CHEM/ASTRO/PTYS 588
Astrochemistry
Fall 2017

Time:	Tuesday/Friday, 3:15-4:30 PM
Location:	CSB 402
Professor:	Lucy Ziurys
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Office Hours:	Tues/Fri 4:30-5:30 PM, Wed 4:00-5:00 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 via their gas-phase spectra with radio and optical telescopes, including new facilities such as ALMA. Minerals and condensed organics can be studied with state-of-the-art electron, ion, and X-ray microscopes involving solid-state spectroscopic methods. Spectroscopy and quantum mechanics therefore play important roles in astrochemistry, and will be emphasized in the course.

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

Class Website: All lectures and problem sets will be posted on 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 and Labs:	45%
Midterm project:	25%
Final:	20%
Class Participation:	10%

Lecture Topics:

Beyond the Solar System: 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. Circumstellar chemistry and evolved stars (RGB/AGB)
8. Molecules in planetary nebulae and diffuse clouds
9. Molecular Clouds
10. Extragalactic molecules
11. Interstellar Dust
12. Deriving molecular abundances and chemical modeling

Laboratory: Molecular Observations and Analysis (Kitt Peak)

Chemistry of the Presolar Nebula and Solar System Bodies

13. Molecular cloud collapse and disk formation/Solar system leftovers
14. Comet properties and origins
15. Mineralogy and crystallography: Chemistry of the solid state
16. Meteoritic Composition and Analysis
17. Presolar grains: recorders of stellar and interstellar processes
18. Solar system chronology
19. Chemistry of Inner Planets
20. Chemistry of the outer planets and satellites
21. Astrochemistry and the Origin of Life

Laboratory: Meteorite Analysis (LPL)

Midterm Project: ALMA proposal (2 page scientific justification/observational set- up)
Fifteen minute presentation on proposal