



COURSE OUTLINE

1. **Course:** ASPH 503, The Interstellar Medium - Winter 2019

Lecture 01: MWF 15:00 - 15:50 in SA 119

Instructor	Email	Phone	Office	Hours
Rene Plume	rplume@ucalgary.ca	N/A	SB 517	By appointment

Course Site:

D2L: ASPH 503 L01-(Winter 2019)-The Interstellar Medium

Note: Students must use their U of C account for all course correspondence.

2. **Requisites:**

See section [3.5.C](#) in the Faculty of Science section of the online Calendar.

Prerequisite(s):

Astrophysics 401, Physics 325, 343 and Mathematics 375.

Note(s):

- a. Concurrent or prior enrolment in Astrophysics 403 is highly recommended.

3. **Grading:**

The University policy on grading and related matters is described in [F.1](#) and [F.2](#) of the online University Calendar. In determining the overall grade in the course the following weights will be used:

Components	weighting %	Dates
Assignments	50	Feb 4, Mar 4, Mar 25, Apr 12
In-Class Exam (1)	15	Friday, Mar 8
Final Exam	35	TBA

Each piece of work (reports, assignments, quizzes, midterm exam(s) or final examination) submitted by the student will be assigned a grade. The student's grade for each component listed above will be combined with the indicated weights to produce an overall percentage for the course, which will be used to determine the course letter grade.

The conversion between a percentage grade and letter grade is as follows.

	A+	A	A-	B+	B	B-	C+	C	C-	D+	D
Minimum % Required	95 %	90 %	85 %	80%	75%	70 %	65 %	60%	55%	50 %	45 %

This course has a registrar scheduled final exam.

4. **Missed Components Of Term Work:**

In the event that a student misses the midterm or any course work due to illness, supporting documentation, such as a medical note or a statutory declaration will be required (see [Section N.1](#); for more information regarding the use of statutory declaration/medical notes, see [FAQ](#)). Absences must be reported within 48 hrs.

The regulations of the Faculty of Science pertaining to this matter are found in the Faculty of Science area of the Calendar in [Section 3.6](#). It is the student's responsibility to familiarize themselves with these regulations. See also [Section E.3](#) of the University Calendar.

5. **Scheduled Out-of-Class Activities:**

There are no scheduled out of class activities for this course.

6. **Course Materials:**

Recommended Textbook(s):

Sun Kwok, *Physics & Chemistry of the Interstellar Medium*. Univ Science Books.

7. **Examination Policy:**

All tests and exams are closed book. A formula sheet will be provided. Calculators are allowed.

Students should also read the Calendar, [Section G](#), on Examinations.

8. **Approved Mandatory And Optional Course Supplemental Fees:**

There are no mandatory or optional course supplemental fees for this course.

9. **Writing Across The Curriculum Statement:**

For all components of the course, in any written work, the quality of the student's writing (language, spelling, grammar, presentation etc.) can be a factor in the evaluation of the work. See also Section [E.2](#) of the University Calendar.

10. **Human Studies Statement:**

Students will not participate as subjects or researchers in human studies.

See also [Section E.5](#) of the University Calendar.

11. **Reappraisal Of Grades:**

A student wishing a reappraisal, should first attempt to review the graded work with the Course coordinator/instructor or department offering the course. Students with sufficient academic grounds may request a reappraisal. Non-academic grounds are not relevant for grade reappraisals. Students should be aware that the grade being reappraised may be raised, lowered or remain the same. See [Section I.3](#) of the University Calendar.

a. **Term Work:** The student should present their rationale as effectively and as fully as possible to the Course coordinator/instructor within **15 days** of either being notified about the mark, or of the item's return to the class. If the student is not satisfied with the outcome, the student shall immediately submit the Reappraisal of Graded Term work form to the department in which the course is offered. The department will arrange for a re-assessment of the work if, and only if, the student has sufficient academic grounds. See sections [I.1](#) and [I.2](#) of the University Calendar

b. **Final Exam:** The student shall submit the request to Enrolment Services. See [Section I.3](#) of the University Calendar.

