

The department maintains schedules for its classrooms online at bu.edu/astronomy/astronomy-department-facilities/room-schedules. Rooms 502, 500, and 413 can also be reserved at that site if you would like to schedule a study group or other student event; requests made online will go to the department administrator for approval.

Observatory
The Judson B. Coit Observatory is located on the roof of the CAS building. The stairwell to the observatory is located next to room 520. The observatory has two large domes that house our large refracting telescopes, a 7" refractor (currently out of commission) and a 6.5" refractor. We also have about five 8" Schmidt-Cassegrain telescopes that can be set up on permanent mounts on the north side of the roof. The refractors and the 8" scopes are used mainly by the undergraduate laboratory courses. There are also domes for the 10" and 14" Schmidt-Cassegrains, as well as a small radio telescope on the roof, all of which are used by graduate and undergraduate labs.

TFs teach the night lab portion of the lab courses in the observatory. Access to the observatory is gained by use of a card swipe system. Your ID must be activated before you can access the observatory. See Quinn to make sure you are on the list.

We also hold a Public Open Night at the observatory every Wednesday evening, provided it is not cloudy. These are run by the Observatory Manager; grad students are not responsible for these sessions.

Computer Facilities

Accounts

Please set up your BU account first (as described above), and give it overnight for the account information to propagate through the BU system. Then drop by Jeff & David's office (511) and they can set you up in a few minutes. Your email address is ACCOUNT@bu.edu for the duration of your stay at BU. You can control where this mail is directed online (bu.edu/directory/change-entry.html).

Local Computer Facilities

You will likely have a computer at your workstation—either managed by the department (if you are a Teaching Fellow) or by your advisor when you join a research group. **One important thing to note**: Windows machines are not centrally backed up. UNIX machines have central backup capability that is bandwidth limited; if you're working with gigs of data, it may not be able to finish backing up within the allotted backup window. Talk to Jeff or David if you would like to use the central backup capability. If you are a Research Assistant, your advisor likely already has a backup solution for their research group in place. Otherwise, you will want to invest in your own backup solution—an external drive, cloud storage, or both.

> As part of your BU account, you also get 50 MB of web space to host a personal site for your professional and academic activities. If you don't currently have a web host, taking advantage of this is highly recommended. As an astronomer, in general, having a site is highly recommended for networking, visibility, and search engine optimization purposes.

As mentioned above, there is a small computer lab available in 606, which has about eight Windows machines available for small classes.

There are printers available throughout the department—mostly black and white laser printers. They are all on the internet at NAME.bu.edu.

lp0 (duplex; Room 510)

lp1 (Room 414)

lp2 (Room 508)

hp1 (Room 606)

monet (Room 524)

ar0 (owned by IAR; color; Room 414)

csp1 (owned by CSP; color; Room 506)

ar0 and **csp1** are operated by their respective research centers and are meant to be used for research done under a grant administered through them. Other printers may also available if you ask nicely.

The copier in the main Department office, Room 510, is also available on the network as **ikon1**; it can be used to print 11''x17'' pages and has more elaborate finishing capability than the other printers. It also has scanning capabilities and can email you the result in PDF form. Please note that equipment in 510 is primarily

intended for educational use. If you are using the facilities in there for research purposes and someone needs them for class preparation, please allow them access to prepare for class. Copies for research purposes should be made in the CSP or IAR offices. Make sure you have network printing set up on your work computer—ask Jeff Sanborn.

There is also a poster printer in 510—stop by David and Jeff's office if you need to use it. All requests to print posters must be given to the systems managers *at least* three days in advance.

As each user has specific needs and experience, the best way to get what you need is to ask for it. Please don't feel that you are bothering the systems administrators—they expect new users to need help getting going. Any time you need assistance, either drop by their office (CAS 511), send mail to bugs@skynet.bu.edu, or phone them at 353-4884. They're also happy to help advise you on hardware purchases for personal use as well.

BU Computer Facilities

The BU IT website has some useful software free for download, including Mathematica: http://www.bu.edu/tech/about/research/training/scv-software-packages/.

Email lists

The department's main form of communicating stuff like *free food*, seminar schedules, and other important announcements is through its Skynet mailing lists. You should be signed up for the [grad] list automatically when joining the department. You may also be automatically signed up for [announce] and/or [dept]. You will *not* automatically be signed up for [CSP], [IAR], [CSP_grad], or any of the other mailing lists. A list of the lists is available at skynet.bu.edu/cgi-bin/mailman/listinfo and you can join most of them easily. (You won't be able to join Faculty freely, though!)

Pertinent lists for grad students include (but aren't limited to):

[grad]
General-purpose list used by both grads and faculty to reach the grad student community. Want to share an interesting link? Have extra Sox tickets you need to sell? Inviting everyone to a party? [grad] is the place to do it. (There is also a separate [CSP_grad] list to reach just CSP-affiliated grad students, but it's rarely used.)

[codinghelp]
If you have questions on programming—IDL, Python, Fortran, whatever—odds are good that someone else has fought through the same issue. This list is for those questions and is also a repository for helpful programming links.

[CSP] and **[CSP_seminar]**
Used for general CSP announcements and the weekly space physics seminar announcements, respectively.

[IAR]
Used for both IAR announcements and weekly astrophysics seminar notices.

[announce]
Used for general announcements. Unlike most of the lists here, subscribers to [announce] include people outside of BU (such as collaborators with BU researchers)—so don't spam it!

[dept]
For internal department-wide announcements that don't need to reach people outside of BU.

You should be signed up for *at least* [CSP] + [CSP_seminar] or [IAR] every semester. The announcements about journal club papers are generally sent out to one or the other of the CSP lists and the IAR list, though this also varies by semester (sometimes people email the whole grad or announce lists with papers for talks they feel may be of interest to everyone!)

In most cases, you can email LISTNAME@skynet.bu.edu if you want to send out an email to that list. If you're on the fence about joining a list (such as codinghelp@skynet.bu.edu, even if you don't have any coding questions at this moment), you might as well sign up for it because you can always unsubscribe if you're finding you're getting too many emails.

The Department Website (bu.edu/astronomy)

The Astronomy Department website is database-driven. Edits to the webpages can be made by either of the sysadmins and any of the administrators. If you would like to suggest an addition to the website, or if there is a correction you would like to make to an existing page, talk to David Bradford about it. We are always happy to get feedback about the website! If you're looking for a .pdf form that you need to fill out, or instructions, or just general info on the graduate program, you can find it here under "Graduate Studies".

Another good place to find information is:

The AstroWiki

The Astronomy Department wiki can be found at astrowiki.bu.edu (although it is only accessible from inside the department or via BU VPN). You can find lots of random stuff here, and you can create and edit pages to inform and help your fellow students. Feel free to post or edit any information on these pages. Questions about the wiki? Ask Jeff Sanborn.

The Astronomy Library

The Library (Room 601) is less vital in the day-to-day rhythm of research than in days of yore, but it is still an impressive collection of authoritative and interesting works, circulating in self-service form. (It's also a nice quiet place to do some studying on your own.) To check out a book you should fill out a check-out slip, located on the check-out table at the front of the library. Faculty, staff, and graduate students are, by tradition, allowed to keep books for up to a semester. But as there is no full-time staff librarian, book returns are on the honor system; please put them back in the return box outside of the library.

Mailboxes

The main office in Room 510 contains internal mailboxes for students; faculty and staff mailboxes are located in Room 514. You can also have outside packages shipped to the office and use it as your work address. Your mailing address is:

Your name
Boston University
Department of Astronomy
725 Commonwealth Ave.
Boston, MA 02215

Security

Lastly, a word about security. BU sits in the middle of Boston, and the classroom buildings (like CAS) are not secure. If a room is empty and contains valuable items, it should be locked. Most of the problems we have had are associated with petty thievery, but there have been periods of time when something more organized has occurred (a lot of laptops disappeared). BU does not insure your personal belongings, so you should check and make certain that your homeowners or renters insurance covers you and your belongings. If you are here late at night and alone, you may wish to lock the room you are in. Walking around BU alone late at night can be a bit risky—you can call (617) 353-4877 and arrange an escort. If you notice anything odd going on, call the BU Police at (617) 353-2121. They are quite helpful, and show up promptly.

Department Duties

Funding

Graduate school is like freedom—it isn't free. Unless you have loads of money and can afford to pay your own tuition *plus* live in Boston, you'll need financial aid while you are here. This can come from within the department or from an outside agency.

If you seek funding within the department, it will be in the form of either a Teaching Fellowship (TF)[1] or a Research Assistantship (RA). Both of these cover tuition and also provide a stipend and health insurance. These are discussed further under **Academics > Financial Aspects > Payroll** and **Life in the Astronomy Department > Healthcare** in this document. Beginning in Fall 2013, the Graduate School of Research (which the Astronomy Department is part of) guarantees five years of funding for all of its incoming students.

Alternatively, you can seek outside funding in the form of a fellowship from a funding agency such as the National Science Foundation (NSF) or NASA, or apply for predoctoral fellowships at a partnering institution. These options are discussed later in this handbook, but it is important to note that funding by *an outside fellowship gives you financial independence*. This affords you certain advantages, chief among them being greater freedom in choosing the research group you would like to join.

This is very important:

The department has likely offered to fund you for your first year (although this may not always be the case in special situations), meaning that if you don't come in with outside funding, you will either be a TF or RA during the Fall and Spring. However, while this is a guarantee of availability, **it is still *your* responsibility to secure your own funding**. That is, if you have no outside funding, *you must actively seek an RA or a TF position from the department.* This is not to say that the faculty and staff won't help you—we want our students to succeed and if they're making progress, we do our best to find them funding one way or another. There has not been a case in recent history where someone had to leave the program due to lack of available funds within the department. But if you wish to be a Research Assistant for a certain project, it is *your* responsibility to approach the professor in charge of that project and make the arrangements, and if you wish to be a TF, you must make your request known to the Department Administrator well before the semester in which you wish to do so. We have a limited number of TF slots, so each semester only 8–9 students may TF.

[1] Known more commonly at other institutions as a Teaching Assistant or TA.

Additionally, if you want to get paid over the summer, you should find an RA position. There is usually only one TF slot for the two summer terms. Everyone usually finds an RA position, though in the first year or two, it may not be your first choice.

Most of the time, students TF their first year and then obtain an RA-ship from a professor in whose research they are interested. Each academic year you will fill out a Graduate Student Contract letting the Department know what you have arranged for your funding for the following year, and the Principal Investigator of the project you are working on (or the Chair in the case of TFs) will sign it to indicate his agreement. It is *your* responsibility to get this signed contract to the Department Administrator and the Grant Administrator so you can get paid. Without it, they can't set you up on the payroll.

The Department Administrator generally begins the paperwork process of setting up each student's funding source a few months or so in advance of the start of each term. This means that if you are looking to do research during the summer, it is to your interest to begin asking no later than January or February.

Teaching Fellows

If you are a teaching fellow, you will be working with a professor on one of the undergraduate courses. Usually, the TF is responsible for the laboratory /discussion sections (a few per week) and for grading homework assignments and exams. The nominal workload is about 20 hours per week. Some professors ask that you attend lectures. Please contact the professor well before the semester begins to discuss your duties. The department Chair makes the TF assignments. The College of Arts and Sciences (CAS) holds orientation and training sessions in late August. If you are a new TF, you must attend these. You can find the schedule online (bu.edu/grs/academics/resources/tf.html). The Department also holds its own training sessions for TFs teaching laboratory sections. These are arranged by Quinn, and are usually held the week before classes begin or in the afternoon of the first day of classes. There is also a briefing session by Quinn every week to discuss lab activities for the following week.

Labs

TFs are assigned to teach laboratory sections or manage discussion sections for the introductory level astronomy course for which they are TFing. The lab manuals for the courses are available for download on the Astronomy Department's home page. For reference, the manuals are online (bu.edu/astronomy/academics/undergraduate-studies/manuals). Do verify that you have downloaded the correct lab manual for the course you are teaching, and check with your professor to see if they have a particular version of the manual they prefer to use.

The lab equipment will be set up by the Observatory Manager ahead of time. It is up to each individual TF to ensure that they are acquainted with the material being taught and the equipment being used. It very important that you understand how to do the lab yourself before attempting to teach it. If you do not properly prepare for a lab or discussion section, you will likely stumble over your words and become frustrated as

you try to communicate with your almost certainly confused undergraduate students. It is important to realize that most of these students will struggle with basic algebra, so communicating clearly is of paramount importance.

In case of queries about a lab or the available equipment, please contact Quinn (CAS 520) either in person or via email. If required, you can run through the lab yourself before you have to teach, depending on the lab schedule and your class schedule. If your lab section requires the use of the computers in Room 606 (usually courses for undergraduate majors such as AS 202/203), you must contact Jeff Sanborn (CAS 511) to get your students access to those computers. It is also a good idea to contact Quinn Sykes to get your students swipe access to the computer lab. If you are assigned to be a TF for AS 101 in the solar lab (CAS 521), you have to operate the solar telescope and project the Sun across the room, before you start your laboratory section on a given day. It is also your responsibility to close the solar telescope at the end of the day.

Quinn will contact all the TFs at the beginning of each semester in order to schedule a weekly meeting. During these meetings, Quinn will teach TFs how to use the telescopes for night lab, how to set up the solar telescope, the digital spectrometers, etc. Although the meetings do not last long, it is important to attend as a part of your laboratory preparation.

During the lab students will break or lose pieces of equipment. If the lab cannot function without the equipment that was broken, let Quinn know immediately; otherwise just let him know after class. Make sure the laboratory is clean after your section is over (including erasing the chalkboard!).

Night Labs

Part of your TF duties include teaching the night lab portion of the lab section. About one night a week you and a fellow TF will be scheduled to instruct students in basic astronomy on the roof of the department. Night lab activities include assisting students in identifying different constellations, instructing them on parts of a telescope as well as using the department available telescopes and binoculars to observe astronomical objects in the night sky. The lab manuals for the night labs are available on the Astronomy Department's homepage. To help you become familiar with the department's telescopes, Quinn will hold a training session sometime in the first week of classes, and explain the different telescopes that are used for the AS 100 and AS 200 level classes. A basic overview of night lab procedures can be found in **Appendix B** of this handbook and on the AstroWiki (https://astrowiki.bu.edu/AstroWiki/Observatory/Night lab). The observatory phone number that students should call to check on night lab status is **(617) 353-2630**.

Research Assistants

If you are a research assistant, you will be conducting research in a professor's research group or laboratory. The minimum workload as counted by payroll is 20 hours per week, the same as that for a teaching fellow. However, since the primary objective of a graduate education is to develop an understanding of the forefront of an active

scientific field and to engage in original research, you should expect to spend far more than the minimum. Most successful scientists spend far more than 40 hours per week (often double that) engaged in research.

Research Assistants are affiliated with one of the department's research centers—the Institute for Astrophysical Research (IAR), the Center for Space Physics (CSP), or the Center for Space Weather Modeling (CISM). Each of these centers has a grant administrator, and your salary is paid from grants administered by the center.

Seminar + Journal Club

The department runs two weekly seminar series of talks from invited speakers affiliated with other institutions as well as from our department. The topics are roughly divided into astrophysics and space physics. The seminar consist of two parts: (1) a "journal club" in which a student analyzes a recent paper in the field of specialty of the upcoming invited speaker, followed by a group discussion and (2) the seminar talk itself. This is a very important activity in your grad student life—arguably as important as the classes you will be taking.

Each seminar series is scheduled and led by a professor from the astrophysics or space physics side. Hence the topics covered are sometimes potentially aligned with the research interests of the professor in charge. They are usually open to requests; therefore you are welcome to email your suggestions for the upcoming semester's seminar series to the organizing professor.

