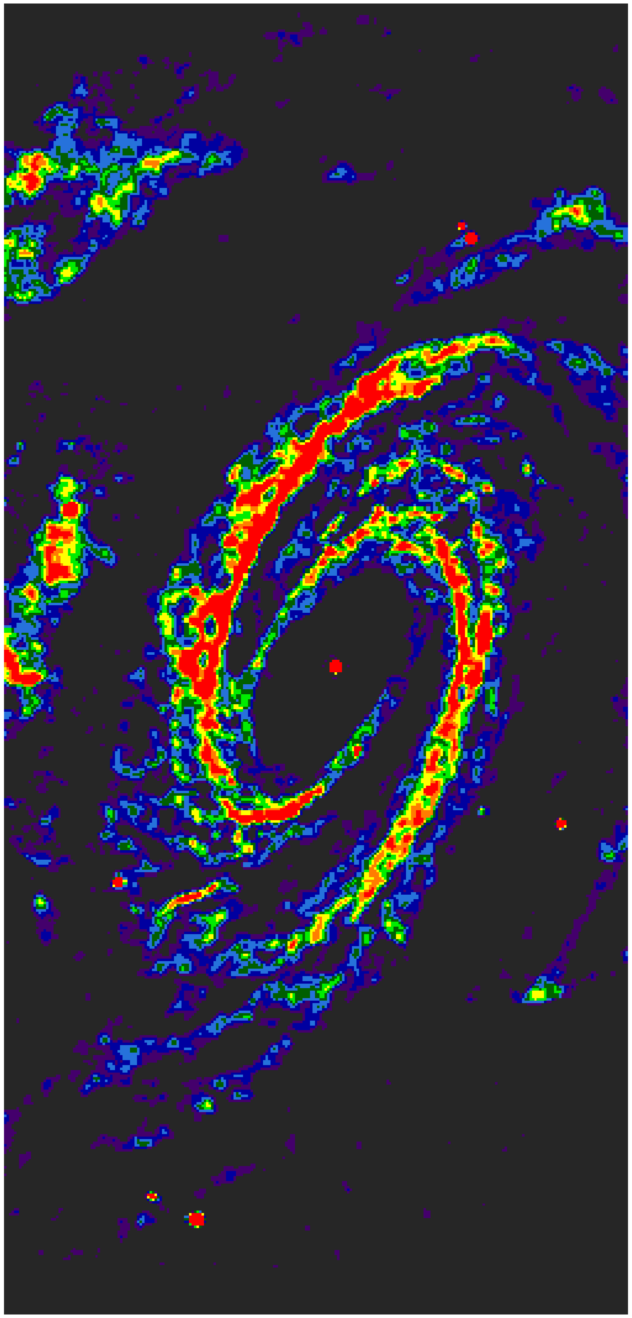
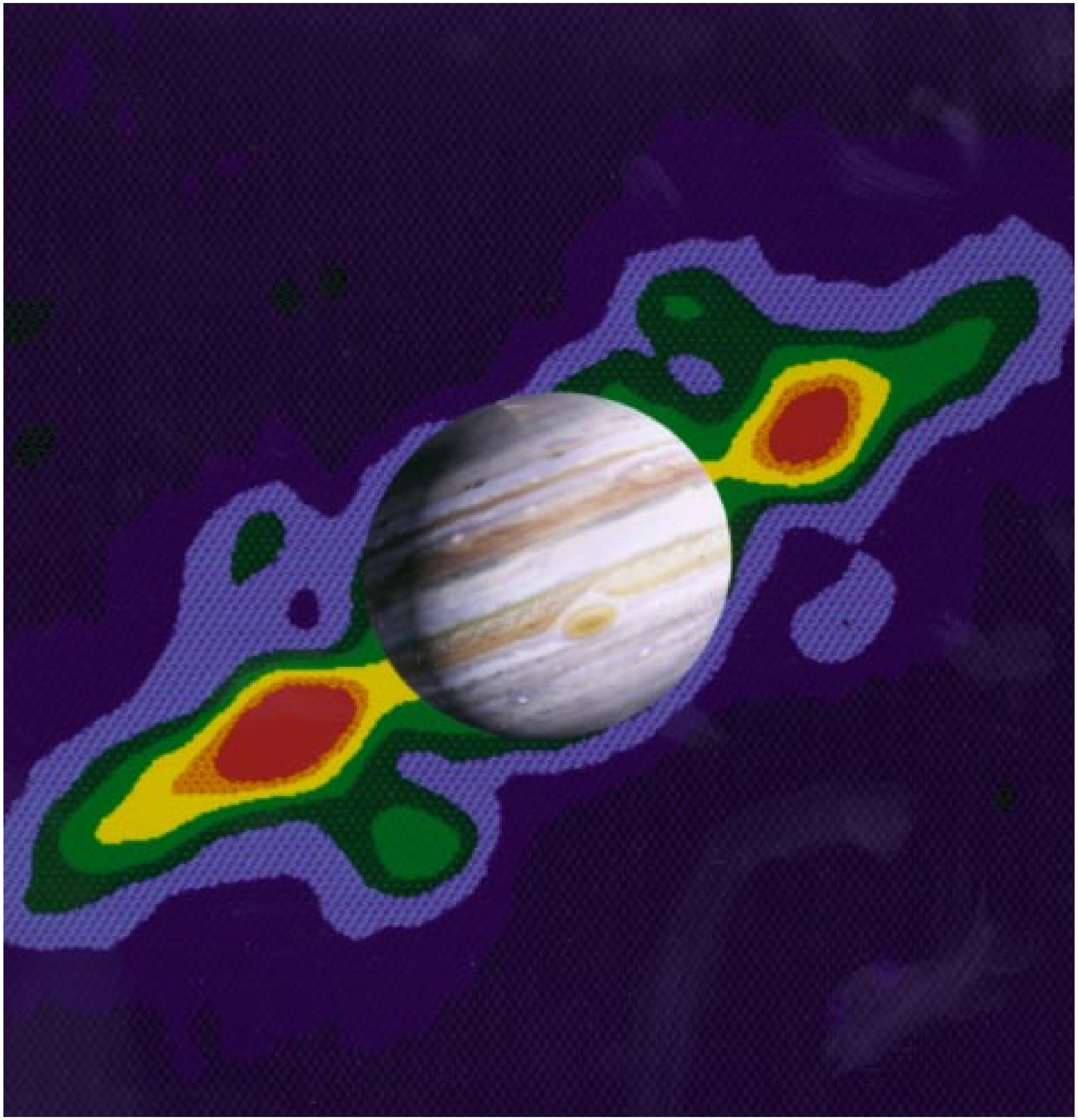
National Aeronautics and
Space Administration

