McMaster University | SCIENCE Department of Physics & Astronomy

We recognize and acknowledge that McMaster University meets and learns on the traditional territories of the Mississauga and Haudenosaunee nations, and within the lands protected by the "Dish with One Spoon" wampum, an agreement amongst all allied Nations to peaceably share and care for the resources around the Great Lakes.

ASTRON 3Y03 – Stellar Structure

2024 Fall Term (Version 2 – 27th August 2024)

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* See "Class Communication" section below

Course Description

The physics of stellar interiors. The main sequence and the life cycle of a star. Stellar evolution, including white dwarfs, neutron stars, and black holes.

Prerequisite(s): Six units from Level II PHYSICS, PHYSICS 1E03, ENGPHYS 2A04, 2H04, 2P04, 2QM3. PHYSICS 2G03 is strongly recommended.

Course Website: Information for this course, announcements, etc., will be posted on Avenue to Learn.

Course Learning Objectives

By the end of this course, you should have a good idea of what kinds of stars exist in the universe, how stars form, evolve and die, and how we know about them. You will use the current astronomical literature, real astronomical data, and modern stellar research tools.

Class Activities:

In this course, we will study the formation, structure, and evolution of stars. There will be a strong emphasis on hands-on learning and self-directed education. I expect that you will have a good grounding in basic physics, particularly mechanics and thermodynamics. I expect that you have some experience with data analysis and computer programing. Python is the preferred language for this course. This class will have both a lecture and a "lab" component. Usually, the lecture will be in the two-hour timeslot and the "lab" will be during the one-hour timeslot, and the latter will primarily be used as a time in which you can ask questions about the projects that you are working on.

Materials & Fees

- **Textbooks**
  - This course does not have a required textbook; however, there are textbooks that may be of interest:
    - An Introduction to Modern Astrophysics, B.W. Carroll & D.A. Ostlie (this textbook is also useful for Astronomy 3X03, although slightly outdated)
    - An Introduction to the Theory of Stellar Structure and Evolution, D. Prialnik
    - Introduction to Stellar Astrophysics (3 volumes), E. Böhm-Vitense
- **Calculator** (recommended)

  The McMaster Standard Calculator is the recommended and ideal calculator for tests. For details on what the McMaster Standard Calculator is and what models are acceptable please visit: https://registrar.mcmaster.ca/exams/requirements/
- **Course notes**

  Full copies of the lecture slides will be posted along with the lecture recordings.

Class Communication

- **MS Teams**: We strongly encourage the class MS Teams channel as the main method of communication for content-related questions.
- **Email**: Communication for private matters (e.g., MSAFs and test/assignment-related questions) should go directly to the instructor via the email above. We will generally respond as soon as possible (within 24 hours), but please allow 2-3 business days for a reply during busy periods.

If you have any questions about expectations or due dates, please ask your instructor for clarification – don't guess or rely on chatting with your peers.

Class Schedule and Activities:

The following in-person activities are scheduled:

Tue	8:30-10:20 am	See Mosaic for location
Thu	8:30-9:20 am	See Mosaic for location

Blended Course Delivery

To follow and participate in virtual components of this course it is expected that you have reliable access to the following:

- A computer that meets performance requirements found here.
- An internet connection that is fast enough to stream video.
- Computer accessories that enable class participation, such as a microphone, speakers and webcam when needed.

If you think that you will not be able to meet these requirements, please contact uts@mcmaster.ca as soon as you can. Please visit the Technology Resources for Students page for detailed requirements. If you use assistive technology or believe that our platforms might be a barrier to participating, please contact Student Accessibility Services, sas@mcmaster.ca, for support. Logging out of Teams and restarting your computer on a regular basis is advisable for the best user experience. If you experience any issues with MacVideo, please see the MacVideo documentation page.

