CHEM/ASTRO/PTYS
488/588
Astrochemistry
Spring 2015

Time:	Tue/Thur 12:30-1:45 PM	
Place:	Steward 202	
Professor:	Lucy Ziurys	Tom Zega
	Room N208A, Steward Observatory	Room 522, Kuiper
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Office Hours:	Wed/Th 2:00-3:00 PM or by appointment	

Course Description: Molecular astronomy is still a new frontier, with Astrochemistry, the study of molecules in astronomical and planetary environments, at its core. Molecules are present in the interstellar medium and in the solar system in the gas-phase and the solid state. They are studied by many forms of spectroscopy and other analytical techniques. Their spectra span the UV to radio by electronic, vibrational and rotational transitions, each with their uses and limitations. Molecules also play a critical diagnostic role for many astrophysical regions, including evolved stars, planetary nebulae, diffuse clouds, dense clouds, and Giant Molecular Clouds with star formation. Planets and planetary systems, including comets, asteroids, and meteorites, are substantially molecular in nature as well. These planetary materials contain condensed molecular matter, and recent advances in laboratory analytical techniques are forcing us to think about the connection between this solid-state chemistry and the gas-phase chemistry that occurs around stars and in clouds. Molecules can be studied with the Steward telescopes, as well as special, new national facilities such as ALMA, available at a wider range of wavelengths and higher angular resolution than ever before. Minerals and condensed organics can be studied with state-of-the-art electron, ion, and X-ray microscopes here at UA as well as regional and national facilities. Competitive use of these facilities requires a working knowledge of how to make and use molecular observations. This course will provide such background. No previous background in chemistry or radio astronomy is required. The course will be tailored to the needs of the students.

Class website: All lectures and problem sets will be posted in PDF form to the class d2L website Supplemental material for lectures, e.g., journal articles, figures, will also be posted. We will try to have each lecture uploaded prior to class, and we will alert you via email when the lecture is online.

Textbook: There is no formal textbook assigned for the course. It is intended that all material will be self-contained within the lectures. However, several textbooks can be recommended by the instructors to serve as references.

Performance Metrics:

Final project:	40%
Problem Sets:	50%
Class participation:	10%

Schedule	**Lecture Topics**
Interstellar Chemistry	
1	Introduction to Astrochemistry: Goals of the course and resources
2	Basic Chemical Principles I: Electronic and molecular structure
3	Basic Chemical Principles II: Overview of spectroscopy
4	Basic Astronomical Principles
5	Nuclides and elements: The building blocks of matter
6	Origin of the elements: Big Bang and Stellar Nucleosynthesis
7	Radio telescopes and spectroscopy instrumentation
8	Field Trip: Kitt Peak
9	Circumstellar chemistry and evolved stars (RGB/AGB)
10	Molecules in planetary nebulae and diffuse clouds
11	Molecular Clouds
12	Extragalactic molecules
13	Interstellar Dust
14	Molecular clouds and star formation
15	Deriving molecular abundances and chemical modeling
Solar System Chemistry	
16	Molecular cloud collapse and disk formation
17	Solar nebula leftovers: Meteorites, IDPs, Comets
18	Comet properties and origins
19	Mineralogy and crystallography: Chemistry of the solid state
20	Components of meteorites: Refractory dust, Organics
21	Laboratory analytical techniques: Electron, Ion, and X-ray microscopies
22	Field trip: Microprobe and FIB Lab (pending installation) – LPL
23	Solar system abundances of the elements and isotopes
24	Presolar grains: recorders of stellar and interstellar processes
25	Chemical Fractionation
26	Radiogenic Isotopes – Basic principles
27	Solar system chronology
28	Geochemistry of Moon and Mars
29	Chemistry of the outer planets and satellites
30	A cosmochemical model of solar system formation
31	Astrochemistry and the Origin of Life