Syllabus: Astronomy 132 – Stars, Galaxies and Cosmology

Instructor: Dr. Alex Pettitt **E-mail:** pettitt@csus.edu

Class time and location

Day/time: Monday/Wednesday/Friday, 14:00 – 14:50
SQU325, or virtual lectures via Zoom when required.
If a faculty member is not available during the semester, students will be contacted and advised how the course will proceed. This may include a change in instructor or modality.

Catalogue Description

Types and evolution of stars; structure and evolution of galaxies; overall structure of the universe; current developments in astronomy.

Office Hours

Monday 15:00 – 15:50, Wednesday 10:00 – 10:50, Thursday 9:00 – 9:50.
Also by appointment when necessary, or virtually by Zoom if ever required.
Office hours are held in SQU414 by default, if I am not present then I will instead be holding my office hours in the physics tutor center just downstairs (SQU238).

Contacting the Instructor

Email is the standard route to getting in contact, but messaging via Canvas also works. A dedicated Slack channel will also be available for more "live" discourse.

Online Resources

Canvas will be used for all online class elements. This includes: announcements, links to external websites, posted grades, homework assignments, quizzes, exams, and lectures via Zoom integration when needs require.

Mathematics

This is a non-calculus course but requires a knowledge of algebra and some basic trigonometry. Mathematics is not required to *pass* the course, but some will be needed to get the highest grades. As such, you will require a basic scientific calculator.

Course Commitment

This course involves lectures/discussions three times a week, but it is expected that students read and study their texts themselves in tandem to the course. The university recommends students spend twice the lecture time as private study (be it on assessments or digestion of course material), which means you should plan to dedicate at least 7 – 8 hours each week on this course (2.5hr on lectures + 5hr on non-lecture activities).

Course Goals

This is an upper division GE (General Education) area B5 (Physical Science) course, with a Writing Intensive Graduation Requirement (WI). The over-arching course **writing goals** are:

- To hone student's writing ability, including how to concisely and accurately put forward scientific ideas.
- To ready students with the knowledge needed to explain complex astrophysical phenomena in the general field of stellar and galactic astrophysics.
- To improve student's ability to research complex topics on their own, which will be the first stages in preparing for their written assignments.
- To encourage students to think critically about multi-faceted topics, using astronomy as a general backdrop.

While the goals related to the **astronomy content** of course are:

- To describe the basic principles of modern astronomy: classical mechanics, the electromagnetic spectrum, the formation and evolution of stars, and the structure of galaxies.
- To describe how advances in astronomy shape our changing understanding of the Universe we live in, and how ideas change and adapt to new evidence.
- To explain how astronomers apply knowledge of physics and chemistry to study distant objects via observations and theoretical modelling and apply models yourselves to a number of astronomical phenomena.
- To identify key properties of stars and galaxies: how they are formed, how they change with time, and their statistical properties.

Classes

Time in class will be spent covering the major topics, with opportunities for open discussion. Students will be set readings before class so they are prepared for the topics covered. Time will also be spent giving feedback on previous assignments. Students are *strongly* encouraged to attend these, but attendance is not mandatory. Beware though: some coursework elements will take place *in class,* so do not make a habit out of continually skipping class as it will start to impact your grade.

Topics

The topics we will cover are as follows, split into 4 main parts:

Part A: Light

Luminosity, magnitudes, the duality of light, the electromagnetic spectrum, the Doppler effect, bands and filters, atomic structure, spectroscopy and spectral lines.

Part B: Stars

The Sun, sun-spots, hydrodynamic equilibrium, binary stars, nuclear fusion, stellar interiors, the Hertzsprung Russell diagram, parallax, the interstellar medium, star formation, stellar evolution and stellar death.

Part C: Galaxies

The Milky Way, the interstellar medium, galactic structure, galactic kinematics, galactic evolution, dark matter, galactic interactions, starburst galaxies, dwarf galaxies, active galactic nuclei and quasars.

Part D: Cosmology

Large-scale structure of the Universe, galaxy groups, inter-galactic medium, the expansion of the universe, the Big Bang, the early Universe, dark energy, the shape of spacetime and the fate of the Universe.

