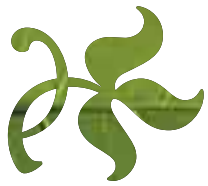
# LEARNING AND COMMUNICATING ACROSS DISCIPLINES



The University of Arizona's LAPLACE facilitates interactions between life and physical sciences through joint research in astrobiology.

**by Anna H. Spitz**

Although researchers have been studying astronomy and biology for hundreds of years, astrobiology is relatively new to the list of "named" fields of scientific research. Astrobiology has been termed multi-, cross-, inter-, or transdisciplinary. Because academic research tended to more and more specialization during the 20th century, many scientists are at a loss about what it means to collaborate in multidisciplinary work. Astrobiology encourages the new 21st century paradigm under which researchers, educators, and students seek new inter-, or transdisciplinary solutions to profound research problems.

The trick is how to achieve close coordination of diverse scientific disciplines and programs. Too often researchers are focused on their very specific areas of research or at best on the general subject areas such as astronomy or biology. But in order for scientists working at the confluence of these two broad scientific disciplines to make significant and comprehensive discoveries in a specific area of expertise, they must have an appreciation and understanding of the techniques, limitations, and power of disciplines other than their own. This multidisciplinary approach is critical for solving some of the most fundamental questions facing humankind—from how did life begin to how will the changes in Earth's climate affect life's future on this planet.

## Centering Efforts

The **L**ife **A**nd **PL**anets **A**strobiology **CE**nter (LAPLACE) of the University of Arizona grew out of a project of the same name funded by NASA's astrobiology program. NASA began using the term *astrobiology* in 1995 and established the virtual institute, NAI, in 1997. NAI selected the University of Arizona/National Optical Astronomy Observatory/National Solar Observatory (UA/NOAO/NSO) project as one of its sixteen teams in 2003. The Arizona team injected a dose of astronomy into NAI's emphasis on biological research in astrobiology. While the group of scientists who created LAPLACE is intently focused on astronomical research, the researchers also recognize the essential need for a multidisciplinary approach to their subject in order to answer some of their fundamental research questions. Both established and young researchers are embarking on a new way of collaborating and educating. For an introduction to LAPLACE, visit *www.laplace.arizona.edu*.

LAPLACE makes a major emphasis of the research program educating the next generation—perhaps the first generation—of *astrobiologists*. The Center began its commitment to collaborative and multidisciplinary education by hosting the first Astrobiology Graduate Student Conference in 2004, a conference guided by faculty but planned and executed by astrobiology graduate students.

The commitment to new ways of interacting and educating discussed at the conference and in university departments flowered with discussions between LAPLACE and another NAI team, the University of Washington (UW). UW research concentrates on the biology of astrobiology. The members of both groups believe that their students and faculty benefit from learning about how other teams pursue their research; thus, they decided to initiate an exchange program in 2005.

Rather than a lecture-heavy curriculum in which professors stand and address the audience, LAPLACE and UW settled on an exchange in which students acquire hands-on experience in the other field. Biology students traveled from Seattle to Tucson to learn about the "astro" in astrobiology by observing with three telescopes at Kitt Peak National Observatory to understand the evolution of chemicals and solar systems. Astronomy students traveled from Tucson to Seattle to learn about the "biology" in astrobiology by dredging Puget Sound to collect biological samples for laboratory work to support their body plans to illustrate the Cambrian Explosion. At the UW Marine Biology Laboratories in Friday Harbor on San Juan Island, students conducted a molecular biology experiment that involved DNA sequencing and mathematical algorithms in order to construct a (very small) portion of the "tree of life." Students learned more than just the published results of scientific labors; they learned the techniques of the trades through these activities—a vital part of understanding another scientist's discipline.

Both LAPLACE and UW prepared introductory and background materials and discussions for visiting students, but the emphasis was on hands-on research in the


**The virtual NASA Astrobiology Institute (NAI) is located at *nai.arc.nasa.gov*.**

**Kitt Peak National Observatory. Kitt Peak houses telescopes of NOAO, NSO, and Steward Observatory, among other facilities. The LAPLACE-UW Exchange and LAPLACE Winter School held observing sessions for students of various disciplines at the facilities. Photo courtesy of NOAO/AURA/NSF.**

field. To tie the academic research to some of its real-world concerns and broaden the experience, planners also included in the Tucson materials background information about the owners of the mountain, the Tohono O'odham Nation, and the growing concern about outdoor lighting's effect on observing. With guidance from UA and UW faculty, post-doctoral researchers and graduate students from UA, the National Optical Astronomy Observatory, and the National Solar Observatory helped plan and lead observations at three telescopes on Kitt Peak for their fellow astrobiology graduate students from UW. Despite weather limitations, students observed and had ample formal and informal discussions on the mountain.

## "Astrobio 101"

LAPLACE took the exchange model and expanded and refined it during the winter of 2006 into a five-day school for a wide variety of students interested in astrobiology. Thirty students from local, national, and international programs attended: they traveled to Tucson from nineteen institutions throughout the United States and from as far as Spain and Australia to expand their understanding of astrobiology. Their research interests included ecology and evolutionary biology, microbial ecology, climate modeling, molecular and cellular biology, biochemistry, paleontology, geochemistry, astronomy, meteoritics, planet formation, and extrasolar planets. LAPLACE provided introductory materials so students unfamiliar with astronomy and its research techniques could gain some understanding and establish a level of comfort with the subject before embarking on the lab and observing work.