These seminars are a great way to acquire knowledge on the latest developments and research advances in astrophysics and space physics as well as to interact with your favorite expert. In the past, there have been seminar talks not only by astronomers, but also by space lawyers, policy experts and NASA officials, each experts in their own fields. Sometimes the department has joint seminars between astrophysics and space physics if the speaker's research generates interest among both groups.

Seminars are usually followed by an informal gathering with the speaker at the BU Pub, after which the speaker is invited to dinner with professors accompanied by students on rare occasions. Every semester, the students from the space physics seminar series are given the opportunity to invite a speaker of their choice. They are allowed to spend time with the speaker informally, take him/her out to lunch as a group, and the student who suggested the speaker can join him/her for dinner.

Journal club is an hour-long meeting and is an equally important part of seminar in which a paper from the field of the next week's speaker is analyzed, picked apart, praised, or criticized in a group setting. The exact format depends on the professor teaching it and varies from semester to semester. A general overview of how it might typically be run is as follows:

In the beginning of the semester, the students taking journal club for credit are assigned a slot pertaining to a scheduled talk by an invited speaker the following seminar day. Upon being assigned a slot, it is your responsibility to contact the respective seminar speaker and ask for suggestions on which papers you could review before his talk. In general, the speakers are encouraged to suggest recent papers on their topic of interest, written by other authors.

You are then required to prepare a short introductory lecture (usually a PowerPoint) on the chosen paper. You can work closely with older graduate students more familiar with the topic as well as the professors in the astronomy department. The presentations go up to about 20 minutes in length, after which there might be questions. Consider your presentation a chance to practice giving scientific talks in a relatively low-pressure environment and prepare for when you will be giving talks on your own research at conferences! The rest of the time is reserved for group discussion on various aspects of the paper—from the way it is written and the way figures are made, to its scientific reasoning and the validity of the assumptions used, and the overall impact the paper has. This is an opportunity to sharpen your analytic skills and learn to identify weaknesses and strengths—in essence, it is the heart of what you are training to do.

Both astrophysics and space physics journal clubs are held concurrently on Fridays at 4:00 pm; seminars are held on Mondays at 4:00 pm for astrophysics and Thursdays at 4:00 pm for space physics. All graduate students are required to attend journal club and one or both talks regardless of whether they are taking seminar for credit.

Life in the Astronomy Department

Social life in the department

One of the things we pride ourselves on is the amount of time we *do* make to sit around, socialize, and bounce ideas off of each other. After all, we are a fairly large department, and if you stay stuck at your desk all day, you might not ever see another student. But that's no way to live! So here are some recurring events where we all hang out:

Social Hour

Every Friday during the semester after Journal Club at 5 pm, the department gathers in Rm 502 for Social Hour, which includes free pizza and beverages—yes, including beer.

The first years are traditionally responsible for purchasing the beverages (the closest liquor store is The Wine Press near the St. Mary's T stop). To get reimbursed, bring the receipt to the department administrator.

Seminars + The Pub

We gather at 3:45 pm on seminar days in Room 500 for cookies and coffee before going into 502 for the talk. This is a good chance to decompress and see everyone again after emerging from an intense afternoon of coding/homework/writing. Someone has to set up the cookies and coffee (usually doing this around 3:20-3:30), but that person varies by semester—be sure to pay attention in the organizational meeting at the beginning of the semester!

Perhaps even better is after the seminar, when everyone attending the seminar is invited to head over to the BU Pub for beer and snacks on the IAR/CSP dime. This is a fantastic chance not only to socialize and chew over the talk, but to *network* with the invited speaker if you have questions about their talk, and with people who might have attended the seminar from other institutions. It is difficult to overstress how important making these network connections is for your astronomy career. Many collaborative efforts begin through a simple conversation over some beer and nachos...

Tuesday lunch talks

Year-round, there is also a series of less formal talks in Room 500 on Tuesday during lunch, often given by visiting postdocs or graduate students. This is also an opportunity for *you* to give a talk and practice presenting your own work! Talk to Professor West if you're interested in giving a talk.

Grad lunch

Once a week, we try to reserve Room 500 for a grad student lunchtime. The day varies from semester to semester, but don't worry, you'll hear about it. Remember, your fellow graduate students are your primary resource while at BU, so don't underestimate the value of this time!

astro_ph discussion

Once a week, we also have a time set aside where we talk about recent interesting papers posted on the astrophysics section of the arXiv (arxiv.org), the scientific paper e-print archive. During the week, there is an online poll to choose the papers to be discussed through the site bu.voxcharta.org. But unlike journal club, having read the papers in advance is by no means required! Nevertheless, this is a great chance to *practice* reading papers and have more advanced students help you become familiar with the language of the field. It is also good practice to explain papers that you have read to others in a low-key setting (as you'll soon discover if you haven't already).

Unplugged & Soiree

Each year, the department has two musical events where we all dig out that guitar or flute we have lying around but never seem to have enough time to play. Unplugged is essentially a rock-and-roll open mic night in Room 502 (despite the name, traditionally, there are few acts that truly are unplugged), while Soiree is a concert of more classical-oriented music held in the Tsai Performance Center. Alcohol and refreshments are provided at both, and they are lots of fun. Hope to see you on stage!

Other activities

There are other department traditions—for example, various intramural teams (softball and volleyball are among those currently running), as well as an annual weekend ski trip in the winter to a New England ski resort. Of course, each of these only happen because one of the grad students has stepped up and organized it. If you'd like to start a new tradition or activity, just ask around and you'll probably find some people willing to help make it happen!

There is life outside your department

Sometimes you need to leave the office and do something fun, relaxing, or exciting (that's not astronomy-related). Don't forget, you are going to school in *Boston*! It's a great city with tons of students (over 50 colleges and universities in the metropolitan area) and young people, and there is always something going on. The following are some suggested activities for fall, winter, spring, and summer.

Fall

Canobie Lake Park: A haunted amusement park in southern New Hampshire (about 40 minute drive from Boston) that runs all fall. There are amazing rides with short lines and haunted houses. Unlike Six Flags, you get to ride a lot of rides with very little

waiting. The haunted houses are also pretty good. Admission is only $30 and you can get discounts online for $25.

Mt. Auburn Cemetery: The most beautiful cemetery you will ever go into. You can go here all year, but don't miss it in the fall with the amazing fall leaves. Be sure to go to the tower at the top of the hill (tower closes at 5pm). You can see an incredible view of the city. Go to Mary Baker Eddington's grave monument (She founded the Christian Science Church). There are ponds, gazebos, towers, marble head stones, trees from all over the world and even a sphinx.

Corn Mazes: Sauchuk Farm in Plympton, MA is only $9. You can do hay rides as well. There are other more expensive mazes that are more difficult and you probably wont be able to get out without help.

Sturbridge, MA: An amazing little town near Boston that serves an incredible Thanksgiving dinner.

Plymouth, MA: Good to visit during Thanksgiving time. You can see the famous Plymouth Rock (not actually that impressive; it's just a rock in a monument structure). You can tour a replica of the Mayflower and you can walk through a replica of the Plymouth plantation. People are dressed in colonial outfits and they act in character as they work on the plantation.

Salem, MA: A must see before Halloween. Don't go *on* Halloween though—it's too busy then. But definitely walk around the town and go to the witch wax museums. Their harbor area is pretty nice to see as well. There are old boats parked next to a little lighthouse near an incredible hot chocolate store. Make sure you check the hours of the places you want to visit, though, as most places close at 5:00 PM (this may be different during October).

Hull, MA: Go before it gets too cold. Near the tip of the peninsula there is an abandoned, "haunted" Revolutionary War bunker called Fort Revere. Drive to the lit monument on the top of the hill and you'll see buried in a ravine an amazing maze of cement rooms covered with graffiti. It's on the side of a hill with a cemetery. It's been on *Unsolved Mysteries* for ghost sightings. It's really fun to explore in the dark with a flash light and a fun group.

Ghosts and Graveyards trolley tour of Boston: It costs $35 but you can get a discount if you get a big group of people. They take you around the city telling you all about haunting stories in the city. You get off the trolley a number of times to go into graveyards that they have keys for. They are in costume and tell amazing stories.

FanPier hot air balloon: Every October you can fly above downtown Boston in the FanPier hot air balloon. It's tethered to the ground but you go up pretty high.

MIT's glass-blown pumpkin exhibit in October; it's often displayed outside in front of MIT's student center.

Apple picking: This author isn't sure what the big deal is with paying for the privilege of picking your own apples for twice the price you can get them at the grocery store, but apparently people in Boston love this (especially Jane Austen fans). There are many orchards where you can do this. A nice one is Phil's Apple Orchard. The apples and leaves during fall are amazing. You can watch them press fresh apple cider and it's a very romantic area. Getting there via Lovers Lane (Google it) is recommended.

Fire Water in Providence, RI: The city lights bonfires on the canal in Province and they play really cool music while everyone sits on the bank of the canal. Happens in September. Brown is a fun college to visit if you are there as well.

Horse Back riding outside in early fall on a New England Farm

Winter

See the lighting of the Christmas tree on the Boston Common.

Go ice skating on the frog pond in the Boston Common

Jordan's Furniture in Reading and Natick, MA are probably one of my favorite things in Massachusetts. It's a furniture store with a movie theater inside, but it also has multiple wintertime attractions. Not only is it fun to walk through a huge furniture store checking out beautiful furniture, but you can also see the enchanted village (wax moving figurines in Christmas Wonderland; they play music and blow snow on you). You can also see a Christmas laser light show and watch *The Polar Express* in 4-D; three of the dimensions are on a huge screen and you wear 3-D glass and the fourth dimension is that your seat moves like a Disneyland ride and they spray water and different scents out of your seat.

Museum of Fine Arts: You can go to this all year, but it's a nice thing to do in winter when it's cold outside. You can get in FREE with your BU ID. Just show it at the desk.

CocoKeys Waterpark: an indoor waterpark in a hotel. It's only $10 on Wednesdays but is $40 on weekends. They have a huge arcade inside as well.

Cross country skiing: The best place is called Windblown in New Ipswitch. You ski in a beautiful forest for $33 (cost of pass, equipment and everything).

Go sledding at various places.

Go to New York City: New York City has a ton to do, and you can get there in 4 hours by car or bus for $20-40 (Boltbus, Meagbus, Greyhound).

Spring

Arnold Arboretum: a beautiful park (free) with trees from all over the world. There are beautiful view spots and it blooms absolutely beautifully during spring. There is a nice vineyard inside as well.

Boston Public Garden: The flowers and trees are in bloom during the spring and it is breathtaking. Be sure to do a swan boat ride on the pond in the Public Garden.

Wellesley College has an amazing lake that's beautiful to walk around. There are trimmed trees and wooden walkways that go out of the lake. A must-see during spring. The school and town of Wellesley is very beautiful as well.

Half marathon around Lake Winnipesaukee (around May 10th). It's amazingly beautiful.

Boston Marathon: Watch people run, run it yourself, or volunteer. The entire city is packed (don't take the T if you can help it) on Marathon Monday, and it's a holiday, so don't stay in the office.

Boston's Zombie March: One day in late spring hundreds of people congregate at porter square dressed as zombies and walk down to central square.

A city-wide pillow fight is usually put on by Boston SOS (Societies of Spontaneity—a flash mob group).

Summer

Shakespeare on the Commons: A free Shakespeare play that plays once a week during the summer in the Boston Common. Pretty high quality.

Free tango on the Week's Footbridge every full moon during the summer. It's on Harvard campus and the bridge is a beautiful brick bridge that spans the Charles river.

Free swing dancing outside the harbor hotel near the gazebo every Wednesday nights during the summer. A boat of old men dressed in tuxes play live swing music. You dance on a checkered floor and everything is decked out with Christmas like lights.

Scooper Bowl in Government Center. A 3-day event in June where you pay $10, go into a gated area in Government Center, and proceed to eat as much ice cream as you like from a dozen ice cream stores like Ben and Jerry's, Edy's, etc. Proceeds to go the Jimmy Fund cancer research charity.

Kimball Farms: A must-visit in the summer. Go play bumper boats, miniature golf, and eat awesome homemade ice cream. Try the Gingersnap flavor; it's amazing.

Hatch Shell: Free movies are shown every Friday in the Hatch Shell during summer. It's an outdoor theater place. Free concerts come there as well. That's also where the Boston Pops play for the 4th of July. Google it to get the schedule.

Charles River Canoe and Kayak: Rent a canoe or kayak and sail the Charles river. It's amazing to do this during the 4th of July (they have special rates for 4th of July rentals—get a group together). They set fireworks off from a barge on the river and you can be right underneath it all if you're on the river. The 4th of July is amazing in Boston!

Walden Pond: Located in Concord MA, it's a must-visit at least once while you live here. You can swim in the pond and walk around it to see Thoreau's shack.

Old North Bridge in Concord, MA, where the first shots of the Revolutionary War were fired. Also continue on over the bridge to Longfellows garden. It's pretty. Also check out Emerson's, Louisa May Ellcot's, and Thoreau's Houses. See their graves in Sleepy Hollow Cemetery. It's kind of a creepy but beautiful cemetery that never closes.

Bike the Minute Man trail. It's 11 miles one way and starts at the Davis T station. It goes through Lexington and Concord. See the Lexington green and the visitor's center there

Six Flag's New England: Fun but expensive and long lines. Great roller coasters!

Beaches that are close to Boston: Lynn Beach near Nahant. It's cheap and good. It's shallow water for a while as you walk out so the water tends to be the warmest in New England. It's also pretty cheap ($3). Revere Beach is close and free but its really dirty and crummy. If you want to go to really nice beaches that are farther away and are more expensive here are some good ones: Singing Beach, Light House Beach in Chatham on the Cape, and Crane Beach in Ipswich.

Martha's Vineyard and Nantucket Island: Nice ferry ride to get there. Beautiful town that is way overpriced. The beaches are incredible. Worth going once at least. I hear Nantucket is better just because it isn't as big a tourist trap. Biking on the island is incredible. You can rent mopeds and drive to the cliffs of the island.

Rockport, MA: An amazing little tourist town. Walk down Main Street out onto Bearskin Neck. Also be sure to go to Halibut Point state park. There are beautiful places to walk with views of the ocean and cliffs. There are tidal pools and incredible ponds! Must see!

Newport, RI: Do the entire cliff walk. On one side you see the ocean and on the other you see incredible mansions and estates! Really beautiful seaport town. The Newport Folk Festival, where Bob Dylan famously went electric in 1965, is held every year in late July.

P-town (Provincetown): It's at the tip of the cape. You can take a ferry out to it (expensive though). It's a gorgeous seaport town with a perfect beach. A very, very, liberal town.

Winthrop, MA: It's a beautiful peninsula that has an incredible view of Boston. I'd recommend eating at D'Parma, an incredible little Italian restaurant. Walk around Deer Island (it's a peninsula). It has an incredible view of the ocean, harbor and the city. You can also see several lighthouses as you walk around it. Some parts don't smell good, though, because there's a waste storage facility at the tip of it. But it lights everything up and is actually very pretty. Good for longboarding, too!

Harbor Islands: Take a ferry from downtown Boston and go to any of the Harbor Islands. George's Island is a great one. There is a beautiful Civil War fort there that you can explore. It's also haunted by the lady in black (Google it). Great picnic place. You can also camp on some of the islands, but be sure to make reservations first.

Pleasure Bay in South Boston: Incredible. It's a romantic walk out into the ocean. You can see the city and planes landing at Logan. You walk by a lighthouse and a civil war fort. There are monuments along the way as well.

Walk around in the "World's End": It's a beautiful park area in Hingam, MA with a view of the Boston skyline.