Important Dates

Some useful dates to keep in mind. Please note examination dates are tentative as of writing but will be confirmed several weeks in advance.

Mon. Jan 22rd – First class
Fri. Mar 1st – Exam 1 (*tentative*)
March 18th – 22th – Spring recess
Mon. April 1st – No class (C Chavez)
Fri. April 19th – Exam 2 (*tentative*)
Fri. May 10th – Last class
Wed. May 15th – Final Exam, 12:45-14:45

Schedule

Note that "Reading Material" refers to chapters in the recommended textbooks:
K = Kutner, CM = Chaisson & McMillan, BOB = Caroll & Ostile (fondly known in astronomical circles as the "Big Orange Book").

Week	Topic	Reading Material	Assignment
1	Intro, radiation	K2; CM3; BOB3	
2	Spectra	K3; CM4; BOB5	Homework 1
3	The Sun	K6,9; CM16; BOB10,9,11	Paper 1
4	The Sun	K6,9; CM16; BOB10,9,11	Homework 2
5	Stars	K5,3,13; CM17; BOB7,8,13	Paper 2
6	Stars (**Exam 1 week**)	K5,3,13; CM17; BOB7,8,13	Exam revision
7	Interstellar medium and stellar birth	K14,15; CM18,19; BOB7,8,13	Homework 3
8	Interstellar medium and stellar birth	K14,15; CM18,19; BOB7,8,13	Paper 3
9	Stellar life	K9; CM18,19; BOB12	Homework 4
10	Stellar death	K10,11,12; CM21,22; BOB15,16,17,18	Paper 4
11	The Milky Way	K16; CM23, BOB24	Homework 5
12	Galaxies (**Exam 2 week**)	K17; CM24,25; BOB25,26	Exam revision
13	Active galaxies	K19; CM24; BOB28	Final Paper
14	Large scale structure	K18; CM25,26; BOB27	
15	The Universe	K20,21; CM26,27; BOB29,30	Exam revision
Finals	**Comprehensive Final Exam**		

Required Material

- Access to a computer with some word processing software (e.g. MS Word, LibreOffice, Apple Pages). Handwritten assignments will not be accepted.
- Access to the internet, for out-of-class activities and virtual lectures as needed.
- A scientific calculator. Graphical is ok too and will be allowed in exams.
- [*Strongly recommended*] Access to one of the textbooks listed below. Be sure to check out possible rental access at a reduced cost.

Textbooks

It is advisable you have access to one of the following textbooks. While not necessary, students should consolidate what they encounter in class outside of the classroom, and textbooks offer a good benchmark of what has been covered. I list a few good choices below; each has their merits and you should pick in accordance with your level of interest in the topic:

- *Astronomy: A Physical Perspective*, Kutner
  This follows the level of the course well, and is a strong recommendation, though has more math than we'll need. The main downside is that it is a little out-of-date in a few places (I'll cover such shortcomings in class). **Recommended for**: science majors.
- *Astronomy Today,* Chaisson & McMillan
  This text is quite nice, very readable and modern. However, it doesn't go into the highest levels of detail we will be in class. **Recommended for**: non-science majors.
- *An Introduction to Modern Astrophysics,* Carroll & Ostlie
  Higher level and much more *physics-y* than the other two. I would suggest this if you are mathematically inclined and are interested in studying more astronomy/astrophysics in the future. **Recommended for**: physics, engineering or math majors.

If you absolutely cannot access any of these, then *Astronomy* from OpenStax (Fraknoi, Morrison, and Wolff) is freely available at: https://openstax.org/details/books/astronomy-2e. This is too basic in level for our needs, but it will be better than nothing.

Coursework

Every week there will be some kind of assignment. Please make the most of the opportunity to take some of the pressure off your exams! Some of the coursework elements may also take place in lectures themselves, but most will be "take home" to complete out of class. Some examples of coursework:

- Papers, fulfilling the writing intensive requirement of the course (see below for details).
- Short exercises, including occasional mathematical questions.
- Interactive experiments/activities with some assessment of student understanding, utilizing online tools.

