# ASTR 102: Introduction to Stars and Galaxies

2023W2, 3 credits
MWF 12:00-12:50

**Course instructor**: Prof. Scott Oser (oser@phas.ubc.ca)
Office hours: immediately after class

**Teaching assistants**:
- Head TA: Raelyn Sullivan rsullivan@phas.ubc.ca
  - Office hours TBA
- L2A: Alyssa Cassity acassity@phas.ubc.ca
- L2B: Simran Kaur simran@phas.ubc.ca
- L2C: Justine Obidowski jusdowski@phas.ubc.ca
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- L2E: George Wang georgecpwang@phas.ubc.ca
- L2G: Alyssa Cassity acassity@phas.ubc.ca
- L2H: Simran Kaur simran@phas.ubc.ca

**Course delivery**: All lectures will be in-person in the UBC Life Building 2201 unless otherwise announced. Lecture attendance is highly encouraged -- we will ask in-class questions to help you to develop your understanding of the course material. Lecture slides and supplementary materials will be posted on Canvas.

**Required resources**:

- **Astronomy by OpenStax**: accessible at this link:
  https://openstax.org/books/astronomy/pages/preface
  This is a free e-book that will be updated and available to you (if you download a PDF copy) long after this course ends.
- **Lab Manual**: posted on Canvas, and updated throughout the term.
- **Piazza**: The Piazza discussion board will be available via Canvas.
- **Gradescope:** We will be submitting labs via Gradescope, available via Canvas.

**Prerequisites**: One of BC PHYS 11, BC PHYS 12, UBC PHYS 100 or equivalents (plus BC Principles of Mathematics 12 or equivalent).

**Note**: This course is *not required* for the Astronomy Major or for the Combined Honours specialization in Physics and Astronomy. These specializations begin with ASTR 200/205, which do not have this course as a prerequisite. If you are thinking of majoring in astronomy, I recommend you take those courses instead of this one. The mathematics involved in this course will include unit conversions, scientific notation, logarithms and algebra (rearrangement and use of formulas). We will not use calculus, sadly.

**Learning Goals**:
At the end of this course, you should:

- Be able to characterize a star (colour, brightness, distance to us, etc.).
- Be able to picture the location of our solar system in the Universe.
- Have a perception of the size of the Universe and different astronomical objects like galaxies, star clusters, galaxy clusters or voids.
- Provide an overview of today's knowledge of the history of the Universe.
- Understand the basic physical laws driving evolution of our Universe.
- Be able to answer questions like, "What powers a star?" "What is a galaxy?" "How big is the Universe?" "Where is the centre of the Universe?" "What are the big questions about the Universe we have left to learn?"

**Course Outline:**
Stars and stellar evolution from protostars to black holes; galaxies and quasars; cosmology.

| Wk | Week of | Lab # | Pre-reading (due Sunday at 11:59 pm) | Topics covered in class (target) | HW/quizzes/exams (Wednesdays) |
|---|---|---|---|---|---|
| 1 | Jan 7 | - | - | Powers of ten, astronomical angles, the nature of light, blackbody radiation. | - |
| 2 | Jan 14 | 1 | • Chapter 5<br>• Sections 3.1-3.3 | Spectra (absorption and emission), Doppler shift, Newton's laws review, gravity. | HW 1 due Jan 17 11:55 am |
| 3 | Jan 21 | 2 | • Section 19.2<br>• Sections 16.1-16.4<br>• Chapter 17 | Our Sun, fusion. Parallax, proper motion, radial velocity, luminosity, magnitude, apparent brightness | Quiz 1 Jan 24 during class time |
| 4 | Jan 28 | 2 | • Chapter 18<br>• Section 20.1 | Stellar spectra, spectral class, H-R diagrams, stellar binaries, ISM, nebulae | HW 2 due Jan 31 11:55 am |
| 5 | Feb 4 | 2 | • Sections 20.2 & 20.3<br>• Sections 21.1 & 21.2<br>• Chapter 22 | Protostars and stellar formation, stellar evolution, star clusters | HW 3 due Feb 7 11:55 am |
| 6 | Feb 11 | - | • Chapter 23 | Star cluster evolution, variable stars, mass transfer, late stellar evolution, planetary nebulae | Quiz 2 Feb 14 during class time |