Walk/run/longboard the Esplanade on the Charles River, particularly near the city. There are monuments, ponds, etc. Also, there are beautiful docks that stick out into the river and nice trees to sit in.

Nice Walks: Fresh Pond (Cambridge) is a beautiful walk. Jamaica Pond (in Boston) is also beautiful. Or, just Google Earth any peninsula and go to it. They are usually beautiful and have monuments at the tips of them with nice walks. Nahant has a beautiful, quaint gazebo at its tip with a beautiful view of the city.

Sailing on the Concord River is nice as well.

There is an incredible park with all sorts of elaborate play ground swing sets and fun playground stuff for children with springy floors behind the Museum of Science bridge near Boston. If you Google "Industrial Park Rd" you'll see it.

Revere Park in Charlestown: a great place to play frisbee or kickball. There's an amazing view of the iconic Zakim Bridge (the cable-stayed bridge that's lit up all blue at night).

During the summer, the city of Cambridge always hosts a block party dance in Central Square.

Other

MIT lecture halls never close and all the video equipment is open to the public. You can watch videos or DVDs in any lecture hall with large screens and Bose surround sound. We get groups of friends together and have movie nights, and it's great fun. Like going to a theater, only more free. We bring candy and popcorn.

The MIT Lecture Series Committee also puts on recently-released movies throughout the year. Admission during the year is $4, but in the summer it's been free in recent years! Concessions are similarly low-priced. Check their website (lsc.mit.edu) for info and schedule.

New England Aquarium IMAX Theater plays cool things like documentaries and U2 concerts in 3D. Also see the seals outside the New England Aquarium (for free).

The North End: Amazing Italian food. Mike's Pastries is a favorite place to get Cannoli and if you go to the cupcake store on Hanover street just before 11 pm they give away the best free cupcakes you'll ever have.

Quincy Market at Faneuil Hall: See street performers as you check out their food court. They have amazing clam chowder there.

The Oyster House: Oldest restaurant in America, located near Quincy Market and Faneuil Hall in downtown Boston. It was Benjamin Franklin's favorite restaurant and it is supposedly where the toothpick was invented.

Omni Parker House Hotel: Speaking of things being invented, the Boston cream pie and the Parker House roll were both invented here. It's also the oldest hotel in America. It has a haunted hotel room and is where Malcolm X used to be a bus boy. John F. Kennedy announced his candidacy for Congress in the hotel's Press Room and held his bachelor party here. JFK proposed to Jackie Kennedy at Parker's Restaurant (at table 40). Charles Dickens lived in the Parker House for 2 years. If you want to eat the "original" Boston cream pie, go here, but else it's not really that great, and kind of overpriced.

Haymarket: You can get cheap produce from sunrise to sunset every Friday and Saturday. It's super exciting. Bring cash, expect to hear a lot of yelling, and don't touch the produce (or you will get yelled at). Tell them how much you want and they will bag it for you. This is not a true Farmer's Market, however, since the produce is left over from what the grocery stores didn't sell. It needs to be eaten quickly.

Christian Science Center: In their visitors' center you can go inside the Mapparium: a huge reverse-projected globe that you walk into while they play music from all over the world. The projection used creates the perspective as if you were looking at a globe from the outside, and the amazing acoustic effects of standing inside a globe alone are worth the price of admission. Try to stand in the very center and talk—it's awesome.

Blue Man Group is a really fun show to see in Boston's theater district.

Shear Madness is an interactive play that shows in Boston. It's a mystery story that makes fun of Boston. It's really funny and a must-see before you leave the city.

Boston Museum of Science. Also I would highly recommend seeing a documentary in the Mugar Omni theater. They project the image onto a huge sphere that you sit in and look up at. The movie extends beyond your periphery. They have a cool planetarium and a laser light show as well.

The Boston Symphony is amazing. If you show your BU ID at the student events desk in the George Sherman Union, you can get a BSO College Card, which gets you free tickets to weekday BSO concerts during the normal classical season. You have to take your College Card to the box office at Symphony Hall to get your tickets for a particular concert the week before. In past years (hopefully they will keep this up), thanks to an anonymous donor, you can also get a huge discount on great seats to weekend and Boston Pops concerts if you are under 40 years old.

Museums:

Isabella Steward Gardener Museum (a Venetian palace museum; they have free piano concerts there)

MIT Museum (lots of moving mechanical exhibits that are really cool)

Children's Museum (free on Friday nights and open late)

Institute of Contemporary Art (ICA—a modern art museum that's free every Thursday nights)

Harvard Museum of Natural History ($9 admission)

Transportation Museum, MFA (Museum of Fine Art, BU IDs can get you in for free)

JFK Presidential Library in South Boston (amazing and huge)

The bad art museum in Davis Square (yes a museum actually collects and displays bad art and advertises it as such…it's amazing)

Music venues:

Paradise Rock Club (near campus (967 Comm Ave.), gets some great acts and tickets are typically $15-25)

Brighton Music Hall (Allston, gets some good acts and tickets are typically $15-25)

House of Blues (Kenmore, gets some big acts, tickets typically $35-60)

Agganis Arena (On campus, Gets big acts, tickets typically more expensive ~$50)

Boston Symphony (mentioned previously)

Boston Calling Music Festival (near the Government Center T Stop, started in 2013).

Jordan's Furniture: Cool year-round. It's aforementioned theater has the most comfortable theater seats you will ever sit in: basically leather armchairs made with memory foam. They also have jelly bean villages with statues made of jelly beans, trapeze artists (you can pay for trapeze lessons), fountains with lights ("liquid fireworks")—just crazy random things that have nothing to do with furniture stores. Of course you have to walk through the store and see the furniture to get to the theater (so don't come late—it's like a maze). There are two locations near Boston: Reading, and Natick. You will need a car to get there.

Volunteering: BU's Community Service Center is a good place to start (offering both long-term involvements and also one-time service projects). Boston Cares requires attendance at an orientation and a joining fee (currently ~$10), but offers a far wider range of one-time service projects. Science Club for Girls and the Museum of Science have also been popular organizations for which to volunteer.

Transportation

Boston is a very compact city for its size, and the city is well-served by its public transport network of subways (colloquially, the "T"), buses, and even ferries (you can catch one to Logan Airport from Long Wharf). Public transit in Greater Boston is operated by the Massachusetts Bay Transportation Authority (MBTA), online at mbta.com. Schedules and real-time vehicle tracking are available on Google Maps, NextBus.com, and a plethora of smartphone apps.

Owning a car has its advantages, but it can also be expensive and a hassle. The city of Boston proper has on-street resident permit parking (cityofboston.gov/Parking/residentparking), but across the city line in Brookline, there is no overnight on-street parking. Parking spots are rarely included with apartments in Boston and monthly rates to rent them are typically $100/month or more. Other transportation options include car sharing through Zipcar (zipcar.com), which is convenient both for grocery runs and day trips outside of Boston. The bike sharing network Hubway (thehubway.com) is also an option, although currently, most of its bike stations are concentrated closer to downtown.

Fitness

Gym

A membership at the BU Fitness and Recreation Center (FitRec; bu.edu/fitrec) is included for graduate students. Besides FitRec classes and individual workouts, there are regular intramural department teams in softball, soccer, and volleyball.

Running

The Charles River (mass.gov/dcr/parks/charlesRiver/brochures.htm), both the south (Esplanade) and north sides, has bike paths and dirt tracks suitable for running. Both are scenic and heavily used near the city. The authorities, however, advise caution after dark, particularly on the South side, which is isolated by Storrow Drive.

The Emerald Necklace (emeraldnecklace.org/static/filelib/ENC_Eng_reprint_FINAL_091610_page_2.pdf) is a chain of parks that runs South from Kenmore Square through the Fens and provides miles of scenic urban/park running. If you wander too far south, however, nighttime caution is again advised.

The Chestnut Hill Reservoir in Chestnut Hill (near Cleveland Circle at the end of the Green C line) has a running path that takes about 8-10 minutes for one lap.

Road biking

Landry's Bicycles and the International Bicycle Center are quality shops on Commonwealth and Brighton Avenues, respectively. EMS and REI are often more affordable, if less knowledgeable. Boston bike maps are available at most bike shops.

The Charles River Wheelmen (crw.org, co-ed) have group rides and an extensive lists of good area rides.

Hiking/mountain biking/trail running

The Middlesex Fells Reservation (or "the Fells"; mass.gov/dcr/parks/metroboston/fells.htm) and Blue Hills Reservation (mass.gov/dcr/parks/metroboston/blue.htm) are good options close to Boston. ("Reservations" are the Massachusetts equivalent of state parks, operated by the Massachusetts Department of Conservation and Recreation, or DCR.) The Fells has towers you can climb and see beautiful views of the city. For bigger peaks and more extreme weather, most of the White Mountains are about a two to three hour drive. Mt. Monadnock in NH is one of the most famous hikes. The Appalachian Mountain Club (AMC) maintains huts, trails, campsites and an invaluable trail guide, "The White Mountain Guide" (indiebound.org/book/9781934028445).

Rock climbing
BU FitRec has a climbing wall; MetroRock (metrorock.com) is the more serious indoor option.

Skiing
Most of the DCR parks are good for cross country skiing in snowy years. There is a short groomed track at the golf course in Weston (skiboston.com) for groomed and skate skiing. For downhill, Wachusett Mountain is the closest medium-sized mountain. Sugarloaf in Maine, which is a 4 hour drive from Boston, is the largest ski area east of the Rockies.

A grad's personal life—got kids?
Getting married, divorced, losing a family member, or having a child are things that can "happen" to a graduate student and not all life events can be planned. It's important to remember that you are human and that there are priorities in life other than your research. A leave of absence (unpaid, sadly) can help a grieving student or new parent, but it is also important to get the support of your advisor.

If you have or are planning to have children, it helps to tell your advisor. There are no standardized maternity/paternity leave policies or childcare benefits available on the BU campus for students. Historically, each department has dealt with their graduate students with families on a case by case basis. However, you could negotiate some sweet deals with your boss. Some include:

a few weeks off to care for a newborn,

local lactation facilities by recycling an empty room,

the option of working from home for days when you need to be there for your dependents,

excessive use of the coffee machine.

BU offers students a local referral package that provides a list of names of family-care and day-care centers near campus. They are all wicked expensive when compared with your stipend. The most affordable to date is the BU daycare center, and its reviews are pretty decent. There is a long waiting list and you will be competing with faculty and staff who use this facility as well, so put yourself on that list as soon possible.

Get in touch with your local student organizations such as BU's GWISE (Graduate Women in Science and Engineering)—they aren't just for women—and the GSO (Graduate Student Organization). They have been working relentlessly over the years with the Deans and Provosts to provide benefits and standardized policies to students with kids. By the time you read this, some changes may have happened!

Healthcare

Insurance/Plan Options

Part of your support from the university either for being a Teaching Fellow or a Research Assistant includes the Student Basic Health Insurance. You are required by the university as well as Massachusetts' individual mandate (yes, *that* individual mandate, aka Romneycare) to have at least a basic level of health insurance coverage. If you have qualifying health insurance from some other source (the most common sources are through another job, your spouse's job, or your parents) and would rather not have the secondary insurance, you may waive the BU student Basic health insurance. If you do not waive the health insurance, the cost that BU pays for it will appear on your W-2 (along with the rest of the stipend). If you would prefer the Plus plan, you can upgrade from the Basic plan by paying the difference in the yearly premium. You can also extend coverage to spouses and/or dependents by paying the additional premium cost. These actions can be done using the Student Link. Please read the document describing the Health Insurance coverage levels (available at https://www.aetnastudenthealth.com/stu_conn/student_connection.aspx?GroupID=711110) before deciding if you want to stick with the Basic plan, upgrade to the Plus plan, or consider a third option. **You have until September 30, 2013 to waive or upgrade.**

We do not have the very best, fanciest health insurance at the Basic level. There is a staff member at Student Health whose job it is to answer insurance questions. You can contact them using Patient Connect, through the Student Health Services website, if you think they can help you with your decision.

The BU health insurance covers most physical and mental health issues. It does *not* provide non-emergency dental coverage. *Only* the Plus plan covers vision exams, other than those as part of a standard physical. The Aetna Vision Discount Plan (which is not insurance, just a discount plan), however, is available to all enrollees in an Aetna Insurance plan. This means that some places will offer you slightly discounted services and corrective lens options, but this does not count towards your out-of-pocket maximum and you will have to pay for the full amount billed.

Options for dental coverage are to sign up for the "Vital Savings" Dental Discount plan from Aetna for $25/year for just the student (*new* in 2012), which is also not insurance—just a discount plan (similar to the vision discount plan—which is included in either the Basic or Plus plan), *or* to sign up with the BU Dental School's Student Dental plan. There is no law requiring dental coverage, so you can also just visit dentists as needed. (This can be a painful option.) The Vital Savings plan is new, so no one will have any feedback about how much they save vs. the $25 sign up fee. The student dental plan involves having a dental student in their 3rd or 4th year of the program in the BU Dental School assigned to you, and they will perform all of your cleanings, cavity fillings, and other tasks that a general dentist would perform. These services take longer than with a certified dentist because they have to have the instructors check out their work throughout the visit and sign off on it. Braces and other dental care not covered by the yearly fee are also offered to enrollees at significantly reduced prices than they would be from a certified dentist.

Survey results from the overall Graduate School of Arts & Sciences were largely negative about the Student Dental Plan, though some people have found the

affordability of coverage outweighed the long wait times and other inconveniences and did appreciate the service.

Healthcare Providers

If you have the BU Health Insurance, you can get most health services provided at Student Health Services (SHS) without having to pay additional amounts! It is possible to make some appointments with SHS online, but for other types you will have to call. Appointments can only be made for the next up-to-three days that SHS is open. You can also try to walk-in in case of emergencies.

Unless you are traveling, if covered by the BU Basic health insurance you should almost always try to visit Student Health and get a referral before going to another doctor. (There are some exceptions, please see the insurance brochure for complete details.) If you go to another doctor without a referral, the BU Basic insurance may not cover it as well or possibly at all, except in cases of emergencies or for the other exceptions.

Once you are done with your visit to student health, please check out at the front desk to find out if you need to pay anything. If you have external health insurance, Student Health will treat you the same as a student covered by the BU health insurance, but you may end up having to pay more for the services. Externally-provided insurance may or may not cover Student Health provided care as readily or as well as the BU health insurance, though, or possibly as well as it covers other services from care providers. Please consult with your health insurance provider about your best choices for care before it becomes an issue.

If you are referred to external health providers, make sure that SHS is referring you to a provider that is in-network when possible. This makes a big difference in how much the insurance will cover of your bill. Just say “Is this person in-network for BU Aetna health insurance?” When making the appointment with the external care provider, ask the same question.

After these visits you will receive an “Explanation of Benefits” (EoB) from Aetna describing how much you ought to be billed for, generally followed by a bill by the provider. The EoB is NOT a bill, though if you notice discrepancies in it from what you believe ought to be the case based on the insurance brochure, make inquiries as soon as possible. You may receive a separate EoB and bill for the health care provider and the hospital or other organization that the provider is based out of.

Research in the Astronomy Department

Overview

The department courses are great and essential, but sooner or later (and hopefully sooner), you'll want to get started on what you came here to do—to get research done so you can write your thesis and get your PhD.

What is space physics, anyway?
Judging by an informal poll, this is probably one of the least understood aspects of the department for incoming grad students.

Scientifically speaking, space physics is the study of anything within the solar system. The sun, planets, their atmospheres, ionospheres, and magnetospheres—these fall within the bounds of space physics.