Writing

As a writing intensive course, you are expected to produce at least 5,000 words throughout the semester. There will be two main ways this will be fulfilled. Periodically students will be given short writing assignments as part of the coursework. These will require some critical opinion on a topical aspect of astronomy, explaining some complex astrophysical idea, and will necessitate independent research into the topic in question. The second writing component is the preparation of a final paper, which will contribute towards 20% of the final grade. This paper will be a long-term endeavor, with the instructor helping students select a topic and plan the paper's structure.

Writing must be of a certain standard, note the phrase "*show me you can write"*, is a more accurate description of the written aspect than "I will teach you how write".

Exams

There will be three exams in this course, see "Important Dates" above. The first exam will occur before Spring, and will cover material encountered up to that point (mostly stars and radiation). The second exam will be held in the latter 2/3 of the course and cover the material covered since the first exam (likely stellar death and galaxies). We then have a final exam that covers the entire semester's material, occurring in "finals week". Make-up exams will be given only in the most extraneous of circumstances with proof provided of their necessity, and only by prior arrangement.

Course Grade

Your course grade is determined by the points you earn during the semester in each of the following categories:

Coursework:	25%
Participation/activities	10%
Final paper:	20%
Exam 1:	15%
Exam 2:	15%
Final Exam:	15%
Total:	**100%**

Note that: *No extra credit will be offered in this class by default*. Grades will be assigned based upon a traditional grading scale:

≥ 95 %	A	≥ 77 %	B –	≥ 62%	D +
≥ 90%	A –	≥ 73 %	C +	≥ 58%	D
≥ 87 %	B +	≥ 69 %	C	≥ 55%	D –
≥ 82 %	B	≥ 66 %	C –	below 55 %	F

Participation/activities

Participation is not mandatory, BUT it does constitute part of your "Participation" grade and attendance will be taken every class. "Activities" take a number of guises; including weekly reviews of material, and small in-class quizzes.

Canvas

Please check announcements via email and Canvas ***frequently***. Please set your Canvas announcements to automatically send you a message when an announcement has been posted. I will post details of exams, homework, lecture material etc., please don't ignore it!

Course Etiquette and Questions

Questions are valid at any time during a class, and are also welcome via the discussion board in Canvas or Slack. If you are unsure of something the instructor has just said, there is a very good chance that someone else is unsure as well, so help your fellow classmates by asking a question. Questions during virtual classes can be posted into the Zoom chat window or asked by unmuting your microphone and asking out loud ("excuse me Professor") but it's polite to use the *raise hand* option initially.

COVID: Safety and wellness

You should be aware by now of Sacramento State's Fall 2022 COVID 19 policies. You can find out more at Sacramento State's COVID-19 page. We will be following those policies in this classroom. Vaccines are required for everyone on campus except those who have been granted a religious or medical exemption per the CSU's COVID-19 vaccination requirement. Masks are not required at this point but are recommended indoors. Please respect your fellow students' decision to mask or not mask. You can schedule a vaccine at My Turn California and find out more about vaccines and booster eligibility on the CDC website. Remember that COVID-19 is still a threat, even for those who are vaccinated and boosted. Please practice self-care, monitor your health for any possible symptoms of COVID-19, and contact a health care provider immediately should you believe you may be infected.

COVID: Attendance

Do not come to class if you have COVID-19 symptoms or test positive. COVID-19 tests and safety supplies are available at many locations around campus, including the library and student union. The University will continue to offer free testing to students who are symptomatic through Student Health and Counseling Services. To increase safety on campus, you are required to report a positive COVID-19 test. You will find a confidential reporting form on the Student Affairs COVID-19 web page. Everyone who tests positive, regardless of vaccination status, is required to stay home for at least 5 days. You should stay home for up to 10 days if your symptoms are not resolved or you continue to test positive. If you come into contact with someone who has tested positive for COVID-19, please refer to this flowchart. If you need to isolate, please notify me immediately.

- If you are isolating and not ill, I expect you to stay up to date with your academic work remotely as best you can. Checking in with me for assignments will be your responsibility.
- If you are ill, please contact me as soon as you are well so we can work together to catch you up with the rest if the class.
- You will find the latest updates to academic continuity during COVID-19 here.

COVID: Flexibility

The degree to which COVID-19 will impact the Sacramento State campus this fall is hard to predict. We want to focus on making your time as a Hornet a memorable and fulfilling experience. But patience and flexibility on all our parts will still be necessary as we navigate COVID-19 -related absences. Communicating with me in a clear and timely manner will help you stay on track academically and help all of us stay healthy.