12. **Other Important Information For Students:**

a. **Mental Health** The University of Calgary recognizes the pivotal role that student mental health plays in physical health, social connectedness and academic success, and aspires to create a caring and supportive campus community where individuals can freely talk about mental health and receive supports when needed. We encourage you to explore the mental health resources available throughout the university community, such as counselling, self-help resources, peer support or skills-building available through the SU

Wellness Centre (Room 370, MacEwan Student Centre, [Mental Health Services Website](#)) and the Campus Mental Health Strategy website ([Mental Health](#)).

- b. **SU Wellness Center:** The Students Union Wellness Centre provides health and wellness support for students including information and counselling on physical health, mental health and nutrition. For more information, see www.ucalgary.ca/wellnesscentre or call [403-210-9355](tel:403-210-9355).
- c. **Sexual Violence:** The University of Calgary is committed to fostering a safe, productive learning environment. The Sexual Violence Policy (<https://www.ucalgary.ca/policies/files/policies/sexual-violence-policy.pdf>) is a fundamental element in creating and sustaining a safer campus environment for all community members. We understand that sexual violence can undermine students' academic success and we encourage students who have experienced some form of sexual misconduct to talk to someone about their experience, so they can get the support they need. The Sexual Violence Support Advocate, Carla Bertsch, can provide confidential support and information regarding sexual violence to all members of the university community. Carla can be reached by email (svsa@ucalgary.ca) or phone at [403-220-2208](tel:403-220-2208).
- d. **Misconduct:** Academic misconduct (cheating, plagiarism, or any other form) is a very serious offence that will be dealt with rigorously in all cases. A single offence may lead to disciplinary probation or suspension or expulsion. The Faculty of Science follows a zero tolerance policy regarding dishonesty. Please read the sections of the University Calendar under [Section K](#). Student Misconduct to inform yourself of definitions, processes and penalties. Examples of academic misconduct may include: submitting or presenting work as if it were the student's own work when it is not; submitting or presenting work in one course which has also been submitted in another course without the instructor's permission; collaborating in whole or in part without prior agreement of the instructor; borrowing experimental values from others without the instructor's approval; falsification/ fabrication of experimental values in a report. **These are only examples.**
- e. **Assembly Points:** In case of emergency during class time, be sure to FAMILIARIZE YOURSELF with the information on [assembly points](#).
- f. **Academic Accommodation Policy:** Students needing an accommodation because of a disability or medical condition should contact Student Accessibility Services in accordance with the procedure for accommodations for students with disabilities available at [procedure-for-accommodations-for-students-with-disabilities.pdf](#).

Students needing an accommodation in relation to their coursework or to fulfill requirements for a graduate degree, based on a protected ground other than disability, should communicate this need, preferably in writing, to the Associate Head of the Department of Physics & Astronomy, Dr. David Feder by email phas.ahugrd@ucalgary.ca or phone [403-220-8127](tel:403-220-8127). Religious accommodation requests relating to class, test or exam scheduling or absences must be submitted no later than **14 days** prior to the date in question. See [Section E.4](#) of the University Calendar.
- g. **Safewalk:** Campus Security will escort individuals day or night (See the [Campus Safewalk](#) website). Call [403-220-5333](tel:403-220-5333) for assistance. Use any campus phone, emergency phone or the yellow phones located at most parking lot pay booths.
- h. **Freedom of Information and Privacy:** This course is conducted in accordance with the Freedom of Information and Protection of Privacy Act (FOIPP). Students should identify themselves on all written work by placing their name on the front page and their ID number on each subsequent page. For more information, see [Legal Services](#) website.
- i. **Student Union Information:** [VP Academic](#), Phone: [403-220-3911](tel:403-220-3911) Email: suvpaca@ucalgary.ca. SU Faculty Rep., Phone: [403-220-3913](tel:403-220-3913) Email: sciencerep@su.ucalgary.ca. Student Ombudsman, Email: suvpaca@ucalgary.ca.
- j. **Internet and Electronic Device Information:** Unless instructed otherwise, cell phones should be turned off during class. All communication with other individuals via laptop, tablet, smart phone or other device is prohibited during class unless specifically permitted by the instructor. Students that violate this policy may be asked to leave the classroom. Repeated violations may result in a charge of misconduct.
- k. **Surveys:** At the University of Calgary, feedback through the Universal Student Ratings of Instruction ([USRI](#))

survey and the Faculty of Science Teaching Feedback form provides valuable information to help with evaluating instruction, enhancing learning and teaching, and selecting courses. Your responses make a difference - please participate in these surveys.