In a sense, this isn't a scientifically meaningful distinction; most people wouldn't think to make a division between "astronomy" and "space physics". How this subfield of astrophysics became to be known as space physics is somewhat an accident of history.

Historically, space physics as a discipline was born in the satellite era in the 1950s. For the first time, scientists could get *in situ* measurements of the space environment. It was only then that the complex, open structure of the Earth's magnetic field was discovered, and its interaction with the sun's magnetic field and effects like aurora were understood to be linked.

There is a wide variety of research going on in our department. This includes work that is observational and computational in nature, and ranges across the fields of planetary to stellar, galactic to extragalactic, with a large dose of instrumentation.

When it comes to data collection, in the most general sense, it can be said that researchers affiliated with IAR are more likely to use telescopic observations, while researchers affiliated with CSP are more likely to collect *in situ* measurements. Expertise in the design and construction of instruments is a particular strength of our department, both ground- and space-based. Our observing time on the Perkins and Discovery Channel Telescope makes up a key component of many groups' observational campaigns.

Other instrumentation projects include designing instruments for NASA missions and constructing payloads for sounding rocket missions. Due to the instrument-heavy nature of space physics, several faculty and students also have links to the School of Engineering, either by affiliation or collaboration.

Funding, again

We all want to do exciting research for an advisor who inspires us, funds us, and has a working style that is compatible with our own. But although everybody is accepted to the program with the expectation that *a* faculty member will be able to fund you, there is no guarantee that your dream advisor will be the one.

In general, your odds of getting to work with the advisor of your choosing and on the research project *you* want to work on will be significantly increased if you are able to secure your own funding from an outside source in the form of a graduate student fellowship.

In astronomy, the two biggest graduate student fellowship programs are from the National Science Foundation (NSF) and NASA, and many more are available from various foundations. **The best time to apply for these fellowships is in the fall of the first year**. This is when you are eligible for the most scholarships. Yes, that's right—you've just arrived, and you should already be thinking about developing a research proposal!

In fact, most fellowships intended for graduate students accept applications only from first and second years. Applying as a first year is highly recommended as even if you are not accepted, you may get valuable feedback for revising and resubmitting your application in your second year.

Most applications require at least one letter of recommendation—some require two to four. You will also need to include things such as a proposed research project, a CV, previous research experience, and various other essays, depending on the specific fellowship. The bottom line is: *Start working on your application early*! You can't put the whole thing together in a few days or a week (especially if you need recommendation letters from other people). Make sure to give your recommenders plenty of notice if you want a letter (one to two months is the standard) and follow up with them so they don't forget. (This may require multiple follow-up emails—remember, academics are extremely busy and get a high volume of email!) It is also a good idea to provide them with a CV and any essays you have written for the application so they will have a better idea of what research you plan to do and can write a more personalized letter.

The following is a list of fellowships you can apply for, grouped by approximate deadlines. Check the websites for each fellowship to find the exact deadline for the year you wish to apply, along with the application details.

List of Some Common Fellowships

October

Hertz Foundation Fellowship
hertzfoundation.org/dx/fellowships/award.aspx
Requirements: US permanent resident or citizen, within first two years of starting graduate school
$31K/yr for 5 years + Travel expenses
~15 given, probably the hardest to get

November

NSF Graduate Research Fellowship Program (GRFP)
nsfgrfp.org
Requirements: US permanent resident or citizen, within first two years
$30K/yr, 3 years + Travel expenses
~1000 given

NAS Ford Foundation Predoctoral Fellowship
sites.nationalacademies.org/PGA/FordFellowships/index.htm
Requirements: US citizen and preferably a racial minority, within first two years
$20K/yr, 3 years + Travel expenses
~60 given

NAS Ford Foundation Dissertation Fellowship
sites.nationalacademies.org/PGA/FordFellowships/index.htm
Requirements: US citizen and preferably a racial minority, must be at a later stage in grad career
$21K/yr, 1 year
~60 given

National Physical Science Consortium
npsc.org/Applicants/Applicants/fellowshipinfo.html
Requirements: US citizen, if you receive the fellowship you need to work at a national lab over the summer
$20k/yr, up to 6 years

DOE Office of Science Graduate Fellowship
scgf.orau.gov
Requirements: US citizen, within first two years
$35K/yr + $5K/yr, 3 years + Travel expenses
~300 given

DOD SMART
smart.asee.org
Requirements: US citizen, requires 1 yr of post-PhD employment commitment for each funded year
$25K-$41K/yr, up to 5 years

December

National Defense Science and Engineering Graduate Fellowship

ndseg.asee.org
Requirements: US citizen, no later than second year
$31K/yr, 3 years
~200 given

February

NASA Earth and Space Science Fellowship (NESSF)

nspires.nasaprs.com/external (click "solicitations")
Requirements: open to *all* students accepted or enrolled full-time at accredited U.S. institutions; however, U.S. citizens and permanent residents will be given preference
$30K/yr, one year, renewable for 2 more years

Note that Jan Marie Andersen (janmarie@bu.edu) has received various fellowships including NSF and Fulbright, and is the self-declared fellowship application consultant for the department. Contact her if you have any questions about applications (especially NSF), want any help writing/proofreading your essays, or anything else.

Predoctoral programs

These are programs designed to help you explore research interests that are parallel to research being conducted at BU. They offer the opportunity to build your network and conduct research off campus with various professionals.

Harvard–Smithsonian Center for Astrophysics (Cambridge, MA):

cfa.harvard.edu/opportunities/fellowships/predoc
Due: varies

Lowell Observatory (Flagstaff, AZ):

Contact Lowell staff for more information (lowell.edu/contact.php)
Due: varies

Finding an advisor

Finding a research advisor is your own responsibility. You are expected to take the initiative and find an advisor to work with who has a project you can work on and money to fund you. (If you have your own funding, this part will be a bit easier, see the Funding, again section, above.)

In an ideal world, you would have both an advisor with whom you get along and work well with, in addition to having research interests that blend well with your own. However, in reality, you can't always be so picky. Which of these things is more important is up to the individual student. Below is a list of suggestions to help you find an advisor.

Make a list of priorities: Do you need someone that will supervise you well and often, or are you more comfortable with someone that will give you space and let you work at

your own pace (or will that arrangement result in you watching hours of YouTube videos and not getting any work done)? Do you absolutely need to do astrophysics, or would you be open to space physics research as well? Do you want to do instrumentation or something more hands-on? Do you want to do a lot of observing? Figure out what things are important to you and write them down.

Talk to other grad students: Ask the older grad students what they do and who they work with. It's one thing to read the faculty "research interests" online (bu.edu/astronomy/research/astronomy-department-research-highlights), but another thing entirely to find out what kind of projects they actually have their students doing. Ask what their advisor is like. This is the best way to find out how much one-on-one time you are likely to get, how much supervision you can expect, how quickly you will get help and feedback, and if there are potential personality clashes. Most students can also tell you if their advisor is looking for new students or has the funding for another student. Also, they will (maybe) tell you if they hate their advisor and their life (this is rare).

Meet with faculty members: Choose a few professors that you think are good potential advisors. Email them and ask if there is a time you can get together and talk about their research. *Do not* send a mass email to every professor in the department telling them you might want to work with them. Professors talk, and this could just annoy them. It will also not benefit you since you will eventually need to narrow down your list, anyway. Keep it personal. Even if you don't make a physical list of priorities, you should have some idea of what you're looking for. Research the professor and their recent publications and come in with a list of questions before you talk to them.

Go to the pub, journal clubs, seminars, Friday Social Hour, Unplugged, etc. The more interaction you have with the faculty, the better they will know you and (hopefully) like you. This is important not just for courting potential advisors, but for your entire graduate school career—and your postgraduate job prospects (networking!). Journal club and seminar will also expose you to research topics that you might not have considered.

How to break up with your advisor

Many students end up with a different advisor that the one they start out with. If you are a TF in your first semester at BU, take the time to shop around for a research advisor. You should have a list of ~3 that offer projects you feel you can spend the next 5–7 years working on. Talk to prospective advisors, talk to their students and post-docs, talk to administrators to see if they are people you would click with. Ask them about their funding availability, their current and future projects, your research interests and how that may intersect with theirs.

If you are an RA in your first semester and you love what you do, then great! You can move along to another section in the handbook. If you find yourself working on a research project that you just don't see yourself working on for the next 5 years, first see if there is an alternative project you can work on with the same advisor. If not, then follow the same advice as that given to a TF above and find something you would like to do for a few years.

It's fine to experiment with different advisors and summers are a great way to do that if you are a TF in the fall and spring. By the end of your second year, you typically

want to settle down with an advisor for the remainder of your graduate tenure. If you do make the switch from one advisor to the next, be honest about why you are leaving (not the research you feel you can do long term, does not have enough funding for a continued career post graduation, your interests lie in another field, etc.). A graceful way to do this is to TF in between RA positions. If you don't have the time for that, just transfer directly in the next semester. It's your career, your future, your decision.

Astronomy Department Faculty Research Interests

Thomas Bania: Radio spectroscopy; galactic structure, and interstellar medium. Major projects include the Green Bank Telescope H II Region Discovery Survey.

Elizabeth Blanton: High-energy astrophysics, optical and NIR observational astronomy, clusters of galaxies (specifically cooling flows and AGN feedback in the cluster), radio galaxies, galaxy formation and evolution, and cosmology.

Tereasa Brainerd: Theoretical astrophysics, cosmology, computational astrophysics, galaxy formation & evolution, astrophysical applications of gravitational lensing, dark matter, dynamics and locations of satellite galaxies, faint galaxy clustering.

Kenneth Brecher: Neutron stars, theoretical high-energy astrophysics, cosmology and relativity, history of astronomy, astronomy education, psychophysics of visual perception.

John Clarke: Planetary atmospheres (specifically aurorae on Jupiter and Saturn, as well as the escape of the Martian and Venusian atmosphere), UV astrophysics, FUV instruments for remote observations.

Dan Clemens: Galactic structure, interstellar medium, star formation, infrared and optical astronomy, instrumentation. Major projects include the Galactic Plane Infrared Polarization Survey (GPIPS), which is an effort to map and study the magnetic field of star forming regions in the Milky Way.

Nancy Crooker (Research Professor): Heliospheric and solar–terrestrial physics, particularly: coronal mass ejections, the structure of the heliospheric current sheet, and the magnetic flux budget of the heliosphere.

Catherine Espaillat: Planet formation, structure and evolution of protoplanetary disks.

Theodore Fritz: Space plasma physics, magnetospheric physics, magnetosphere-ionosphere coupling in the atmospheres of planets, with a focus on Earth, substorms, charged particles and compositions, rocket and satellite experiments. Many of the projects involve providing hardware for the rockets and satellites.

W. Jeffrey Hughes: Space physics, solar wind-magnetosphere-ionosphere coupling, and dynamics.

James M. Jackson: Radio, infrared and sub-mm astronomy, interstellar medium, starburst galaxies, star formation, the Milky Way, Antarctic astronomy.

Kenneth Janes (Emeritus): Observational optical astronomy, galactic astronomy and stellar photometry, star clusters, stellar population of the galaxy, stellar activity, planet searches, photometric rotation rates and deriving ages based on stellar spin-down.

Svetlana Jorstad (Senior Research Scientist): Multifrequency monitoring of blazars.

John Lyon (Research Professor): Space plasma physics and magnetospheric physics, numerical simulation, and computational physics. He is a full-time faculty member at Dartmouth, so spends much of his time there.

Alan Marscher: Quasars, active galaxies (AGN, specifically blazars), high energy astrophysics, fine structure of interstellar clouds, galactic and extragalactic astronomy, radio, infrared, x-ray, and gamma-ray astronomy, black-holes, jets. Telescopes used currently include the Fermi Gamma-ray Space Telescope, the Very Long Baseline Array (VLBA), and the Swift satellite observatory. See http://www.bu.edu/blazars/AlanMarscher.html for more info.

Carlos Martinis: Electrodynamics of the equatorial and low latitude ionospheres. Uses all-sky imagers, FPI's and various theoretical and empirical models.

Michael Mendillo: Space physics, planetary atmospheres, observations and models, planetary exospheres.

Philip Muirhead: Exoplanets around low-mass stars, designing and building IR instruments, precise radial velocity techniques.

Merav Opher: Space physics, heliophysics, effects of stellar activity on exoplanet habitability, computational and theoretical plasma physics in space and astrophysics, magnetic field processes in space physics and astrophysics, interaction of stellar systems with the interstellar medium (with a focus on using data from the Voyager satellites), magnetic interaction of extrasolar planets with their host stars, solar wind, shocks in the lower corona, T-Tauri and solar-like stars.

Meers Oppenheim: Computational and theoretical space plasma physics, ionospheric and meteor science.

Joshua Semeter (Engineering Faculty): Ionospheric and space-plasma physics, radar signal processing, spectroscopy of atmospheric airglow and aurora, optical sensors, image reconstruction and tomography. Professor of Electrical and Computer Engineering.

George Siscoe (Research Professor): Space physics, including the solar wind, magnetospheres, and space weather.

Andrew West: Kinematics, distribution and magnetic activity of low-mass stars, metallicity, structure and evolution of the Milky Way thin disk, nearby galaxy evolution, magnetic field generation in and internal structure of M and L dwarfs.

Paul Withers: Upper atmosphere and ionosphere of Mars and Venus, using lander accelerometer data to study neutral atmospheres.

The above list is just a starting point. For more information, you should contact the professor whose work you are interested in and talk to them about what they're currently working on, as well as if there's a place for you in their lab.

Other resources on current research

In the fall of 2011, the Astronomy Department held an internal research symposium. It featured presentations by the professors and posters presented by the graduate students and post-doctoral researchers. PDFs of the posters and presentations are available on the department website (bu.edu/astronomy/events/astronomy-research-symposium). This is one of the most up-to-date resources on current research in the department.

You might also be interested in perusing the annual reports of the Astronomy Department, IAR, and CSP. They can be found online on each entity's respective website. The most recent reports available are linked below:

Astronomy Department (FY 2011): bu.edu/astronomy/files/2011/07/astronomy-annual-report-2011.pdf

IAR (FY 2012): bu.edu/iar/files/2012/07/iarannrep12.pdf

CSP (FY 2012): bu.edu/csp/files/2009/10/FY12-CSP-Annual-Report.pdf

Department research facilities

The Astronomy Department has a long-standing partnership with Lowell Observatory in Flagstaff, AZ. The BU–Lowell partnership is detailed at bu.edu/iar/current-research-activities/boston-university-lowell-partnership (note: some links are dead). The Lowell Observatory Telescope Schedule is online (www2.lowell.edu/rsch/telsked/index.html)

BU has 60 nights on the 72" Perkins Telescope for internal use; time is allotted on a quarterly basis. Most recently the allocation process was coordinated by Prof. Marscher. Instruments include Mimir (an IR detector; more info at people.bu.edu/clemens/mimir) and PRISM (optical; more info at bu.edu/prism). Student proposals are encouraged.

BU is also a partner on the Discovery Channel Telescope (DCT), Lowell Observatory's new 4.3 m flagship telescope. It saw first light in spring 2012 and the first shared-risk science observations are expected in the spring semester of 2013. As announced in an October 2011 press release, "The agreement in perpetuity grants BU astronomers use of the world-class, four-meter telescope for 40 or more nights each year." (lowell.edu/news/2011/10/lowell-observatory-boston-university-announce-discovery-channel-telescope-partnership)

Other telescopes and facilities that people can propose to get time on or use data from include the following:

Kitt Peak: The National Optical Observatory. 4 m and smaller optical observatory. BU is a member of the Association of University for Research in Astronomy (AURA) which administers Kitt Peak. Used by the Blanton group and West groups.

