In 2003 a group of researchers from Steward Observatory, National Optical Astronomy Observatories/ National Solar Observatory (NOAO/NSO) and the Lunar and Planetary Lab (LPL) led by Nick Woolf of Steward Observatory proposed an astronomical team for the study of astrobiology to the NASA Astrobiology Institute (NAI). In the fall of 2003, LAPLACE (Life and Planets Astrobiology Center ) became one of sixteen teams of the virtual NAI. Last fall, LAPLACE also became a Center within the University of Arizona. In their research, LAPLACE staff members utilize the Arizona Radio Observatory (ARO), Spitzer Space Telescope, MMT, and other facilities. Education and public outreach are also important aspects of LAPLACE. A sampling of these activities provides a look at the breadth of the LAPLACE research and outreach.

The interdisciplinary nature of astrobiology demands communication and knowledge that steps out of the narrow focus of individual research. The theme of wide collaboration and knowledge defines the educational and outreach pursuits. Last year the LAPLACE team worked with another NAI team, the University of Washington (UW), on an exchange where biologists visited and learned

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Astrochemistry: Studying Organic Molecules in Space
By Lucy Zirurs

Carbon is the crucial element for living systems. Yet, the history of carbon compounds on Earth is uncertain. The Earth, if it can be considered a representative planet, has been bombarded by organic material contained in cometary fragments, meteorites and interplanetary dust particles (IDPs) since its early history. Meteorites that are carbonaceous chondrites, for example, appear to contain a broad range of organic compounds. There is some thought that the bulk of carbon on Earth today was brought from interstellar space via meteorites, comets, and IDPs. The high deuterium content of some of
LAPLACE Communication (continued from front page):

Winter School students study solar image at McMath-Pierce Telescope.

about the astro of astrobiology. Then UA astronomers visited UW to learn about the biology of astrobiology. Building on the innovative exchange design, LAPLACE hosted its first Winter School in January 2006 with Michael Meyer as Winter School Director. Twenty-nine astrobiology graduate students, most from other states and countries, participated. The five-day school included laboratory and class work, mirror lab and tree ring lab tours, and a visit to the Sonora Desert Museum in Tucson followed by three days of observing at Steward’s Bok 90-inch, ARO's 12-meter, and NSO's McMath-Pierce telescopes on Kitt Peak. The list of all those who made these events possible is found on the LAPLACE website.

LAPLACE brings together interested people in a variety of forums. The LAPLACE weekly journal club continues to expand in both the number and type of attendees as well as in topic. As with the Winter School program, the journal club format relies on the active and organizing participation of the next, perhaps first, generation of astrobiologists; Daniel Apai and other students often take the lead in organization and discussion. LAPLACE hosts the monthly astrobiology lunch where colleagues meet and discuss topics of interest. This past semester, speakers included international visitors Anatoly Pavlov, Director of Russia Astrobiology Center, and Juan Perez Mercader, Center for Astrobiology, Spain. UA Regents Professor Roger Angel, Steward Observatory Mirror Lab Director, discussed his concept for a space mirror to slow global warming. Steve Mojzsis of the University of Colorado (Boulder) presented evidence from the geologic record for early evolution on Earth. These far-ranging monthly astrobiology lunches and discussions are popular and well attended.

LAPLACE also works with other innovative programs underway at UA. Working closely with the Astrobiology and the Sacred Lecture Series committee, Tim Slater piloted a program for K-12 educators examining the impact of astrobiology on society and classroom applications. Nick Woolf and Cathi Duncan worked with this Templeton Foundation-sponsored lecture series as well as the College of Science Lecture Series: Evolution this past spring. The huge success of this series, open to the UA community and general public, will no doubt be matched by the Fall 2006 College of Science Lecture Series: Global Climate Change starting on October 17th.

Finally LAPLACE has been the recipient of generous support from the College of Science’s Galileo Circle (http://cos.arizona.edu/sci_support/galileo_circle.asp) and Edward and Jill Bessey, who have provided scholarship funds for outstanding students researching a variety of astrobiology topics. This spring Galileo Circle scholarships were awarded to Matt Pasek, LPL graduate student, for his work on phosphorous and the origin of life and to Charles Peterson, an undergraduate who is pursuing science education. Five graduate students received the Edward and Jill Bessey Scholarship in Astrobiology: Doug Archer, Stephanie Cortes, David Minton, Catherine Neish and Erika Offerdahl.

LAPLACE will be expanding its collaborative efforts over the next years. We will build these efforts as the Center and graduate and undergraduate astrobiology programs are developed.

http://www.laplace.arizona.edu
the organic molecules found in pristine objects such as Tagish Lake meteorite means that these compounds had to originate in a very cold (T ~ 10 K) environment. The only objects that are this cold are gas-phase molecular clouds in space. These objects, in fact, are the only other places beside Earth that are known to contain organic molecules.

What organic molecules are present in molecular clouds? What are the relative abundances? What is the extent of the chemical complexity? Could complicated pre-biotic molecules such as the sugar ribose, or an amino acid, or even DNA itself be synthesized in interstellar gas clouds? To begin to answer some of these questions, the Astrochemistry Group has been conducting very sensitive, spectral line searches for organic molecules in space, using the facilities of the Arizona Radio Observatory (ARO). Radio astronomy offers a unique and quantitative way to study such species, because of the extraordinary high spectral resolution inherent in these spectra. Such observations have shown that the chemical complexity in certain clouds is very high. A typical spectrum, observed at a wavelength of 1 mm towards a dense cloud in the Galactic Center known as Sagittarius B2(N), is shown in the figure below. Here a variety of organic molecules are observed, including ethanol (CH₂OH), ether (CH₃COCH₂), and ethyl cyanide (CH₃CH₂CN). These molecules exhibit strong features, indicating that large abundances of these compounds exist in the Galactic Center. The Astrochemistry Group has been searching for even more complex species. Recently, they identified the two-carbon sugar, glycolaldehyde (CH₂OHCHO) in the Galactic Center. Glycolaldehyde is an important precursor to the five-carbon sugar, ribose, which is one of the main chemical components of DNA. However, they did not find other “ketose” sugars, including hydroxycetone (CH₃COCH₂OH) and dihydroxyacetone (CH₂OHCOCH₂OH). These results suggest that the chemistry in interstellar clouds is highly selective.

Such searches are in progress for other molecules, such as lactonitrile (CH₂CH₂OHCN), trans ethyl methyl ether (CH₂CH₂OCH₂), cyclopropanone (H₂C₃O), and acetimide (CH₃CONH₂). Some of these studies require new laboratory measurements, also conducted by the Astrochemistry Group using their newly-constructed Fourier Transform Microwave Spectrometer. As these studies progress, a clear picture should emerge about the contribution of interstellar synthesis to pre-biotic chemistry. Comparison with the compounds found in the carbonaceous chondrites (Tagish Lake, Murchison) could reveal significant clues to how the biochemistry that lead to life emerged.

http://aro.as.arizona.edu
http://www.chem.arizona.edu/faculty/ziur/ziur-group.html

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