| | | | | | |
|---|---|---|---|---|---|
| | **Feb 18** | | | **Midterm break** | |
| 7 | Feb 25 | 3 | • Chapter 24 | White dwarfs, nova and supernovae, neutron stars, pulsars, X-ray binaries, relativity, black holes, gravitational waves, LIGO, GRBs | **Midterm exam Feb 28** during class time |
| 8 | Mar 3 | 3 | • Chapter 25 | SMBHs, Schwarzschild radius, BH evaporation, MW structure, MW observations, dark matter, galaxy morphology | HW 4 due Mar 6th 11:55 am |
| 9 | Mar 10 | 4 | • Chapter 26<br>• Chapter 28 | Galaxy classes, measuring extragalactic distances, Hubble's Law, galaxy clusters, large-scale cosmic structure, grav. Lensing | HW 5 due Mar 13 11:55 am |
| 10 | Mar 17 | 4 | • Chapter 27 | Galaxy formation, dark matter distribution, quasars, active galactic nuclei (AGN), cosmological expansion | **Quiz 3** Mar 20 during class time |
| 11 | Mar 24 | 5 | • Sections 29.1-29.4 | The Big Bang, the Cosmic Microwave Background, geometry of the Universe<br>**No lecture Friday (holiday)** | HW 6 due Mar 27 11:55 am |
| 12 | Mar 31 | 5 | • Sections 29.5-29.7<br>• Sections 30.1 & 30.3<br><br>(note: due Tuesday Apr 2 due to holidays) | Dark Energy, Inflation, History of structure formation in the Universe<br>**No lecture Monday (holiday)** | HW 7 due Apr 3 11:55 am |
| 13 | Apr 7 | - | - | Prospects for life on other planets, SETI, review session for final (ask me anything session) | **Quiz 4** April 10 during class time |

**Marking Scheme:**

- Final exam (April, TBD): 35%
- Midterm exam (Wednesday February 28 during class time): 25%
- Quizzes (Jan 24, Feb 14, Mar 20, April 10 during class time), best 3 of 4: 10%
- Labs: 20%
- Homework assignments (any week without an exam or quiz): 6%
- Pre-reading assignments (weekly): 2%
- Class engagement (iClicker): 2%

**Class engagement:**

- We will use iClickers for attendance (we will not consider whether answers are correct - just attendance)
- Everyone gets 6 free missed classes (no additional free missed classes; no exceptions). Any missed classes beyond 6 will result in a proportional decrease to your engagement score for the term.

**Homework assignments:**

- Homework assignments will appear under "Quizzes" on Canvas on Wednesday afternoon (at 1:00 pm, just after class nominally ends).
- HW assignments will be due the following Wednesday (except for weeks we have a quiz or midterm exam) 5 minutes before class starts, at 11:55 am.
- Late homework will be accepted for up to one week after the deadline, with a 3%/day penalty. No homework will be accepted more than one week after the deadline. There will be no further extensions (no exceptions).
- All homework assignments will be weighted equally.

**Pre-reading assignments:**

- Pre-reading assignments will appear under `Quizzes' on Canvas by Sunday afternoon.
- Pre-reading will be due the following Sunday, every week, at 11:59 pm.
- Pre-reading assignments will be accepted for up to one week after the deadline, with a 3%/day penalty. No pre-reading assignments will be accepted more than one week after the deadline. There will be no further extensions (no exceptions).
- All pre-reading assignments will be weighted equally.

**Exams:**

**Midterm exam**: February 28 during our nominal class time, covering material we've covered in class through Friday Feb. 16.

**Final exam**: In April, covering the entire course. To pass the course, you must earn a mark of 45% or higher on the final.

**Labs**

2 hours per week beginning the week of Sun. Jan 14, the 2nd week of term. Labs will be held in Henn 312. Students will work in small groups with their section's TA circulating.