Chandra: X-ray telescope run by NASA. This telescope is used by the Blanton group.

X-ray Multi-Mirror Mission–Newton (XMM–Newton): X-ray telescope run by the European Space Agency. Used by the Blanton group, although not as much as Chandra.

Spitzer Space Telescope (SST): IR telescope run by NASA. Its supply of coolant has run out and it is currently operating in a limited warm phase. The mission will most likely end in a few years; however, a wealth of data will still be available. Used by Jackson, Bania, Clemens, and Blanton groups.

Sloan Digital Sky Survey (SDSS): West, Brainerd groups

Hubble Space Telescope (HST): Clarke group

Atacama Large Millimeter Array (ALMA): The biggest interferometer ever! Scheduled to become operational in 2013. The Jackson group has time on one of the first projects.

Combined Array for Research in Millimeter-wave Astronomy (CARMA): Interferometer. Used by: Jackson group

Green Bank Telescope (GBT): 100 m radio telescope. Used by: Bania, Jackson groups

NASA InfraRed Telescope Facility: 3 m IR telescope on Mauna Kea, and the designated US national facility for IR astronomy. We have some guaranteed time as we supplied an instrument long ago (MIRSI). Used by: Jackson group

Kraken: The fastest academic supercomputer in the world, housed at Oak Ridge National Laboratory. Used by: Oppenheim group

Very Long Baseline Array (VLBA): Radio Interferometer used for high-resolution imaging. (Bigger than ALMA!) Currently on the NSF chopping block, but signs are hopeful this will not happen. Used by: Marscher group

Fermi Gamma-ray Space Telescope: Used by: Marscher group. Marscher is currently chair of the Fermi Space Telescope Users Group.

Conferences (go to them!)

Printing posters

Jeff Sanborn is in charge of printing posters. Make sure you let him know a few days in advance of when you need to print posters. He will usually send out an email to the department before the major conferences (AAS winter and summer, AGU) regarding his deadline for sending him your poster. Make sure you get it in *before* his deadline!

Travel booking and reimbursement

Alyson Savoie (asavoie@bu.edu) in the research support office (Room 506) is in charge of all things travel-related.

Popular conferences

The following is a list of some of the most popular conferences regularly attended by researchers in the department.

AAS
American Astronomical Society; summer and winter

AGU
American Geophysical Union; fall

DPS
Division of Planetary Sciences of the AAS; October

CEDAR
Coupling, Energetics and Dynamics of Atmospheric Regions; a conference for everything terrestrial–space physics related

COSPAR
COmmittee on SPAce Research; held every other year in awesome locations

There are many smaller conferences that specific groups attend, including:

SHINE
Heliophysics: Opher, Hughes groups

Cool Stars
Low mass stars: West group

Academics

Registration

You have to register for classes before the beginning of every semester. For your first semester, please see the Director of Graduate Studies (currently Prof. Oppenheim) and he will advise you on your course selection. You will then fill out a registration form, and take this to the Department Administrator in CAS 514. The administrator will register you online. You will also need to fill out a financial support form, which indicates whether your salary is coming from a teaching fellowship or from a research grant. In future semesters, the Director of Graduate Studies will meet with you about 2/3 of the way through the semester to discuss your courses for the next semester.

Some other registration forms that you will encounter are the Certified Full-Time Form and the Summer Research form. You need to fill out the Certified Full-Time form if you are registering for less than 12 credits (not uncommon). The Summer Research form should be filled out during the spring semester of each year to certify you as a full-time student over the summer (if you are doing research) for tax purposes, even though you are not taking classes.

When you are all done with your required classes and are just doing research for your thesis, you will turn in a form called a Continuing Student Status form instead of the normal registration forms. This form allows you to keep your Student status without taking classes for credit while you work on your thesis.

The Department Administrator will get the registration process started. He will put all the necessary forms in your mailbox and let you know when they are due back to him. However, you will need to have all of these forms completed on time in order to get paid, so if you don't see any forms or an email about registration after □ of the semester, ask!

Taking courses outside of the Astronomy Department

There are two ways to approach taking classes outside the department. The easiest is if you are registered for 12 credits or more—this makes you a "full-time student" by virtue of courseload in the eyes of the University, and you are free to register for any other course offered to graduate students without the department having to shell out more tuition money on your behalf. If you have this goal in mind, the director of graduate studies may be able to help you arrange your schedule accordingly—signing up for research credits and/or seminar credits can boost your credit count. Many

people have taken advantage of this approach to take phys. ed. courses in their free time, or to branch out and take courses in other departments that may be valuable for scientific careers, such as the Science Journalism department.

However, registering for 12 credits becomes more difficult when you are a post-comps student taking fewer classes. (So take advantage of the free yoga classes while you can!) In that case, if there is a specific class you would like to take that is pertinent to your research, you can go through the department administration to work it into your degree program. This has been done in the past, particularly with courses in engineering that are useful for instrumentation projects. You need to request that the course be counted, and preferably do so *before* the semester starts in which you'll be taking the class. It should be in the form of a letter to the director of graduate studies in which you describe why you want to take the course. You should also mention if anyone else has previously taken it to fulfill post-comps course requirements to strengthen your case.

Financial aspects

You can track your tuition, fees, pay stubs, and all aspects of your account and employment on Student Link (bu.edu/studentlink). Everything mentioned in this section can be found under the "Money Matters" or "Work" tabs. The Department Administrator can help with any questions regarding fees or employment, though he cannot give you tax advice.

Payroll

You should sign up for direct deposit on Student Link as soon as you can. There is a link for "Direct Deposit Authorization" under the "Work" tab that will take you to the BU Works site. You may have to click through several menus before getting to Direct Deposit. Look for the "Employee Self Service" tab, and then click on "Benefits and Pay." You should find a link for direct deposit here. (You can have your check deposited to more than one account and even bank, if you are splitting it between checking and savings, for example!) Paychecks are issued every Friday, and you can check your pay stub on BU Works by clicking through from Student Link.

Your pay will probably vary throughout the year. Teaching Fellows are paid one rate that is uniform throughout the university. It has been the case in the Astronomy Department for years, however, that Research Assistants get slight raises (~$200 per year) after passing comps and then again after passing the oral exam. Make sure that when you pass an exam you see an increase in your salary or check with the Department Administrator to see if this is no longer the policy. If you are a Teaching Fellow, you will not see these raises in your paycheck; however, if you are also working with a research advisor, you can ask that they cover the difference.

Every semester you will get an offer letter in the mail that you will need to sign and turn in to Financial Aid, which specifies how much your semester's stipend will be. The base pay this year, approved by GRS, is $9,900.00 per semester.

The logistics of payroll tend to fluctuate from year to year. Occasionally, the stipend-per-semester amount will be raised at the beginning of the fall semester, which it has

historically stayed at until the next fall semester (unless you pass an exam and get a raise). On top of this, the university presently pays students their stipend rate-per-week, with the number of payments per semester's stipend varying throughout the year. For instance, in 2011–2012, this was 19 payments in the fall semester, 18 in the spring semester, and 15 in the summer; for 2012–2013, it was 17 weeks for fall and spring semesters. In the 2012–2013 school year, a first-year pre-comps TF/RA might expect to receive about $382.35 per week before taxes and other deductions.

Taxes

Taxes are automatically withheld from your paycheck. The scholarship that covers your tuition does not count as income, and is not taxed. The money that is used to pay your insurance, however, does count as income. These are based on your W-4 and M-4. You can file a new W-4 and new M-4 if you find that you have been over- or under-withholding for either or both of federal or state taxes. Your health insurance costs will appear on your W-2 along with the rest of the stipend.

FICA

FICA taxes are Social Security and Medicaid. These taxes are matched, at least partially, by the employer. Employees whose primary affiliation with their employer is "student" (enrolled at least full time and employed only part-time, which grad student stipends declare us to be) are exempt from these withholdings. During the fall and spring semesters, provided that your registration has gone through properly, FICA taxes will not be withheld. If you start working for the department before you start taking classes, FICA taxes will be withheld for this time period (if you start doing research in July and start your first year of classes in September, FICA will be withheld for July-August.) For summers after you have started taking classes, make sure to fill out "Certification of Full Time Status" form. If you fill out that form and have no compliancy issues (check student link under "personal"), at best you will not see FICA withheld. At worst you will see FICA withheld and then eventually get paid back that amount, which has happened in October in some years and 2 weeks after it was withheld in other years. (This varies year-to-year. In Summer 2012, FICA was not withheld if you are certified as full-time.) Find out if other students are seeing Social Security and Medicaid withholding on their checks. If there are differences, approach the Department Administrator about it.

Fees

On Student Link you can check your Student Account, which shows all of your paid and outstanding fees. Some of these are paid by the Graduate School of Arts and Sciences (GRS) as part of your fellowship (provided you have one), and some will be your responsibility. Note that if you have an outside fellowship (such as the NSF or NASA NESSF) and it does not cover all of the tuition and fees usually paid by GRS, you can ask the Chair to petition GRS to cover the remainder. Provided the fellowship is sufficiently prestigious, these petitions are generally granted.

Fees GRS will pay:

Tuition: Your fellowship that will cover this, provided you are a TF or an RA.

George Sherman Union Fee: Your fellowship will also cover the union dues.

Medical Insurance—Basic Plan: This will be charged once for the year, but will be paid in two installments, once each semester. You may see an outstanding balance for this during the fall semesters, but it will be paid by your teaching fellowship or research assistantship and will not count against your compliance status. You have the option to enroll in the Student Plus plan, which has more coverage, but you will need to pay the difference in the premium up front in the fall. Further information on this plan and other health options can be found in **Life in the Astronomy Department > Healthcare** in this document. Even though it will not count against your compliance status, you should pay this difference off by the Fall to avoid late fees.

Fees you will need to pay:

Health Services Fee: "This is a mandatory fee charged to all Charles River Campus graduate students on a per-semester basis to defray the costs of services at the Student Health Clinic located on campus," as stated at Student Accounting Services' website (https://www.bu.edu/studentaccountingservices/your-bill/tuition-fees). This fee is currently $112 (Fall 2012) and is charged each semester.

Sports Pass (optional): This is optional, but it will automatically be charged to your account when you register, and you will need to decline it on Student Link if you don't want it. You may have to do this every semester you register. The pass is currently $115 (Fall 2012), and allows you into all BU athletic events, including hockey and basketball games, during the year. If you don't have a pass, you will need to buy tickets to sports games.

MBTA pass (optional): The public transport network in Boston is operated by the Massachusetts Bay Transportation Authority (MBTA). You have the option each semester of purchasing a four-month pass for local bus and subway service at a modest (10%) student discount from the standard monthly price. Unlike the Sports Pass, you have to opt-in to purchase it.

You can pay these fees through Student Link.

Course Requirements (as of Fall 2012)

For students who enter post-bachelors

Students who enter our post-bachelors PhD program are required to take a suite of 16 courses, for a total of 64 credits. A grade of B- or above is required for passing every course. The course requirements are as follows:

8 courses (32 credits) in our core courses (AS 700–749)

3 courses (12 credits) in advanced courses (AS 750–799)

1 course (4 credits, 2 credits per semester) astrophysics or space physics seminar (you have to take it for credit once in the spring and once in the fall)

The remaining 4 courses are usually taken as additional semester of seminar, further astronomy courses, directed study or directed research (900 level), but could also be courses in physics or math closely related to the area of research.

With the approval of the Chair or the Director of Graduate Studies, a student may substitute an advanced physics or mathematics course for an advanced astronomy course, provided that the course is directly applicable to the student's research.

For students who enter post-masters

Students who enter our post-masters PhD program are required to take fewer credits, as the school will only pay for you to take 32 credits. Depending on a student's background, more courses may be advisable, and sitting in on the core courses not taken for credit is recommended to help with comps studying. A professor may want you to take a course for credit, even if it exceeds the requirements detailed below. If that is the case, there is a way for him or her to get around the limit. The course requirements are as follows:

- 3 courses (12 credits) in our core courses (AS 700–749)
- 3 courses (12 credits) in advanced courses (AS 750–799)
- 1 course (4 credits, 2 credits per semester) astrophysics or space physics seminar (again, 2 credits must be for the fall semester and 2 must be for the spring semester)

The remaining course is usually taken as an additional semester of seminar, further astronomy courses, directed study or directed research (900 level), but could also be courses in physics or math closely related to the area of research. No more than one of the eight courses may be numbered 900–919.

Note that, generally, graduate level coursework at another university is not granted transfer credit at BU.

How many classes you can fail, and what to do if you fail one

First things first: in grad school, a grade of C+ or worse is considered a failing grade. This is official policy set by the Graduate School of Arts and Sciences (GRS; see bu.edu/academics/grs/policies/incomplete-coursework). If you do not get a grade of B- or better in any course, you will have to take it again to receive credit for it. Additionally, a grade of I (incomplete) becomes permanent if the coursework is not made up within one year, and is then considered a failing grade.

Of course, common sense applies—if your grade throughout the semester is in trouble, you ought to be in communication with your professor and seeking help during office hours. Graduate courses are more demanding than undergraduate courses and you may find yourself requiring more clarification and interaction with the professor to succeed than you had as an undergrad. In undergrad, you may have been able to get by without going to office hours and skating over things you didn't understand; this is a much less tenable approach in grad school. The upside is that because of the higher stakes, professors genuinely do not *want* grad students to fail courses, and will generally be more than willing to go through the material.

But if worst comes to worst and after the grades come back you have failed a course, *don't panic*. People come into the program with backgrounds of varying strengths in the different subjects, and so it is not unheard of for a student to retake a pre-comps course if they happened to have a weak background in that subject as an undergrad. Overextending yourself in your first couple years is undesirable, but also not unheard of. Grad school is exciting with lots of new opportunities, but it is also more

academically demanding than undergrad work, and it can take some time to recalibrate your priorities. Failing a course can be a very good learning experience; when you do retake the course, look at it as an opportunity to fill gaps in your knowledge. It'll be good for you!

The next step after the grades come back is probably to meet with your professor to clear the air and demonstrate your commitment. It's tempting afterwards to shove the course out of your mind for two years until it's offered again. But you should also realize that before it comes up again, you will have to take the comps! In other words, assuming this is a pre-comps course we're talking about (a post-comps student failing a course *is* practically unheard of), you will still be responsible for teaching yourself the course material for the comprehensive exam. Your professor may still be a valuable resource as you prepare for the comps.

If this is your first time failing a course, no further action from the department will likely be taken. But if you fail a *second* course, your position as a stipend-receiving graduate student will be subject to review from the faculty and you may find yourself at the bottom of the funding priority list. *This may result in the loss of your fellowship and your departure from the department*. Failing a *third* course makes you liable for dismissal from graduate school at BU.

Course listing

The following is a list of the classes that are officially offered by the department, as well as some professors who have most recently taught the course or are likely to in the future. However, in practice, there is no exact rotation—the scheduling of courses and teaching assignments is complex and crafted from year to year. Therefore, classes that are listed here may or may not be scheduled in upcoming years. If you have a particular interest in taking one of these classes, it's a good idea to ask the Director of Graduate Studies if the course is being taught. If it is not, you can talk to your fellow grad students, gauge the level of interest, and notify the department Chair. If there is a high level of interest, it can be worked into the schedule.

GRS AS 701 — Introduction to Astrophysics

Introduction to astronomical and astrophysical nomenclature and concepts. Coordinate systems, celestial orbits, radiation, stars, stellar structure, stellar evolution, clusters of stars, galactic components, galactic structure, galaxy types, active galaxies, cosmology. *Blanton, Brecher, Jackson, Janes*. 4 cr.

