ASTRO 488/588
Astrochemistry
Spring 2019

Time:	Tuesday/Thursday 12:30-1:45 PM
Place:	CSB 402
Professor:	Lucy Ziurys
	CSB 108
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Office Hours:	Tuesday/Thursday 1:45-2:45 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.

Prerequisite: CHEM 480a, 480b or equivalent (NO EXCEPTIONS)

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.

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 instructor to serve as references.

Performance Metrics:

Problem Sets:	50%
Midterm project:	20%
Final:	20%
Class Participation:	10%

Schedule	**Lecture Topics**
Background and Tools	
1	Introduction to Astrochemistry
2	Time and Space in Astronomy
3	Coordinate Systems
4	Astronomical Instrumentation
5	Basic Molecular Spectroscopy
Beyond the Solar System: Interstellar Chemistry	
6	Chemical Reactions in Space
7	Identification of Interstellar Molecules
8	Interstellar Dust
9	Circumstellar Chemistry
10	Molecules in Planetary Nebulae
11	Chemistry in Diffuse Clouds
12	Molecular Clouds
13	Influence of Star Formation
14	Deriving Molecular Abundances and Chemical Modeling
15	Extragalactic molecules
	Excursions: Spectroscopy Lab (Campus); visit to 12 m telescope (Kitt Peak)
Chemistry of the Presolar Nebula and Solar System Bodies	
16	Chemistry and Physics of Protoplanetary Disks
17	Isotopes in Astrochemistry
18	Chemical Properties of Comets
19	Meteoritic Composition and Analysis
20	Presolar Grains
21	Chemistry of Our Solar System: Inner Planets
22	Chemistry of Our Solar System: Outer Planets
23	Astrochemistry and the Origin of Life
	Excursions: Meteorite Lab (LPL)

Midterm Project: Telescope observing proposal (2-page scientific justification/observational set- up)