Code of Conduct

The Department of Physics and Astronomy has unanimously approved the following statement: "The faculty of the Department of Physics and Astronomy will not tolerate academic dishonesty. Falsification of data, copying, unauthorized collaboration, plagiarism, alteration of graded materials, or other actions (as described in, but not necessarily limited to the Sacramento State Policy Manual) *will be promptly reported to the Office of Student Affairs.* The offending student will be penalized on the assignment in question. Serious infractions will result in course failure and a recommendation for administrative sanctions."

Plagiarism

As there is a significant writing component in this class, I remind students of the strict plagiarism policy of the university. Below is an excerpt from the CSUS webpage on article STU-100 on the

matter https://www.csus.edu/umanual/student/stu-100.htm. Note the instructor is well-aware of modern approaches to plagiarism at the college level (e.g., A.I. assistance), and has tools at their disposal to root it out. If a student is found to have plagarised the consequences will be severe, with at minimum a failing grade for the course and reporting the offence to the university's Office of Student Conduct.

Plagiarism, as a form of cheating, is the use of distinctive ideas or works belonging to another person without providing adequate acknowledgement of that person's contribution. Regardless of the means of appropriation, incorporation of another's work into one's own requires adequate identification and acknowledgement. Plagiarism is doubly unethical because it deprives the author of rightful credit and gives credit to someone who has not earned it. Acknowledgement is not necessary when the material used is common knowledge. Plagiarism at Sacramento State includes but is not limited to:

1. *The act of incorporating into one's own work the ideas, words, sentences, paragraphs, or parts thereof, or the specific substance of another's work without giving appropriate credit thereby representing the product as entirely one's own. Examples include not only word-for-word copying, but also the "mosaic" (i.e., interspersing a few of one's own words while, in essence, copying another's work), the paraphrase (i.e., rewriting another's work while still using the other's fundamental idea or theory); fabrication (i.e., inventing or counterfeiting sources), ghost-writing (i.e., submitting another's work as one's own) and failure to include quotation marks on material that is otherwise acknowledged; and*
2. *Representing as one's own another's artistic or scholarly works such as musical compositions, computer programs, photographs, paintings, drawing, sculptures, or similar works.*

Netiquette

Given that this class is partially online, it is important that we keep in mind the importance of some basic guidelines for participating in online discussion forums. You can find more info about this in our Canvas course. In short, it is very important to be clear in your messages, avoid potentially offensive comments, and generally reread your messages before posting to make sure they say what you meant to convey. You can also find more information here: http://www.albion.com/netiquette/corerules.html.

Students with Disabilities (SSWD)

Sacramento State is committed to ensuring an accessible learning environment where course or instructional content are usable by all students and faculty. If you believe that you require disability-related academic adjustments for this class (including pregnancy-related disabilities), please immediately contact Services for Students with Disabilities (SSWD) to discuss eligibility. A current accommodation letter from SSWD is required before any modifications, above and beyond what is otherwise available for all other students in this class will be provided. Please be advised that disability-related academic adjustments are not retroactive. SSWD is located on the first floor of Lassen Hall 1008. Phone is 916-278-6955 and e-mail is sswd@csus.edu. For a complete listing of services and current business hours visit https://www.csus.edu/student-affairs/centers-programs/services-students-disabilities/.

Basic Needs Support (CARES)

If you are experiencing challenges with food, housing, financial or other unique circumstances

that are impacting your education, help is just a phone call or email away. The CARES office provides case management support for any enrolled student. Email the CARES office at cares@csus.edu to speak with a case manager about the resources available to you. See the CARES website for more information: https://www.csus.edu/student-affairs/crisis-assistance-resource-education-support/.