Course Overview and Assessment

Topics (subject to change)

Week	Lecture Topics
1: Sep 3-6	Introduction to the course; introduction to stellar structure
2: Sep 9-13	Observing stars – photometry
3: Sep 16-20	Observing stars – astrometry and spectra Assignment 1 due Sep 19 (11:59 pm)
4: Sep 23-27	Observing stars – spectra Quiz 1 (Sep 26, 8:30-9:20 am); MSAF alternate quiz 1 date: Oct 1, 5:30-6:20 pm
5: Sep 30-Oct 4	Stellar structures – the equations Assignment 3 – progress report 1 due Oct 3 (11:59 pm)
6: Oct 7-11	Stellar structures – interiors
Oct 14-18	**Midterm Recess**
7: Oct 21-25	Stellar structures – energy generation Assignment 2 due Oct 24 (11:59 pm) Assignment 3 – progress report 2 due Oct 24 (11:59 pm)
8: Oct 28-Nov 1	Stellar evolution – the main sequence and beyond Quiz 2 (Oct 31, 8:30-9:20 am); MSAF alternate quiz 2 date: Nov 5, 5:30-6:20 pm

9: Nov 4-8	Stellar evolution
10: Nov 11-15	Stellar end states Assignment – 3 progress report 3 due Nov 14 (11:59 pm)
11: Nov 18-22	Star formation and the interstellar medium Assignment 3 due Nov 21 (11:59 pm)
12: Nov 25-29	Presentations Quiz 3 (Nov 28, 8:30-9:20 am); MSAF alternate quiz 3 date: Dec 3, 5:30-6:20 pm
13: Dec 2-5	Presentations

Evaluation

Assessment	Weight
Assignment 1: Introductory assignment	10%
Assignment 2: Observations with Gaia	24%
Assignment 3: Unusual stars	24%
Quizzes	42%

- **Assignments**: Due dates will be spaced throughout the term as per the schedule above. Your instructional team will help answer questions before 5pm of the assignment/project due dates. All assignments/projects are due before 11:59pm on the due date. However, all assignments/projects have a 72-hour grace period (i.e., you may submit your projects and assignments up to 72 hours after the due dates/times without late penalty - and you do not need to request for this grace period as everyone gets it automatically). These grace periods are added to handle conflicts with other courses, internet outages and other issues. We recommend that you **do not wait** until close to the end of the grace period to submit your work.
- **Quizzes**: No exams are planned for this course, but students must average 50% quiz component to pass the course (i.e., you can get less than 50% on an individual quiz and still pass the course so long as you get 50% on the total quiz component).
- **Final grades:** Please contact your instructional team throughout the term about concerns you have regarding grades on specific course components. However, please do not email your

instructor about when final grades will be released or to request grade bumps or make-up assignments. Final grades are calculated as soon as possible at the end of term after all course components have been completed. Final grades are then submitted to the Registrar's Office who will release your final grade. Make-up assignments are not offered in this course.

Requests for Relief for Missed Academic Term Work

McMaster Student Absence Form (MSAF): In the event of an absence for medical or other reasons, students should review and follow the Academic Regulation in the Undergraduate Calendar "Requests for Relief for Missed Academic Term Work". If you are in the Faculty of Science, please follow the guidelines in the notification from the Office of the Associate Dean.

Course Specific Information for MSAFs and Late Penalties

- **Assignments**: Your instructional team will help answer questions before 5pm of the assignment/project due dates. All assignments/projects are due before 11:59pm on the due date. However, all assignments/projects have a 72-hour grace period (i.e., you may submit your projects and assignments up to 72 hours after the due dates/times without late penalty - and you do not need to request for this grace period as everyone gets it automatically). These grace periods are added to handle conflicts with other courses, internet outages and other issues. We recommend that you **do not wait** until close to the end of the grace period to submit your work. The late penalty is a grade reduction of 10% per day up to a maximum of 40%. No assignments or projects will be accepted one week after the original due date. Assignments and projects extended with an MSAF is due immediately after the MSAF period ends (i.e., three days after the grace period ends).
- **Quizzes**: If you need to MSAF a quiz, you must write the quiz on the make-up date specified in the calendar.

If you have special circumstances, we advise contacting the instructor as soon as possible prior to the due date. MSAFs cannot be used for academic work that has already been completed or attempted. Attempting online includes opening a test/quiz on Avenue or another platform.

