A Multi-Disciplinary Discovery Engine

Arecibo Observatory is unique for its size (more collecting area than all other U.S. radio telescopes combined) and for the breadth of scientific research it enables. Arecibo provides the most sensitive maps of our Milky Way and beyond, profound tests of Einstein’s General Relativity theory, and unparalleled ability to discover new and unusual phenomena. Arecibo probes space weather in the upper atmosphere with its radar and lidar instrumentation, and is 20 times more sensitive than the only other radar facility for characterizing potentially hazardous near-Earth asteroids.

A STEM Magnet in Puerto Rico and Latin America

The iconic Arecibo dish, appearing frequently in popular media (such as the movies GoldenEye and Contact) inspires and educates. Every child in Puerto Rico will visit Arecibo at least once during his or her K–12 career. Arecibo provides unique Spanish-language outreach materials across its research disciplines, promoting science, technology, engineering, and mathematics (STEM) education to an underserved population and contributing to the academic, industrial, and economic development of Puerto Rico and the United States.

Scientific Accomplishments

Gravity Radiates

In 1993, American scientists Joseph H. Taylor and Russell Hulse were awarded the Nobel Prize in Physics for their discovery, with the Arecibo radio telescope, of binary pulsars, which provided the first confirmation of Albert Einstein’s 1916 prediction of the existence of gravitational waves, radiating ripples of space-time caused by moving masses. The first millisecond pulsar, spinning 642 times per second, was also discovered at Arecibo.

Planets Beyond Our Solar System

In 1992, Aleksander Wolszczan and Dale Frail reported the discovery of the very first planets outside our Solar System, unexpectedly orbiting a pulsar. Hundreds of extrasolar planets are now known, but only a handful have so far been found in the extreme environment associated with pulsars, where no life is possible. Recently, Arecibo has discovered precursors to biological molecules in distant galaxies.

Planet and Asteroid Dynamics

The rotation rate of Mercury, 59 days, was first determined at Arecibo in 1964, and ice on Mercury’s poles was mapped in 1994. Arecibo produced the first-ever direct image of an asteroid, and continues to characterize the shapes, sizes, morphologies, and spin dynamics of asteroids and comets that make close approaches to Earth. Arecibo radar echoes (above) from Titan, Saturn’s largest moon, first revealed the existence of lakes of liquid hydrocarbons.

Space Weather and the Atmosphere

Arecibo radar measurements monitor the highest levels of the Earth’s atmosphere, the ionosphere, and its reaction to the solar wind; in extreme cases, these particle winds can cause communications glitches, power outages, and other electromagnetic disturbances. Arecibo lidar measurements probe the atmosphere at altitudes between 30 and 110 km, profiling temperatures and chemistry by measuring the by-products of meteor burn-up.

Societal Impact

Arecibo Observatory telescope hours scheduled in 2011, by science discipline of peer-reviewed and approved user proposals. Planetary radar was under-represented because of major equipment maintenance.

In recent years, Arecibo Observatory has served users from 37 states, the District of Columbia, and Puerto Rico, as well as a significant international community of scientists from Canada, Europe, Asia, Australia, and Africa.