GRS AS 703 — Introduction to Space Physics

Survey of physical phenomena in the sun, solar wind, and magnetospheres, ionospheres, and upper atmospheres of objects in the solar system. Introduction to the physical processes governing space plasmas, solar-terrestrial interactions, and ionized and neutral media surrounding the Earth and other solar system bodies. *Hughes, Mendillo*. 4 cr.

GRS AS 710 — Observational Techniques

Telescopes, light detection, and analysis tools and techniques of experimental astronomy. Signal-to-noise calculations. Photometric and spectroscopic instrumentation and applications. Use of the observatory, CCD light detectors, modern software analysis

tools, image processing. Proposal writing and science writing. *Clarke, Clemens, West*. 4 cr.

GRS AS 712 — Radiative Processes in Astrophysics
Generation, propagation, and transfer of electromagnetic radiation. Spectral energy distributions, continuum radiation, spectral lines. Interaction of radiation with matter, transfer of radiation through astrophysical media. Thermal and nonthermal radiative processes. *West*. 4 cr.

GRS AS 713 — Astronomical Spectroscopy
Spectroscopic processes in astrophysics. Energy levels in atoms and molecules. Atomic and molecular spectral lines. Excitation of atoms and molecules. Transfer of line radiation. Spectroscopic instruments. Derivation of physical parameters from spectroscopic observations. *Clemens, Jackson*. 4 cr.

GRS AS 725 — Gravitational Astrophysics
Orbital theory: two-body and three-body problems. Gravitational encounters. N-body problem and star/galaxy clusters. Precession and nutation. Special and General relativity. Collapsed stellar objects and black holes. Gravitational lensing. *Brainerd, Brecher*. 4 cr.

GRS AS 726 — Cosmic Gas Dynamics
Gas dynamics as applied to astrophysical settings. Basic fluid mechanics. Ideal gases. One-dimensional gas flow. Supersonic flows and shock waves. Quasar jets and stellar winds. Fluid instabilities, turbulence, and convection. *Hughes, Marscher*. 4 cr.

GRS AS 727 — Cosmic Plasma Physics
Physics of astrophysical and space plasmas. Magnetohydrodynamic waves and instabilities. Magnetoionic theory, electron waves, ion waves. Kinetic theory of waves in plasmas. Landau damping. Kinetic instabilities. Quasi-linear theory. Particle trapping. *Opher, Hughes, Oppenheim*. 4 cr.

GRS AS 751 — Interstellar Medium
Prereq: GRS AS 712, AS 713, AS 726, or consent of instructor. Interstellar medium components and phases. Neutral hydrogen clouds, 21 cm line, Zeeman effect. Ionized nebulae, free-free radiation, recombination lines, ionization balance, thermal balance. Molecular clouds, collisional and radiative excitation, line formation and propagation, rotational and vibrational energies. Interstellar chemistry. *Bania, Clemens, Jackson*. 4 cr.

GRS AS 753 — Normal Galaxies and the Milky Way
Prereq: GRS AS 712, AS 713, AS 725, AS 726, or consent of instructor. Normal Galaxies and the Milky Way as systems. Stellar components and clusters, elliptical and disk galaxies. Luminosity functions, radial distributions, distance indicators, triaxial spheroids, and central bars. Motions near the sun, asymmetric drift, velocity ellipsoid, Galactic rotation, Oort formulae, gas distribution, Galactic center. *Blanton, Brainerd West*. 4 cr.

GRS AS 757 — High-Energy Astrophysics
Prereq: GRS AS 712, 725, 726, 727, or consent of instructor. Physics of interactions between high-energy particles and photons. Compton scattering. Nuclear collisions. Acceleration and energy losses of high-energy particles. Neutrino production. Physics

of cosmic rays. Pulsars. Accretion onto compact objects. Active galactic nuclei and other high-energy phenomena. *Brecher, Marscher*. 4 cr.

GRS AS 759 — Cosmology
Prereq: GRS AS 712, 713, 725, 726, or consent of instructor. Appearance, content, and physical properties of galaxies. Distances to galaxies and the Hubble Law. Active galaxies and quasars. Geometrical and physical cosmology—the Big Bang model and the early universe. Formation of galaxies and large-scale structure. Alternative cosmologies. *Blanton, Brainerd, Brecher, Marscher*. 4 cr.

GRS AS 781 — Planetary Atmospheres
Prereq: GRS AS 726 or consent of instructor. Planetary and cometary atmospheres; atmospheric vertical mixing; radiative processes; catalytic ozone destruction; aurorae and airglow; planetary ionospheres; energy budgets. Planetary evolution: solar nebula, outgassing, water loss on Venus and Mars, escape of light gases, greenhouse effect, isotope fractionation, impact theory. *Clarke, Withers*. 4 cr.

GRS AS 783 — Ionospheres
Prereq: GRS AS 712, 713, 726, 727, or consent of instructor. The formation of the ionosphere. The structure and dynamics of the ionosphere and thermosphere. Aeronomy. Thermosphere/ionosphere coupling. Ionospheric electric fields and current systems. Ionospheric storms. Ionospheric waves and irregularities. Active experiments in space. Radio and optical ionospheric diagnostics. *Oppenheim, Mendillo*. 4 cr.

GRS AS 785 — Magnetospheres
Prereq: GRS AS 712, 713, 726, 727, or consent of instructor. Solar wind/magnetosphere interaction. Magnetospheric dynamics and substorms. Magnetospheric electric fields and current systems. Ionosphere/magnetosphere coupling. The aurora. Magnetospheric plasma waves and instabilities. *In situ* plasma and field diagnostics. *Fritz, Hughes*. 4 cr.

GRS AS 786 — The Sun and Heliosphere
Prereq: GRS AS 701, AS 703, AS 712, AS 713, AS 726, AS 727, or consent of instructor. Fundamentals of solar and heliospheric physics, including observational methods and theory from the sun's interior through interplanetary space and into the local interstellar medium. The sun as a star. Relation of our heliosphere to astrospheres surrounding other stars. *Opher*. 4 cr.

GRS AS 791 — Special Topics in Astrophysics
Lecture course examining special topics of current interest in astrophysics. Offered as a 2 or 4 credit course, depending on the topic. *Staff*.

GRS AS 793 — Special Topics in Space Physics
Lecture course examining special topics of current interest in solar system space physics. Offered as a 2 or 4 credit course, depending on the topic. *Staff*.

GRS AS 802 — Introduction to Professional Astronomy
An introduction to the methods of research and scholarship required for successful graduate study and the associated ethical issues. Topics include choosing a research advisor, the research topic, the research record, scholarly writing and publishing,

intellectual property, and research funding. This course fulfills the NSF Responsible Conduct of Research training requirement for NSF fellows. *Withers, West, Clemens*. 2 cr.

GRS AS 803 — Computational Programming and Numerical Methods
Prereq: GRS AS 701, AS 703, or consent of instructor. Computer programming skills using Interactive Data Language (IDL). Astronomical image processing including flat fielding, bias removal, sky subtraction, filtering, CLEAN algorithm, and point source extraction. Fitting functions to data, solving linear and nonlinear equations numerically, approximating solutions of ordinary differential equations. *Withers, Opher, Clemens*. 2 cr.

GRS AS 850, 851 — Astrophysics Seminar
Weekly seminar offering graduate students and advanced undergraduates discussions of current research topics in astrophysics with staff and visiting scientists. *Staff*. 2 credits each semester.

GRS AS 865, 866 — Space Physics Seminar
Weekly seminar offering graduate students and advanced undergraduates discussions of current research topics in space physics with staff and visiting scientists. *Staff*. 2 credits each semester.

GRS AS 901, 902 — Research in Astronomy
Staff. Variable cr, 1st & 2nd sem.

GRS AS 911,912 — Directed Study in Astronomy
Staff. Variable cr, 1st & 2nd sem.

Written Comprehensive Examination

Logistics

By the end of the second year, each student must pass the department's Written Comprehensive Exam to continue on in the PhD program.

The Comprehensive Exam (commonly know as the comps) is held from 9:00 AM to 12:00 PM on two consecutive days (usually in mid-May). The Astronomy Department will send an email in advance indicating the exact days of the exam. Students will be provided with a calculator, a sheet with some common constants, and bluebooks to write in the morning of the exam. The exam is designed to test the student's ability to solve quantitative problems in astrophysics and space physics using both his/her knowledge of the material covered in the 8 core courses (courses numbered AS 700–749) as well as application of basic physical principles.

Each day of the exam consists of five questions, of which you answer four. The questions are decided upon in advance by the faculty. Each faculty member has the opportunity to submit one or two possible questions, as well as the solutions. From this pool (as well as previous submissions that did not make it in to earlier exams due to space constraints) the faculty votes on the problems that will make up that year's exam. There is usually one question per core course, and an extra question each for Intro to Astrophysics and Intro to Space Physics. The mapping is not always one-to-one, however, and it is not generally a good idea to try to game the system and figure out

which question goes with which subject. The faculty consider the ideal comps question to be one that requires the synthesis of knowledge from a couple of different courses. Ideally, the questions will not look they came straight off the final exam from one course.

Before the exam, you will be assigned a number which you use in lieu of your name. This way, the questions are graded anonymously. Each question is graded by two graders and is given a score between 0 and 5 (in half-point increments). If the two graders disagree by more than half of a point, the graders discuss the solution and come to an agreement on a consensus grade. The individual scores for each question are averaged, and an overall numerical score between 0 and 5 is awarded. To pass at the PhD level, an average score of 3.0 or higher is required. Historically, the Master's pass has varied a bit from year to year.

Every student has the opportunity to take the exam in their first year of study, **and it is strongly encouraged to do so**. You are not *expected* to pass, however, as you will only have had half of the coursework covered. If the exam is not passed in the first year, every student has another opportunity in the second year.

The exam also serves as the department's master's degree comprehensive exam. If the student passes at the PhD level, he or she automatically qualifies for the master's degree (provided course requirements are met).

Three outcomes of this exam are possible upon taking it at the end of your second year:

You successfully pass and continue in the PhD program.

You fail at the PhD level but pass at the Master's level. You may receive your Master's (provided you have fulfilled the course requirements), but cannot continue as a PhD candidate.

You fail and do not pass at the PhD level nor at the Master's level and cannot continue as a PhD candidate.

In the last case, one has to pass the course work and write a formal thesis describing a research project carried out by the student and directed by a faculty member to get a Master's degree (see the Formal Requirements in the next section).

Most people pass the comps in the second year; however passing in the first year is not unheard of, depending on the strength of your background and problem-solving ability. It is also possible to pass at the Master's level your first year. If you plan on getting a PhD, this is nice, but ultimately useless, as you still have to pass at the PhD level the next year. Regardless of when you pass, you are still required to complete all of the courses.

Studying for the Exam

Copies of past exams, which can be helpful when studying for the comps, can be found in the Astronomy Library in the reserves section. During the spring semester, one or two second years will take charge and organize weekly study session. They contact professors who are willing to help the students as they work through one or two previous comps problems. While this is not a substitute for one's own studying, it is useful to see what a full solution looks like. During these problem-solving sessions, it is best to come prepared. This means looking at the problem(s) before hand and making a

good-faith attempt at solving them. Most professors prefer that one or two students work out the problem on the board and then discuss the solution as a group.

It is also a good idea to supplement these weekly problem solving sessions. Having made it through high school and college and getting in to a graduate program, you presumably have some idea of what your study strategy is when it comes to getting through a major exam. Ideas include smaller study groups, outlining, and possibly sleeping with textbooks under your pillow so that you absorb the material through osmosis. Do what works for you!

That said, focusing on doing as many practice problems as possible is one of the best ways to study. This will give you a feel for the types of questions that get asked, and you can see if there are general patterns (although don't read too much into it). The notebooks in the library contain exams dating back all the way to the early 1990s, but don't go back that far. Times change, and so does the focus of the exam. If you go back approximately 10 years, that will keep you pretty busy, and should provide a good overview of what to expect. Unfortunately, there are no official solutions of these problems; however, some of the older graduate students have kept their study materials and are more than happy to help out if you ask. It bears repeating, though, that these are not official solutions and should not be taken as the gospel truth. *Use at your own risk*.

You should also keep in mind that the department will provide calculators for you for use during the exam. ***However,*** you need to check one out beforehand from the Observatory Manager , Quinn to bring to the exam. These calculators are scientific calculators with very basic memory storage capabilities. It is useful to practice doing problems with these calculators so that you don't get tripped up in the middle of the exams. You can (and should!) ask the Observatory Manager to check out a calculator for the year, and practice with it as much as possible, as it is very different from using the graphing calculator you are probably used to.

Applying for your Master's along the way

Note: You must apply to graduate. MAs are awarded in September, January, and May. Commencement is held only in May.

Pay attention to the graduation application deadlines (available at bu.edu/cas/students/graduate/graduation-information). Currently, to receive your diploma by May, you must submit your application for your diploma by February 1; you must submit by July 1 for September graduation, and by November 1 for January graduation.

Oral Qualifying Examination

Within one year after passing the written comprehensive exam, a student must take an oral qualifying exam. This exam is designed to demonstrate expertise in independent research. By this time the qualifying student will have found a faculty research advisor, and have completed a research project under his or her direction. This research project should be of publishable quality.

The oral exam consists of a 30–45 minute public talk, followed by a private questioning period from the oral exam committee. The oral exam committee consists of

at least 3 astronomy department faculty, and must be approved by the Chair or the Director of Graduate Studies. The committee should have at least one representative from both the Center of Space Physics and the Institute of Astrophysical Research.

Dissertation

The PhD dissertation is a substantial piece of independent, original research. After passing both parts (written and oral) of the PhD qualifying exam, each student should assemble a thesis committee in consultation with his or her advisor.

Thesis committee

The thesis committee will review the student's progress towards the PhD and administer the thesis defense exam. This committee consists of the faculty advisor (first reader), an expert in the field who works outside of Boston University at another university or research institution, and three additional Boston University faculty, usually in the Astronomy Department. The committee should have at least one representative from both the Center of Space Physics and the Institute of Astrophysical Research. The committee should meet at least once a year.

Prospectus

At least one year before submitting a dissertation, and preferably earlier, the student writes a prospectus, which outlines the research to be done. The prospectus should be approved by the thesis committee. The prospectus is then submitted to the Graduate School of Arts and Sciences (GRS). The student should use the appropriate form and obtain the appropriate signatures.

Defense

The defense needs to be scheduled (again, there is a GRS form required) and the abstract approved at least 6 weeks prior to the defense date. After the thesis defense, the revised thesis must be approved and signed by the advisor (first reader), a second reader, and (optionally) a third reader. Either the second or third reader must be on the Boston University faculty.

Thesis

The thesis is then submitted to GRS. There are strict rules on the format and the paper quality; please consult the GRS rules in CAS 112.

For more information...
Please consult the AstroWiki at https://astrowiki.bu.edu/AstroWiki/GraduateStudents/RoadMap for more detailed information on the mechanics of navigating the orals and dissertation processes, including the most recent department LaTeX thesis templates.

Graduation

PhD degrees are awarded in January and May. Commencement exercises are held only in May.

Note that you *must be registered* in the semester in which you defend your dissertation. This requires special registration if you are defending in the summer. (Ordinarily, students don't register for the summer, even when doing full-time research on their dissertations.)

GRS publishes at least annually a list of dates by which the various requirements needed to graduate must be met (available at bu.edu/cas/students/graduate/graduation-information). It is the student's responsibility to know these deadlines, and to allow ample time for the approval process.

Currently, if you want to receive your degree at May commencement (and wear the awesome robes), you must submit your diploma application by February 1. For January graduation, you must submit by November 1.

Appendix A: First Year Paperwork

The following is a list of the paperwork you will need to fill out as a first year grad student. We have provided the points of contact that you will need to sign the pertinent documents.