Note to Late-Arriving Students

If you add this course after the start of term, you must catch up on all relevant material as soon as possible and ask the instructor for any clarification as needed. The course schedule and evaluation system take into account that some students may add the course after the start of term by having no assessment due before the add/drop due date. Students are not permitted to add the course after the add/drop due date.

Academic Accommodation of Students with Disabilities

Students with disabilities who require academic accommodation must contact Student Accessibility Services (SAS) at 905-525-9140 ext. 28652 or sas@mcmaster.ca to make arrangements with a Program Coordinator. For further information, consult McMaster University's *Academic Accommodation of Students with Disabilities* policy.

Academic Accommodation for Religious, Indigenous or Spiritual Observances (RISO)

Students requiring academic accommodation based on religious, Indigenous or spiritual observances should follow the procedures set out in the RISO policy. Students should submit their request to their Faculty Office ***normally within 10 working days*** of the beginning of term in which they anticipate a need for accommodation or to the Registrar's Office prior to their examinations. Students should also contact their instructors as soon as possible to make alternative arrangements for classes, assignments, and tests.

McMaster University Statement on Inclusivity

The University values integrity, inclusiveness, and teamwork, and strives to support the personal and collective growth of the McMaster student community. These values are foundational to ensuring campus environments – both in-person and virtual – are conducive to personal wellbeing and academic success.

Course Statement on Equity, Diversity, and Inclusion (EDI)

Every registered student belongs in this course. Diversity of backgrounds and experiences is expected and welcome. You can expect your instructional team to be respectful of this diversity in all aspects of the course, and the same is expected of you. The Department of Physics and Astronomy is committed to creating an environment in which students of all genders, cultures, ethnicities, races, sexualities, abilities, and socioeconomic backgrounds have equal access to education and are welcomed and treated fairly. If you have any concerns regarding inclusion in our department, in particular if you or one of your peers is experiencing harassment or discrimination, you are encouraged to contact the Chair, Associate Chair of

Undergrad Studies, Undergraduate Advisor (Level I), and/or Undergraduate Advisor (Levels II to IV) (contact details listed here) or to contact the Equity and Inclusion Office. You are also always welcome to contact the instructor and/or your head teaching assistant – either with concerns and/or if you have any suggestions to improve the quality of the course materials.

In an ideal world, according to the Eurocentric/Western definition of science, science would be objective. However, much of science is subjective and is historically built on a small subset of privileged voices. In this class, we will make an effort to acknowledge a diverse group of scientists but limits still exist on this diversity. We acknowledge that it is possible that there may be both overt and covert biases in the material due to the lens with which it was written, even though the material is primarily of a scientific nature. Integrating a diverse set of experiences is important for a more comprehensive understanding of science. We will discuss issues of diversity in science as part of the course from time to time.

To help accomplish our commitment to EDI: If you have a name and/or set of pronouns that differ from those that appear in your official McMaster records, please let us know. If you feel like your performance in the class is being impacted by your experiences outside of class, please don't hesitate to come and talk with us. We want to be a resource for you. We (like many people) are still in the process of learning about diverse perspectives and identities.

Courses with an Online Element

McMaster is committed to an inclusive and respectful community. These principles and expectations extend to online activities including electronic chat groups, video calls and other learning platforms.

Some courses may use online elements (e.g., e-mail, Avenue to Learn (A2L), LearnLink, web pages, CAPA, Moodle, ThinkingCap, etc.). Students should be aware that, when they access the electronic components of a course using these elements, private information such as first and last names, usernames for the McMaster e-mail accounts, and program affiliation may become apparent to all other students in the same course. The available information is dependent on the technology used. Continuation in a course that uses on-line elements will be deemed consent to this disclosure. If you have any questions or concerns about such disclosure, please discuss this with the course instructor.

Online Proctoring

Some courses may use online proctoring software for tests and exams. This software may require students to turn on their video camera, present identification, monitor and record their computer activities, and/or lock/restrict their browser or other applications/software during tests or exams. This software may be required to be installed before the test/exam begins.