Lab reports will be written on worksheets that will be downloaded from Canvas and submitted via Gradescope. Lab due dates are listed below, and these will also be listed in the lab manual. You will need to ensure that you submit your lab to the correct section's "assignment" on Gradescope.

There are 7 lab sections at the following Pacific Times:

- L2A: Tue 12:00-14:00, Alyssa Cassity acassity@phas.ubc.ca
- L2B: Thu 10:00-12:00, Simran Kaur simran@phas.ubc.ca
- L2C: Wed 15:00-17:00, Justine Obidowski jusdowski@phas.ubc.ca
- L2D: Mon 13:00-15:00, , Justine Obidowski jusdowski@phas.ubc.ca
- L2E: Tue 09:00-11:00, George Wang georgecpwang@phas.ubc.ca
- L2G: Mon 09:00-11:00, Alyssa Cassity acassity@phas.ubc.ca
- L2H: Wed 10:00-12:00, Simran Kaur simran@phas.ubc.ca

All students must register for a lab section. **You must pass the lab component of the course to pass the course as a whole (this is a UBC policy)**.

**Lab due dates and times**: Labs are due the week after you finish in-class lab work, before the start of your section's class (even if you attended a different lab section in a previous week).

| Lab Section | Lab 1 | Lab 2 | Lab 3 | Lab 4 | Lab 5 |
|---|---|---|---|---|---|
| **L2A, due Tue. at 11:55 AM** | Jan. 23 | Feb. 13 | Mar. 12 | Mar. 26 | Apr. 9 |
| **L2B, due Thur. at 9:55 AM** | Jan. 25 | Feb. 15 | Mar. 14 | Mar. 28 | Apr. 11 |
| **L2C, due Wed. at 2:55 PM** | Jan. 24 | Feb. 14 | Mar. 13 | Mar. 27 | Apr. 10 |
| **L2D, due Mon. at 12:55 PM** | Jan. 22 | Feb. 12 | Mar. 11 | Mar. 25 | Apr. 8 |
| **L2E, due Tue. at 8:55 AM** | Jan. 23 | Feb. 13 | Mar. 12 | Mar. 26 | Apr. 9 |
| **L2G, due Mon. at 8:55 AM** | Jan. 22 | Feb. 12 | Mar. 11 | Mar. 25 | Apr. 8 |
| **L2H, due Wed. at 9:55 AM** | Jan. 24 | Feb. 14 | Mar. 13 | Mar. 27 | Apr. 10 |

**Late policy for labs**: Late-lab penalties will be 15% per day. All students will receive **a free 7 days on lab reports for the entire term**. Use these days wisely - if you turn in Lab 1 one week late, you are out of free days for the rest of the term.

**Course community agreement:** In order to build an inclusive and engaging learning environment that everyone can benefit from, we must interact with each other professionally. Here are some ground rules we will adopt for our in-class and tutorial discussions and on Piazza:

- Respect (Platinum Rule) – treat your colleagues in this course professionally. Listen while others are speaking. Be aware that others may have a very different perspective, and respect their experiences.
- Support - Learning to do astronomy is hard. Making mistakes during class or labs is the best possible use of our time; it presents the opportunity to give and receive feedback and for us all to improve. Don't be afraid to ask questions and test your understanding - that's what class is for! When giving feedback, make sure to phrase your comments and suggestions constructively – let's all help each other get up to speed.
- Limit Distractions – Close your email/chat tabs, silence your notifications and your phone. Don't chat with your neighbours during class except when prompted to do so.

**Policy on Missed Coursework:**

- Homework and pre-reading assignments: Assignments that are late (even by a minute) will be assessed a 3/day% penalty. Homework or pre-reading assignments that are not turned in within one week of the deadline will receive a grade of zero. There are no make-up homework or pre-reading assignments available, and no further extensions possible.
- Labs: Labs that are late by more than 5 minutes will use up one of the 7 free late days. After all 7 free late days are used up late lab reports will be assessed a 15% per business day penalty. In addition, lab reports not returned within one week of the deadline will receive a grade of zero. Further extensions will only be granted in extreme situations and at the discretion of Prof. Oser and the Head TA.
    - **Note: If you will miss your lab section for one week and plan to join another lab section, please contact that section's TA in advance, ideally at least the day before.**
- Quizzes: We will generally use the final exam grade in lieu of an excused missed quiz. (Note we only count the best 3 of 4 quizzes.)
- Midterm exam: We will generally use the final exam grade in lieu of an excused midterm exam grade.
- ***Students experiencing serious long-term illness, mental health issues, family crises and/or similar problems should contact Science Advising (or an advisor in your home faculty) ASAP with full documentation to request an academic concession***. Only Science Advising (or an advisor in your home faculty) can evaluate such requests.