Step 1: First things first, fill out the required paperwork. Below you will find a few documents that need to be filled out (I-9, W-4, Patent Policy, & Registration Form). To streamline your process once you get here, you should try to fill these out with your information prior to your first day in the department. **If you need help or have questions get in touch with your graduate student representative. They will be especially helpful for the registration form.**

Step 2: Get in touch with Quinn Sykes (qtsykes@bu.edu) to get an office space. **The graduate students will help you with this when you arrive.**

Step 3: Get keys to the offices and work spaces that you will need. This will also be provided by Quinn Sykes. **The graduate students will also help you with this.**

Step 4: Get registered! The office administrator will do this for you after all the you new graduate students arrive. This step must be completed before you can move further down the list.

Step 5: Get your B.U. Identification card. B.U. Identification cards can be obtained by going to the George Sherman Student Union Building (775 Commonwealth Ave.). The Terrier Office is located in the basement of the building. **The other graduate students can help you get around if you need it.**

Step 6: Lastly, get your computer account. Fill out the online form at http://www.bu.edu/computing/accounts/acsaccounts/creating/individual.html. Then you will need to go to Information Technology (111 Cummington St.) to establish a university-wide account name and to set your "Kerberos" password. Once you have obtained your password and account name, contact the department's systems administrators (David or Jeff) to obtain a local account. Sign up for appropriate electronic mailing lists (astrowiki.bu.edu/Mailing Lists).

Form W-4 (2013)

Purpose. Complete Form W-4 so that your employer can withhold the correct federal income tax from your pay. Consider completing a new Form W-4 each year and when your personal or financial situation changes.

Exemption from withholding. If you are exempt, complete **only** lines 1, 2, 3, 4, and 7 and sign the form to validate it. Your exemption for 2013 expires February 17, 2014. See Pub. 505, Tax Withholding and Estimated Tax.

Note. If another person can claim you as a dependent on his or her tax return, you cannot claim exemption from withholding if your income exceeds $1,000 and includes more than $350 of unearned income (for example, interest and dividends).

Basic instructions. If you are not exempt, complete the **Personal Allowances Worksheet** below. The worksheets on page 2 further adjust your withholding allowances based on itemized deductions, certain credits, adjustments to income, or two-earners/multiple jobs situations.

Complete all worksheets that apply. However, you may claim fewer (or zero) allowances. For regular wages, withholding must be based on allowances you claimed and may not be a flat amount or percentage of wages.

Head of household. Generally, you can claim head of household filing status on your tax return only if you are unmarried and pay more than 50% of the costs of keeping up a home for yourself and your dependent(s) or other qualifying individuals. See Pub. 501, Exemptions, Standard Deduction, and Filing Information, for information.

Tax credits. You can take projected tax credits into account in figuring your allowable number of withholding allowances. Credits for child or dependent care expenses and the child tax credit may be claimed using the **Personal Allowances Worksheet** below. See Pub. 505 for information on converting your other credits into withholding allowances.

Nonwage income. If you have a large amount of nonwage income, such as interest or dividends, consider making estimated tax payments using Form 1040-ES, Estimated Tax for Individuals. Otherwise, you may owe additional tax. If you have pension or annuity income, see Pub. 505 to find out if you should adjust your withholding on Form W-4 or W-4P.

Two earners or multiple jobs. If you have a working spouse or more than one job, figure the total number of allowances you are entitled to claim on all jobs using worksheets from only one Form W-4. Your withholding usually will be most accurate when all allowances are claimed on the Form W-4 for the highest paying job and zero allowances are claimed on the others. See Pub. 505 for details.

Nonresident alien. If you are a nonresident alien, see Notice 1392, Supplemental Form W-4 Instructions for Nonresident Aliens, before completing this form.

Check your withholding. After your Form W-4 takes effect, use Pub. 505 to see how the amount you are having withheld compares to your projected total tax for 2013. See Pub. 505, especially if your earnings exceed $130,000 (Single) or $180,000 (Married).

Future developments. Information about any future developments affecting Form W-4 (such as legislation enacted after we release it) will be posted at *www.irs.gov/w4*.

Personal Allowances Worksheet (Keep for your records.)

A	Enter "1" for **yourself** if no one else can claim you as a dependent	**A** _____
B	Enter "1" if: • You are single and have only one job; or • You are married, have only one job, and your spouse does not work; or • Your wages from a second job or your spouse's wages (or the total of both) are $1,500 or less. . . .	**B** _____
C	Enter "1" for your **spouse.** But, you may choose to enter "-0-" if you are married and have either a working spouse or more than one job. (Entering "-0-" may help you avoid having too little tax withheld.)	**C** _____
D	Enter number of **dependents** (other than your spouse or yourself) you will claim on your tax return	**D** _____
E	Enter "1" if you will file as **head of household** on your tax return (see conditions under **Head of household** above) . .	**E** _____
F	Enter "1" if you have at least $1,900 of **child or dependent care expenses** for which you plan to claim a credit . . . (**Note.** Do **not** include child support payments. See Pub. 503, Child and Dependent Care Expenses, for details.)	**F** _____
G	**Child Tax Credit** (including additional child tax credit). See Pub. 972, Child Tax Credit, for more information. • If your total income will be less than $65,000 ($95,000 if married), enter "2" for each eligible child; then **less** "1" if you have three to six eligible children or **less** "2" if you have seven or more eligible children. • If your total income will be between $65,000 and $84,000 ($95,000 and $119,000 if married), enter "1" for each eligible child . . .	**G** _____
H	Add lines A through G and enter total here. (**Note.** This may be different from the number of exemptions you claim on your tax return.) ►	**H** _____

For accuracy, complete all worksheets that apply.

- If you plan to **itemize** or **claim adjustments to income** and want to reduce your withholding, see the **Deductions and Adjustments Worksheet** on page 2.
- If you are **single and have more than one job** or are **married and you and your spouse both work** and the combined earnings from all jobs exceed $40,000 ($10,000 if married), see the **Two-Earners/Multiple Jobs Worksheet** on page 2 to avoid having too little tax withheld.
- If **neither** of the above situations applies, **stop here** and enter the number from line H on line 5 of Form W-4 below.

---------- **Separate here and give Form W-4 to your employer. Keep the top part for your records.** ----------

Form **W-4**
Department of the Treasury
Internal Revenue Service

Employee's Withholding Allowance Certificate

► **Whether you are entitled to claim a certain number of allowances or exemption from withholding is subject to review by the IRS. Your employer may be required to send a copy of this form to the IRS.**

OMB No. 1545-0074

2013

1	Your first name and middle initial	Last name	**2** **Your social security number**
	Home address (number and street or rural route)	**3** ☐ Single ☐ Married ☐ Married, but withhold at higher Single rate. **Note.** If married, but legally separated, or spouse is a nonresident alien, check the "Single" box.	
	City or town, state, and ZIP code	**4** **If your last name differs from that shown on your social security card, check here. You must call 1-800-772-1213 for a replacement card.** ► ☐	

5	Total number of allowances you are claiming (from line **H** above **or** from the applicable worksheet on page 2)	**5**	
6	Additional amount, if any, you want withheld from each paycheck	**6**	$
7	I claim exemption from withholding for 2013, and I certify that I meet **both** of the following conditions for exemption. • Last year I had a right to a refund of **all** federal income tax withheld because I had **no** tax liability, **and** • This year I expect a refund of **all** federal income tax withheld because I expect to have **no** tax liability. If you meet both conditions, write "Exempt" here . . . . . ►	**7**	

Under penalties of perjury, I declare that I have examined this certificate and, to the best of my knowledge and belief, it is true, correct, and complete.

Employee's signature
(This form is not valid unless you sign it.) ► **Date** ►

8	Employer's name and address (Employer: Complete lines 8 and 10 only if sending to the IRS.)	**9** Office code (optional)	**10** Employer identification number (EIN)

Instructions for Employment Eligibility Verification

Department of Homeland Security
U.S. Citizenship and Immigration Services

USCIS
Form I-9
OMB No. 1615-0047
Expires 03/31/2016

Read all instructions carefully before completing this form.

Anti-Discrimination Notice. It is illegal to discriminate against any work-authorized individual in hiring, discharge, recruitment or referral for a fee, or in the employment eligibility verification (Form I-9 and E-Verify) process based on that individual's citizenship status, immigration status or national origin. Employers **CANNOT** specify which document(s) they will accept from an employee. The refusal to hire an individual because the documentation presented has a future expiration date may also constitute illegal discrimination. For more information, call the Office of Special Counsel for Immigration-Related Unfair Employment Practices (OSC) at 1-800-255-7688 (employees), 1-800-255-8155 (employers), or 1-800-237-2515 (TDD), or visit **www.justice.gov/crt/about/osc**.

What Is the Purpose of This Form?

Employers must complete Form I-9 to document verification of the identity and employment authorization of each new employee (both citizen and noncitizen) hired after November 6, 1986, to work in the United States. In the Commonwealth of the Northern Mariana Islands (CNMI), employers must complete Form I-9 to document verification of the identity and employment authorization of each new employee (both citizen and noncitizen) hired after November 27, 2011. Employers should have used Form I-9 CNMI between November 28, 2009 and November 27, 2011.

General Instructions

Employers are responsible for completing and retaining Form I-9. For the purpose of completing this form, the term "employer" means all employers, including those recruiters and referrers for a fee who are agricultural associations, agricultural employers, or farm labor contractors.

Form I-9 is made up of three sections. Employers may be fined if the form is not complete. Employers are responsible for retaining completed forms. Do not mail completed forms to U.S. Citizenship and Immigration Services (USCIS) or Immigration and Customs Enforcement (ICE).

Section 1. Employee Information and Attestation

Newly hired employees must complete and sign Section 1 of Form I-9 **no later than the first day of employment**. Section 1 should never be completed before the employee has accepted a job offer.

Provide the following information to complete Section 1:

Name: Provide your full legal last name, first name, and middle initial. Your last name is your family name or surname. If you have two last names or a hyphenated last name, include both names in the last name field. Your first name is your given name. Your middle initial is the first letter of your second given name, or the first letter of your middle name, if any.

Other names used: Provide all other names used, if any (including maiden name). If you have had no other legal names, write "N/A."

Address: Provide the address where you currently live, including Street Number and Name, Apartment Number (if applicable), City, State, and Zip Code. Do not provide a post office box address (P.O. Box). Only border commuters from Canada or Mexico may use an international address in this field.

Date of Birth: Provide your date of birth in the mm/dd/yyyy format. For example, January 23, 1950, should be written as 01/23/1950.

U.S. Social Security Number: Provide your 9-digit Social Security number. Providing your Social Security number is voluntary. However, if your employer participates in E-Verify, you must provide your Social Security number.

E-mail Address and Telephone Number (Optional): You may provide your e-mail address and telephone number. Department of Homeland Security (DHS) may contact you if DHS learns of a potential mismatch between the information provided and the information in DHS or Social Security Administration (SSA) records. You may write "N/A" if you choose not to provide this information.

Boston University Patent Policy and Agreement
Charles River Campus

Preamble
The patent policy outlined herein is the policy of the Trustees of Boston University (the "University"). The University recognizes that patentable inventions may be made in the course of research sponsored by the University and/or by others through the University. It is the policy of the University to maximize the benefits to the individual who makes such patentable inventions, to the University and to the general public, and thus, to stimulate initiative in the faculty, staff and employees of the University. The University recognizes that this may best be accomplished through patenting and licensing such inventions in a manner consistent with the public interest, and for such purpose the University hereby establishes the patent policy set forth herein. This Policy supersedes all prior patent policies and amendments thereto applicable to the Charles River Campus.

1. Patent Policy
A. In order to protect the public good and the University, and in order to fulfill obligations to research sponsors, the University shall claim equity in all discoveries and its right to acquire the title to and control of such discoveries where the discoveries are made by faculty, staff, employees or students (including all types of trainees or postgraduate fellows) working on or arising from programs supported in whole or in part by funds, space, personnel or facilities provided by the University.

B. When a discovery is made by an inventor outside of any program conducted by the University, and the inventor can demonstrate that the University did not provide or administer significant funds, space, personnel or facilities for work leading to the discovery, the discovery shall remain the exclusive property of the inventor or his/her sponsor. The University shall not ordinarily consider provision of office, classroom, or library facilities as constituting significant use of University funds, space, personnel or facilities. For purposes of this Policy, the term "Inventor" shall include all individuals who participated in and signed a disclosure statement respecting a discovery or invention.

C. When necessary, the University Committee on Inventions and Discoveries (Committee) shall decide whether an invention or discovery should be classified under Paragraph A or Paragraph B of this Paragraph 1. Persons or entities claiming a right to receive royalty interests under the provisions of Paragraph 4 may appeal the decision of the Committee to the President of the University. The President shall recommend final action to the Trustees, whose decision shall be final.

2. Royalties
Where the University is entitled to equity in a discovery, the inventor shall receive 30 percent of the net royalties accruing therefrom, unless the University recommends a lesser share, which shall not be less than 15 percent, based upon relevant circumstances relating to the discovery. In the event the University determines that such lesser share is appropriate, the University shall in its sole discretion designate the recipient or recipients of the percentage share by which the Inventor's share has been reduced. The Community Technology Foundation (CTF) of Boston University, exclusive agent for the administration of patents or discoveries made within the University, shall receive 45 percent of the net royalties (see Paragraph 4). The remaining royalties from, and equities in the invention shall be distributed to the School of the inventor, or in the absence of a School's being involved, the primary unit or entity of the University with which the Inventor works or is affiliated. Net royalties are defined as gross royalties less amounts granted by the University specifically for the invention or discovery process, and the costs of securing, protecting, preserving and maintaining patents, and of licensing and marketing of the patent rights, or other costs or fees directly attributable to the invention's being licensed.

3. Disclosures
Because the securing of rights in discoveries and inventions depends on prompt and efficient patent application and administration, all faculty, staff, students and employees of the University who make inventions or discoveries shall immediately disclose said inventions or discoveries to the CTF Patent Administrator and to the Inventor's supervisor. This disclosure obligation shall apply to all inventions and discoveries without regard to whether they fall under Paragraph A or B above.

4. Patent Administration
The CTF shall be the exclusive agent of the University for the administration of inventions and discoveries made within the University and covered under Paragraph 1.A. CTF shall present the disclosures to the Committee. Such report shall state whether CTF has determined that an invention or discovery will be developed by the University. The Committee

BOSTON UNIVERSITY

REGISTRATION FORM

ACADEMIC SEMESTER AND YEAR
(CIRCLE ONE) (FILL IN)
FALL SPRING 20 ____

OFFICE OF THE UNIVERSITY REGISTRAR

COLLEGE ____

LAST NAME

B.U.I.D./SOCIAL SECURITY NUMBER

SEX
M = MALE
F = FEMALE

FIRST NAME

MIDDLE INITIAL

DATE OF BIRTH
MO. DAY YR.

EMAIL ADDRESS

Students are reminded that in accordance with the Code of Student Responsibilities (Appendix 15), current addresses must be on file with the University.

ADDRESS

STREET & CITY

STATE ZIP

COUNTRY (IF FOREIGN ADDRESS)

COUNTRY OF CITIZENSHIP (FOREIGN STUDENTS ONLY)

HOME PHONE

WORK PHONE

BU DIRECTORY PHONE

CELL PHONE

ETHNICITY
(REQUIRED FOR GOVERNMENT REPORTS)

ARE YOU HISPANIC / LATINO?