The program included work in Tucson on the UA campus. 2006 Winter School students identified fingerprint molecules that might exist in interstellar space as precursors to life in the astrochemistry laboratory of the Arizona Radio Observatory (ARO). Leaders of discussions on topics of planet formation, planet hunting, and planet habitability were mindful of the wide variety of backgrounds and expertise of the audience and addressed basic questions as well as more advanced topics for all levels of the audience. Interactive computer software accessed on-line provided students with the chance to manipulate real data obtained from the Spitzer Space Telescope. Visits to the Lunar and Planetary Lab introduced students to the variety of meteorites and the bombardment history of Earth. Students tied all this information together in far-ranging (and often late-night) discussions about how interstellar molecules arrive on Earth, how Earth evolves, how the stage was set in the distant past for life to arise, and where in the Universe similar conditions might exist.

In addition to the hard work of learning basic astronomy and observing techniques, the school offered other activities that helped to broaden the collaborative experience. Students toured the Steward Observatory

Mirror Laboratory, which manufactures giant mirrors that will search for planets around other stars; the Tree Ring Laboratory, which documents climate change; and the Sonora Desert Museum, which presents the flora and fauna of the desert environment. These visits incorporated related, informal activities that are perhaps the most essential aspect of schools and workshops in multidisciplinary activities. These elements balance the concentration needed in the more structured portions of the experience and provide time to learn about fellow participants and their research as well as LAPLACE astronomy.

After three days of discussions, tours, and laboratory work, the entire group moved to telescopes at Kitt Peak, eighty kilometers from Tucson. Students using Steward Observatory's Bok 90-inch telescope and spectrograph investigated the optical spectrum of different planets to consider their physical conditions and biomarker gases. With the NSO's McMath-Pierce telescope, they observed the Sun and discussed its behavior and how astronomers look for solar-type stars. And with ARO's 12-meter radio telescope, students searched for the molecules in interstellar space that they had fingerprinted in the ARO laboratory in Tucson. These observing experiences topped off the five days of intensive exposure to different research and new colleagues. Students left with a greater understanding of how astronomers do astrobiology and with heightened enthusiasm for pursuing cross-disciplinary (and cross-institutional) collaborations.

These efforts—the LAPLACE/UW Exchange and the LAPLACE 2006 Winter School—mark the beginning of life-long collaborations among students in the many sub-disciplines of astrobiology. The highly interactive and hands-on approach to learning another person's discipline will enrich one's own subsequent research at one's home institution. This intensive workshop environment fostered bonding that will grow into collaborations across disciplines as the students and post-docs go on to the next step in their careers. The intensity was balanced by informal discussions and some touring time to avoid total exhaustion and burnout.

LAPLACE was the catalyst for the students to cross disciplines, to think outside their specialty and, thereby, strengthen their individual research areas. Such experiences will foster a deeper understanding and, therefore, more substantive research collaborations to solve the fundamental and critical questions of our age.

The first generation of astrobiologists is on its way with the help of programs that combine hands-on teaching, respect for and understanding of other disciplines, post-doc/student-led education, and far-reaching collaborations. It is rather ironic that these researchers in some respects are returning to the methods of the pre-20th-century scientists who did not acknowledge that barriers existed among scientific disciplines.

The University of Arizona is building on these educational collaborations between LAPLACE and the University of Washington. The University's College of Science has established the Center for Astobiology to grow the efforts of LAPLACE's astronomers, chemists, and planetary scientists into interdisciplinary collaborations with researchers in biological sciences, ecology and evolutionary biology, molecular and cellular biology, and even hydrology and water resources on its campus. The Center will provide a focal point for interactions between life and physical sciences through joint research, links to international astrobiology efforts, and development of an interdisciplinary astrobiology program at graduate and undergraduate levels.

**"Astrobiology's success depends critically upon the close coordination of diverse scientific disciplines and programs, including space missions."**

## LAPLACE: The Story Behind the Name

Pierre-Simon Marquis de Laplace (1749-1827) proved the stability of the Solar System and produced the nebular hypothesis to explain its formation. Although subsequent research changed our view of the formation of solar systems, Laplace provided the mathematics and ideas that spur on astronomers in their studies of solar-system formation. What better name for the University of Arizona's **L**ife **A**nd **PL**anets **A**strobiology **CE**nter (LAPLACE), an institution devoted to the study of planet formation and other astrobiological research?

For more information about LAPLACE, visit the website at *www.laplace.arizona.edu*. For more information about the College of Science Center for Astrobiology, visit *astrobiology.arizona.edu*.

*—A. H. S.*

*ANNA H. SPITZ (ahspitz@seriaz.org) revels in her multidisciplinary background: she researched the geochemistry of ureilite meteorites for her Ph.D., taught courses in astronomy at Pima Community College, and was an astronomer in the Project ASTRO program for two years. At present she works with the College of Science Center for Astrobiology, which expands on the work of LAPLACE at the University of Arizona.*

**Author's Acknowledgements:**
Thanks to Nick Woolf and Cathi Duncan for helpful comments on this manuscript.