Student Health & Counseling Services (SHCS)

Your physical and mental health are important to your success as a college student. Student Health and Counseling Services (SHCS) in The WELL offers medical, counseling, and wellness services to help you get and stay healthy during your time at Sac State. Asking for support sooner rather than later is often helpful. SHCS offers: Primary Care medical services, including sexual and reproductive healthcare, transgender care, and immunizations; urgent care for acute illness, injuries, and urgent counseling needs; pharmacy for prescriptions and over-the-counter products; mental health counseling, including individual sessions, group counseling, support groups, mindfulness training, and peer counseling; athletic training for sports injury rehabilitation; wellness services, including nutrition counseling, peerled health education and wellness workshops, and free safer sex supplies; violence and sexual assault support services. Call (916) 278-6461 and visit their website at https://www.csus.edu/shcs/. Most services are covered by the Health Services fee and available at no additional cost. A number of services are offered using secure remote technology if students are off-campus. If you or someone you know is feeling suicidal or in danger of self-harm, call someone immediately, day or night: 1-800-273-TALK (8255) to speak with a nurse or call 911.

Gender Violence Resources

CSUS is committed to providing an environment free of all forms of discrimination and sexual harassment, including sexual assault, domestic and dating violence, and genderbased stalking. If you (or someone you know) has experienced or experiences genderbased violence (intimate partner violence, attempted or completed sexual assault, harassment, coercion, stalking, etc.), know that you are not alone. CSUS has staff members trained to support survivors in navigating campus life, accessing health and counseling services, providing academic and housing accommodations, helping with legal protective orders, and more. Please visit https://www.csus.edu/student-affairs/crisis-assistance-resource-education-support/.
The University requires faculty and staff to report any personal disclosures of sexual misconduct including rape, dating/domestic violence and stalking to the Title IX Coordinator. Students who do not wish to report their experience to me or the Title IX Coordinator may speak to someone confidentially by contacting Student Health and Counseling Services.

University Standards and Procedures

- This course is subject to the university's usual ADD/DROP policy, detailed here: Drop and Withdrawal Policy.
- This course uses the university's standard grade terminology, detailed here: Grading Policy.

Links to Other Campus Resources

- Academic Advising
- Information Resources and Technology
- Support Centers and Programs
- Reading & Writing Center

- Student Rights and Responsibilities

Course FAQ

- *I was sick/overworked/absent last week, can I have a "do-over" on the homework?*
  Perhaps, but not as a general rule. Life often gets in the way of things, and the instructor can usually offer some kind of accommodation, e.g. dropping the HW from that student's grade or offering some other substitute (if the accommodation is well-justified). However, this must be requested in advance of an assignment deadline, and repeat requests from the same student are likely to be denied.

- *What is the late HW policy for the course?*
  There is no strict late HW policy (e.g. 1 day late = X% drop). See the answer above.

- *Where can I see my current grade for the course?*
  There is no single place to see a student's current grade. Canvas does keep scores for individual assessments (if the instructor utilizes this feature), but the weighting for the grade "total" may not be indicative of the actual total grade. This depends on the instructor who may apply their own unique policies for grading that may be done outside of Canvas, such dropping lowest scoring HW. It is, however, common to inform students of their grades after midterms as a "sit-rep".

- *I really need this class for graduation, can I have a "grade bump" to a pass?*
  No. Individual requests like this violate academic integrity and amount to asking for special favors. It is not equitable, and bases grades on something other than the student's demonstrated level of performance. Instead, the student should seek help early as the instructor is normally more than happy to oblige and can give advice/extra assistance where needed. Requests like the above often come in far too late to be actionable.

- *What kind of mathematics is required for the course?*
  Any mathematical component takes up only small total fraction of the course, and students can gain a B grade even if they ignore all mathematical questions. That said, the mathematics is only of high school level and includes such elements as: multiplication, division, powers, square roots, simple trigonometry/angles, exponentials and logarithms, and changing units. Students will be given equation sheets in exams that include every equation seen in the course. Note this is an upper-division science class so some mathematics is required.

- *What makes this class "writing intensive"?*
  The main feature is the stipulation that I must assess at least 5000 words of written prose from students throughout the course, which will easily be accomplished by the semester's end. Note that this class's purpose is not to teach students how to write, and class time will be dedicated to astronomy, not writing techniques (this is not ENGL132!). I will, however, give plenty of individual feedback on written assignments, and cover *some* of the nuisances of writing in the context of science (as opposed to the arts and humanities) in class.

Note: the instructor reserves the right to update the syllabus and schedule during the semester.