____ YES

____ NO

(CHECK ALL THAT APPLY)

____ AMERICAN INDIAN or ALASKA NATIVE

____ ASIAN

____ BLACK or AFRICAN AMERICAN

____ NATIVE HAWAIIAN or PACIFIC ISLANDER

____ WHITE (INCLUDING MIDDLE EASTERN)

PERSON TO NOTIFY IN A PERSONAL EMERGENCY

RELATION
M - MOTHER
F - FATHER
O - OTHER

PHONE

BU EMERGENCY ALERT CONTACT PHONE
(REQUIRED FOR NOTICE OF UNIVERSITY-WIDE EMERGENCY)

MARK IF CELL PHONE

#	COLLEGE	COURSE NUMBER	SECTION	CREDIT HRS	AUDIT	COURSE TITLE
EX.	CAS	CS 101	A1	4	__	INTRODUCTION TO COMPUTERS
1						
2						
3						
4						
5						
6						

STUDENT SIGNATURE DATE

ADVISOR SIGNATURE DATE
IF REQUIRED BY YOUR SCHOOL

☐ **1974 Privacy Act Restrict Box.**
See reverse side to restrict specific data.

Visit the Registrar's Office home page at www.bu.edu/reg to view the Class Schedule.

View your academic record, register, add and drop classes, change your address or confirm your registration on the Student Link at www.bu.edu/studentlink.

Appendix B: Formal Requirements

The following is the text of the requirements for graduation as formally laid out on the Department website (bu.edu/astronomy/academics/graduate) in a considerably more concise form than above.

Graduate Program

The graduate program consists of courses in astronomy and original research conducted under the guidance of a faculty advisor. During the first academic year, students generally concentrate on foundation coursework; a research area is usually chosen during the second year. Original research, the most important part of the graduate program, occupies much of the student's time after the first year. Formal admission to PhD candidacy is based on satisfactory performance in coursework and on the Comprehensive Examination, which is administered to ensure that students have mastered intermediate physics and astronomy. Graduate students are primarily supported through teaching fellowships and research assistantships. The normal procedure is for students to receive a teaching fellowship in the Department of Astronomy in the first year or two and to be supported with research assistantships when working closely with individual faculty members on their research.

M.A. in Astronomy

The MA in Astronomy requires completion of a total of eight graduate courses in astronomy and physics with a grade of B– or higher. At least six of these must be astronomy courses numbered 700–799. In addition, the candidate must either pass the written Astronomy Comprehensive Examination or write a formal thesis describing a research project carried out by the student and directed by a faculty member.

The master's thesis must give evidence of the candidate's ability to understand, critically evaluate, and competently carry forward a scientific investigation. This is achieved by advancing an experimental technique, by extending the application of a physical theory, or by collecting new scientifically relevant data. A thesis is required to demonstrate the candidate's ability to present the results of his or her work in a logical and coherent manner. The thesis is judged in an oral examination administered by a committee of three faculty members, including the student's advisor. A prospectus of the thesis must be approved by the committee at least six months prior to the oral examination.

The Comprehensive Exam is given in May each year and is normally taken in the student's second year of graduate school. See entry under the "PhD in Astronomy" section below for details.

Ph.D. in Astronomy

Admission into the PhD program follows completion of the requirements for the master's degree, or, in the case of well-prepared students, candidates may be admitted directly into the PhD program. Requirements for the PhD degree are as follows:

Coursework

Students entering the program without a master's degree must accumulate 64 credits from graduate-level classes with a grade of B– or higher. Of these, 32 credits must be for 4-credit astronomy (AS) courses numbered 701–749; 12 credits must be for advanced AS courses numbered 750–799 or, with the permission of the director of graduate studies, graduate-level physics or engineering courses; 4 credits must be for the research preparation courses AS 802 and 803 or approved substitutes; and four credits for the astronomy seminar courses: GRS AS 850, 851, 865 or 866. No more than 12 credits may be for classes numbered 900–919. Students entering with a master's degree must complete 32 graduate-level credits in astronomy. Of these, at least 12 credits must be for AS classes numbered 701–749, 12 credits must be for AS courses numbered 750–799, and 4 must be for the AS seminar courses: 850, 851, 865 or 866. No more than 4 credits may be for classes numbered 900–919. Both post-bachelor and post-masters students are expected to participate in a journal club and seminar series (AS 850, 851, 865, 866) each semester that they are in residence, though they will only receive four academic credits toward their degree.

Written Comprehensive Examination

A student must pass the written Astronomy Comprehensive Examination and the Oral Qualifying Examination (see below) in order to be admitted to PhD candidacy. The Comprehensive Exam consists of two 3-hour written tests administered on two separate days. The exam is designed to test the student's ability to solve quantitative problems in astrophysics and space physics using both his/her knowledge of the material covered in the core courses (GRS AS 700–749), as well as application of basic physical principles.

Oral Qualifying Examination

After passing the Comprehensive Examination, a student must take the Oral Qualifying Examination within the subsequent academic year. During this year the student should undertake a directed research project with a member of the faculty. Ideally, the research should lead to a potential dissertation topic. The purpose of this directed research is to ensure that the student has the preparation and the ability to conduct the original research required for the PhD thesis. It is expected that the directed research will lead to publishable results. The Oral Qualifying Examination is based on the directed research: the student presents the results of the research in a formal seminar and is examined afterward by a panel consisting of the student's research advisor and other members of

the Department of Astronomy faculty. The panel questions the student, not only about his or her research, but also about the student's knowledge of related fields of physics and astronomy.

PhD Dissertation

The PhD dissertation can be on any topic in astronomy, astrophysics, or space physics. The dissertation must represent original scientific research that contributes substantially to the advancement of the field. Within three months of successful completion of the Oral Qualifying Exam, the student selects a tentative dissertation topic and the department assigns first and second readers for the dissertation. The student and his/her advisor select three additional members of the PhD examining committee. At least one of the members of the PhD examining committee must be from outside the Department of Astronomy and preferably from outside Boston University. The membership of the committee must be approved by the department. A prospectus of the dissertation must be approved by the PhD examining committee, reviewed by the Department of Astronomy faculty, and further approved by the department chair and director of graduate studies at least one calendar year prior to the final oral examination. The prospectus is subject to further review by the Graduate School of Arts & Sciences. The PhD examining committee should meet with the candidate at least twice per calendar year to monitor the candidate's progress toward completing the dissertation.

Final Oral Examination

Candidates must defend their dissertations as worthy contributions to scientific knowledge and demonstrate mastery of related fields of physics and astronomy. The defense is carried out at a final oral examination, consisting of a public presentation of the dissertation research and an examination of the candidate by the PhD examining committee. An abstract summarizing the research and the scientific results of the dissertation must be submitted to the readers at least five weeks prior to the final oral examination. The abstract is limited to a maximum of 350 words and must be written in proper, formal English. Upon approval of a final draft by the readers, the abstract must be approved by the chair and director of graduate studies of the Department of Astronomy and submitted to the Graduate School of Arts & Sciences at least three weeks prior to the final oral examination. Prior to the examination the abstract is made available for comment to all members of the Department of Astronomy faculty. Abstracts are subject to review by the Graduate School as well as by the Provost. At least four members of the PhD examining committee must vote to pass the candidate. Failure to achieve four votes of "pass" constitutes a failure, in which case the candidate must leave the PhD program without obtaining the PhD degree. Upon successful completion of the final oral examination, the final version of the dissertation and abstract, as revised following comments and suggestions by the PhD examination committee and the Department of Astronomy faculty, must be approved by the readers, as well as by the chair and director of graduate studies of the Department of Astronomy. The candidate should consult the Graduate School of Arts & Sciences for the precise format and number of copies of the dissertation to be submitted to the Graduate School.

Appendix C: Observatory Instructions

Getting ready for night lab

If it is your turn in the night lab rotation (typically posted on the bulletin board in the TF office, Rm 524) you have a few things you need to do before the lab starts.

Check the weather. First, look outside to see if it is cloudy (obviously). Next, check the satellite images on weather.com, Weather Underground (wunderground.com), weather.gov, or intellicast.com for our zip code (02215). For example, within weather.com you will see a Doppler image of the area; click the image. This will take you to a larger version of the image with a menu below it that will let you select the satellite image for the region. Once you have selected the satellite images click the "show map in motion" link right below the picture. This will show the cloud movement over the last hour or two. This will help you determine what weather is headed into town.

Another good astronomy weather resource is the Clear Sky Radar (cleardarksky.com/c/Bostonkey.html). Learn how to read it; it is your friend.

Finally, the most useful, precise, and accurate forecasts are often the Terminal Area Forecasts (TAFs) produced for aviation by the National Weather Service. These include detailed cloud forecasts indicating the predicted sky coverage and altitude of individual cloud layers. Go to aviationweather.gov/adds/tafs and type in the Boston Logan airport code "KBOS" into the box. Check the "Translated" toggle if you prefer not to learn the TAF code and hit "Get TAFs and METARs" (the METAR is a report of the current weather conditions). The outlook times for the forecasted conditions are given in Universal Time, so be aware of the time difference and whether daylight saving is in effect. The aviation sky condition definitions are as follows: A layer of *overcast* clouds indicates 100% sky coverage for that particular cloud layer. A layer of *broken* clouds indicates 5/8 – 7/8 sky coverage—when this forecast is in effect the afternoon before a lab, it's usually grounds for canceling lab. A *scattered* layer means 3/8 – 4/8 of the sky is expected to be covered in clouds, and *few* clouds means 1/8 – 2/8 cloud coverage—these can be trickier calls. *Clear skies* means just what you'd expect. Saddle up, partner!

Make the decision on whether or not to hold the night lab and make the announcement on the phone system before 6:30 pm (instructions are posted in the TF office next to the phone, and listed below). Many times you will see clouds in the sky at dusk; however this does not mean it will be a cloudy night. It is important to check the satellite images, because many times the clouds you see at dusk quickly pass through and leave a clear night behind. If the weather looks chancy, just announce on the phone system that you will put off making the decision for 30 minutes, (or if the first night lab begins at 8:30,

make the decision at 7:30). Remember, if too many night labs are cancelled we will have to hold extra night labs so students have an opportunity to come to the lab.

Once the decision has been made, put up signs on the door leading to the observatory indicating whether or not the lab will be held.

If the weather is good you will need to start setting up at least 45 minutes before it is scheduled to begin.

On the chalkboard in the observatory write down the date and time for that night lab and the weather conditions i.e. temperature, cloud conditions, visibility, and moon phase.

Set out the log notebook for the students to sign on the table in front of the chalkboard. The log notebook is usually kept in the table. Turn to a blank page and write in the date, time, and who the TFs are.

Set up the telescopes to be used that night.

Put the large metal buckets over the floodlights pointing up at the tower.

Make sure the red lights in the observatory are on.

You'll probably want to leave the door to the observatory shut until you are ready to begin the lab; otherwise students show up, mill around, and get in the way while you are trying to set up.

The observatory phone number that students should call to check on night lab status is **(617) 353-2630.**

Instructions for night lab phone announcements

Dial 3-9999 from a campus phone, or 617-353-9999 from a non-campus phone

Press * to enter the voice mail system

Enter 353-2630 (the observatory phone number)

Press 1 for 100 level labs or 2 for 200 level night labs

Enter 1054 as the passcode for AS 100 night labs. Enter 51652 for AS 200 night labs.

Press 9 from the main menu

Press 1 to change greetings, mailbox name, etc.

Press 2 to change the greeting message

Listen to the message, press 2 to change the greeting

When recording a message remember to press # at the end of the recording

Press 1 to save the message or 2 to rerecord. You MUST press 1 if you want to save the message.

Press * to exit

So in short: dial 3-9999, and when you hear the recorded instructions begin

enter * 353-2630

press 1 for 100 level labs, 2 for 200 level

Enter password

press 9, 1, 2

listen to the message

to change the message press 2, make the recording, listen to your recording, press 1 to keep or 2 to try again.

When you change the recording, be sure to include the date and weeknight in the message.

Ex: AS 100 level night labs are cancelled for Monday, September 31.

Ex: The AS 100 level night labs will be held tonight, Monday, September 31.

Shutting down

Once you have gotten all of the students out of the observatory close the door so no late students show up and try to sign the sheet.

To prevent "additions" to the log sheet make sure to cross through all the empty slots left and write the number of students on the top of the sheet.

Shut down and put up the scopes.

Bring the buckets in off the floodlights.

Make sure nothing is left outside.

Turn off the lights. Check to make sure no dome lights are left on.

Close all the doors.

Go to Rm 524 and write the weather and the number of students attended the lab in the space under you names on the rotation list.

You're done.

Appendix D: Graduation Checklist

On the following pages is a checklist often used by the Director of Graduate Studies to ensure you are on track to complete your degree. It is included for your reference.

BOSTON UNIVERSITY DEPARTMENT OF ASTRONOMY
CHECKLIST FOR PH.D. CANDIDATES

STUDENT NAME_____ ID#_____
FIRST YEAR_____ ADVISOR_____

COURSES

Core Courses: all 8 required

- ☐ AS701 Intro. to Astrophysics
- ☐ AS703 Intro. to Space Physics
- ☐ AS710 Observational Techniques
- ☐ AS712 Radiative Processes
- ☐ AS713 Spectroscopy
- ☐ AS725 Gravitational Astrophysics
- ☐ AS726 Cosmic Gas Dynamics
- ☐ AS727 Cosmic Plasma Physics

Advanced Courses: 3 required

- ☐ AS751 Interstellar Medium
- ☐ AS753 Normal Galaxies
- ☐ AS757 High-Energy Astrophysics
- ☐ AS759 Cosmology
- ☐ AS781 Planetary Atmospheres
- ☐ AS783 Ionospheres
- ☐ AS785 Magnetospheres
- ☐ AS786 Heliosphere
- ☐ AS791 Special Topics (Astrophysics)
- ☐ AS792 Special Topics (Space Physics)
- ☐ Other: _____
- ☐ Other: _____

Research Preparation: both required

- ☐ AS802 Intro. to Professional Astro.
- ☐ AS803 Computational Programming

Seminar: 2 required, either astrophysics or space physics

- ☐ AS850 Astrophysics
- ☐ AS851 Astrophysics
- ☐ AS865 Space Physics
- ☐ AS866 Space Physics

Directed study/research: no more than 12 credits

- ☐ AS901 Research
- ☐ AS902 Research
- ☐ AS911 Directed Study
- ☐ AS912 Directed Study

☐ Coursework complete – continuing full time form

☐ Advisor: _____

WRITTEN COMPREHENSIVE EXAM

☐ First Year: ☐ Pass ☐ Fail

☐ Second Year: ☐ Pass ☐ Fail

☐ Apply for Master's exam (form)

ORAL QUALIFYING EXAM

☐ Advisor chosen: _____

☐ Topic chosen: _____

☐ Committee formed

☐ Members: Advisor: _____

Chair: _____

_____

_____

_____

Approved: _____

☐ Exam advertised (at least one week before exam)

☐ Exam taken: Date: _____ ☐ Pass ☐ Fail

DISSERTATION

☐ Topic chosen: _____

☐ Committee formed

☐ Members: First Reader: _____

Second Reader: _____

(Third Reader): _____

Chair: _____

Other: _____

Approved: _____

☐ Committee met: Date: _____ Date: _____ Date: _____

☐ External member approved by Dean (vita and form)

☐ Title chosen: _____

☐ Prospectus approved (form) at least 6 months before defense

☐ File diploma application in GRS office

☐ Abstract approved (form) at least 3 weeks before defense

☐ Defense scheduled (form) at least 2 weeks before defense

☐ Defense advertised at least 1 week before exam

☐ Defense exam: Date: _____ Date: _____ Date: _____

☐ Thesis approved (signed by readers)

☐ **ALL DEGREE REQUIREMENTS MET**