Academic Integrity

You are expected to exhibit honesty and use ethical behaviour in all aspects of the learning process. Academic credentials you earn are rooted in principles of honesty and academic integrity. **It is your responsibility to understand what constitutes academic dishonesty.** Academic dishonesty is to knowingly act or fail to act in a way that results or could result in unearned academic credit or advantage. This behaviour can result in serious consequences, e.g., the grade of zero on an assignment, loss of credit with a notation on the transcript (notation reads: "Grade of F assigned for academic dishonesty"), and/or suspension or expulsion from the university. For information on the various types of academic dishonesty please refer to the *Academic Integrity Policy*, located at https://secretariat.mcmaster.ca/university-policies-procedures- guidelines/

The following illustrates only three forms of academic dishonesty:

- plagiarism, e.g., the submission of work that is not one's own or for which other credit has been obtained
- improper collaboration in group work
- copying or using unauthorized aids in tests and examinations

Please note that while we encourage collaboration in astronomy and physics courses all work submitted should be your own, and all tests must be taken individually. Some components in this course may suggest working pairs or small groups – but for the coding assignments, we still require that each student submit their own report, written on their own, and in their own words. Copied work will not be accepted and will result in the appropriate (possibly severe) academic penalty.

Concerning the use of generative artificial intelligence

Students may use generative artificial intelligence ("genAI"; e.g., ChatGPT, Bing, Bard) in this course in accordance with the guidelines outlined for each assessment, and so long as the use of generative AI is referenced and cited. Use of generative AI outside assessment guidelines or without citation will

constitute academic dishonesty. It is the student's responsibility to be clear on the limitations for use for each assessment and to be clear on the expectations for citation and reference and to do so appropriately.

Authenticity / Plagiarism Detection

Some courses may use a web-based service (Turnitin.com) to reveal authenticity and ownership of student submitted work. For courses using such software, students will be expected to submit their work electronically either directly to Turnitin.com or via an online learning platform (e.g., Avenue, etc.) using plagiarism detection (a service supported by Turnitin.com) so it can be checked for academic dishonesty.

Students who do not wish their work to be submitted through the plagiarism detection software must inform the instructor before the assignment is due. No penalty will be assigned to a student who does not submit work to the plagiarism detection software. All submitted work is subject to normal verification that standards of academic integrity have been upheld (e.g., on-line search, other software, etc.). For more details about McMaster's use of Turnitin.com please go to the McMaster Office of Academic Integrity's website.

Conduct Expectations

As a McMaster student, you have the right to experience, and the responsibility to demonstrate, respectful and dignified interactions within all our living, learning, and working communities. These expectations are described in the *Code of Student Rights & Responsibilities* (the "Code"). All students share the responsibility of maintaining a positive environment for the academic and personal growth of all McMaster community members, **whether in person or online**.

It is essential that students be mindful of their interactions online, as the Code remains in effect in virtual learning environments. The Code applies to any interactions that adversely affect, disrupt, or interfere with reasonable participation in University activities. Student disruptions or behaviours that interfere with university functions on online platforms (e.g., use of Avenue, WebEx or Zoom for delivery), will be taken very seriously and will be investigated. Outcomes may include restriction or removal of the involved students' access to these platforms.

Additional information about the Code and netiquette can be found on the McMaster Student Support and Case Management website.

Copyright and Recording

Students are advised that lectures, demonstrations, performances, and any other course material provided by an instructor include copyright protected works. The Copyright Act and copyright law protect every original literary, dramatic, musical and artistic work, **including lectures** by University instructors.

The recording of lectures, tutorials, or other methods of instruction may occur during a course. Recording may be done by either the instructor for the purpose of authorized distribution, or by a student for the purpose of personal study. Students should be aware that their voice and/or image may be recorded by others during the class. Please speak with the instructor if this is a concern for you.

Research Ethics – Not applicable

Extreme Circumstances

The University reserves the right to change the dates and deadlines for any or all courses in extreme circumstances (e.g., severe weather, labour disruptions, etc.) Changes will be communicated through regular McMaster communication channels, such as McMaster Daily News, Avenue, and/or McMaster email.