**Calculators:** Please bring a non-programmable scientific calculator for exams and quizzes. You may not use a programmable calculator or any internet-equipped device. You may not use your phone as a calculator. We will not provide calculators if you forget yours.

**Academic Integrity Policies:**
Collaboration is a key component of building skills in this course! You should discuss strategies and help each other understand and solve homework problems and lab work. When you submit your lab or homework assignment, this should be done on your own and representative of your own understanding.

Assessments (quizzes and exams) you must write completely on your own. As a reminder, do not communicate with anyone else about the content of your quiz or exam before the assessment has closed (including posting it anywhere online). There are serious consequences for academic misconduct (see below).

*Important note on labs:* although you will be working with lab partners to collect data for some labs, you must each submit your own independent lab report which you prepare individually. The following is prohibited:

- Copying another student's lab report, even your lab partner's.
- Sharing your lab report with another student, even with your lab partners.
- Working through the lab report together line-by-line.
- Sharing materials (e.g. text, plots) with Google Docs.
- Sharing Excel spreadsheets, plots, and/or any code or programming tools used.

Lab reports which show evidence of copying or excessive collaboration will be given a grade of zero. Because you cannot pass this class unless you pass the lab portion, this can be disastrous. If you are at all uncertain about what level of collaboration with lab partners is acceptable, ask your TA.

**General:**

I expect all of you to regularly check whatever email UBC has registered for you in the Student Information Service. I will often email announcements and expect you to read them. "I never check my email" is not an acceptable excuse for missing a communication from me.

All UBC students are expected to be familiar with and to comply with the academic regulations in the UBC Calendar, especially:
http://www.calendar.ubc.ca/vancouver/index.cfm?tree=3,286,0,0.
See also UBC's policy on academic accommodation for students with disabilities:
http://www.calendar.ubc.ca/vancouver/index.cfm?tree=3,34,0,0.

This syllabus does not override any regulation outlined in the Academic Calendar or any University policy. In case of any discrepancy, Academic Calendar regulations and University policy take precedence.

UBC provides resources to support student learning and to maintain healthy lifestyles but recognizes that sometimes crises arise and so there are additional resources to access including those for survivors of sexual violence. UBC values respect for the person and ideas of all members of the academic community. Harassment and discrimination are not tolerated nor is

suppression of academic freedom. UBC provides appropriate accommodation for students with disabilities and for religious, spiritual and cultural observances. UBC values academic honesty and students are expected to acknowledge the ideas generated by others and to uphold the highest academic standards in all of their actions. Details of the policies and how to access support are available at https://senate.ubc.ca/policies-resources-support-student-success.

**Extreme weather contingency plans:**

In-person, on campus activities may need to be cancelled due to issues such as weather conditions (e.g., snow). The most up-to-date information about cancellations will be posted on ubc.ca. Please check ubc.ca often during times when an extreme weather event could disrupt our course activities. If in-person classes or exams are cancelled, the following contingency plans will take effect.

In case of an in-person class being cancelled due to weather, the lecture will be held online. The Zoom link will be posted on Canvas. For those unable to participate in an online class on short notice, I will provide a recording of the Zoom session. Online classes will not be included when calculating course participation marks.

If an in-person lab session is cancelled, look for an email from your lab TA with instructions on how to proceed. Some labs can be completed remotely, while others may require scheduling of a make-up session.

If a quiz or the midterm exam is cancelled due to weather, it will be rescheduled and held in person on a later date – most likely at the next in-person class session.