1. **Copyright of Course Materials:** All course materials (including those posted on the course D2L site, a course website, or used in any teaching activity such as (but not limited to) examinations, quizzes, assignments, laboratory manuals, lecture slides or lecture materials and other course notes) are protected by law. These materials are for the sole use of students registered in this course and must not be redistributed. Sharing these materials with anyone else would be a breach of the terms and conditions governing student access to D2L, as well as a violation of the copyright in these materials, and may be pursued as a case of student academic or [non-academic misconduct](#), in addition to any other remedies available at law.

Course Syllabus:

This course covers the distribution, dynamics, chemistry, and physical state of matter (elementary particles, atoms, molecules and dust grains) in interstellar space, and its interaction with photons. Radiation transport and atomic physics are an integral part of the course.

We will give a brief overview of measurement techniques, but this course focuses mainly on astrophysical concepts with attention to astrochemistry. We begin with an overview of the different phases of the interstellar medium, how they are observed, and an introduction to processes that change the interstellar medium. Principles of radiation transport, optical depth and applications of radiation transport in the interstellar medium will be covered. The concepts of local thermodynamic equilibrium (LTE) versus non-LTE are discussed along with some examples of LTE and non-LTE situations. We will discuss photo-ionization and recombination, photo-dissociation of molecules, and spectral line processes of atoms and molecules. We introduce concepts of collisional de-excitation and critical density as well as heating and cooling processes of the interstellar medium. Continuum radiation processes will be discussed briefly. The nature of interstellar dust grains (size distribution, composition, PAH), interstellar extinction, scattering of light by small particles, thermal emission of dust grains and their relation to gas-phase chemistry will be discussed. Finally we will discuss the physics behind star formation including free-fall collapse, Jean's instabilities, and Bonner-Ebert spheres. While the textbook for this course emphasizes astrophysical processes, the lectures and assignments will address practical applications for the atomic, molecular, and ionized phases of the interstellar medium. These processes will include spectral line opacity effects, population of energy levels, and molecules that trace species that are hard to observe, or certain density or temperature intervals.

1. Overview of the ISM
 1. History of ISM studies
 2. Components & Phases of the ISM
 3. Distribution of the ISM
2. Physical Parameters & Processes in the ISM
 1. Local Thermodynamic Equilibrium
 2. Detailed Balance (Statistical Equilibrium)
 3. Radiative transfer in the ISM
 4. Interstellar Radiation Field
 5. Thermal Balance
3. Atomic & Molecular Structure & Emission
 1. Molecular excitation
 1. Rotational
 2. Vibrational & Ro-vibrational
4. Molecular Astrophysics, Formation, & Astrochemistry
 1. Column density, Temperature, and Density from Observed line strengths
 2. 21 cm emission & column density
 3. Molecular Formation
 4. Astrochemistry
5. Interstellar Dust Grains
 1. Extinction & scattering by grains
 2. Polarization
 3. Physical properties of grains
 4. Heating and emission by grains
 5. Formation & destruction of grains
6. Gas Dynamics

1. Continuity Equation & Conservation Laws
2. Cloud Fragmentation & Core-collapse
3. Self-Gravitating Spheres
4. Protostellar Collapse

Course Incomes

Students should be able to:

- solve differential equations
- use matlab or other computer languages to write computer code to solve problems numerically
- recall and employ astrophysical concepts taught in previous (required) ASPH courses

Course Outcomes:

- Students analyze quantitatively the radiation transfer of spectral line and continuum radiation, considering the effects of gas dynamics on the opacity
- Students will be able to discuss two physical processes of emission and two of absorption in the interstellar medium for each of the following parts of the electromagnetic spectrum: radio, (sub)millimeter, infrared, optical, ultraviolet and X-/gamma ray
- Students will relate the processes that determine the exchange of matter and energy between stars and the different phases of the interstellar medium to the evolution of the interstellar medium
- Students will describe the physical processes that govern heating and cooling of each phase of the interstellar medium
- Students will appraise an observational technique for the detection of interstellar matter

Department Approval:

Electronically Approved

Date: 2019-01-07 08:36