Jet Propulsion Laboratory
California Institute of Technology
Pasadena, California

Deep Space Network — Radio Astronomy





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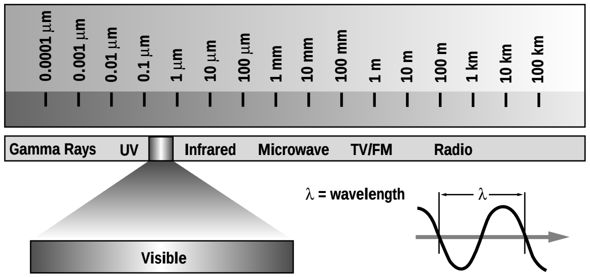
The National Aeronautics and Space Administration (NASA) built the Deep Space Network (DSN) of antennas to communicate with spacecraft exploring the solar system. Dividing the circumference of Earth into approximate thirds, NASA placed the DSN antennas in three locations: Goldstone, California; Madrid, Spain; and Canberra, Australia. Thus, as Earth rotates, a distant spacecraft is always “visible” from at least one site. Each of the three DSN complexes includes several antennas varying from 11 to 70 meters in diameter. When they are not communicating with spacecraft, the DSN antennas are used for radio astronomy.

More Than the Eye Can See Like our eyes, optical telescopes detect visible light, but visible light is just one part of the electromagnetic spectrum. Different wavelengths, or frequencies, of visible light appear to us as different colors. When the frequency is too high, the radiation is no longer visible: We cannot see ultraviolet light, x-rays, or gamma-rays. Similarly, when the frequency is too low, we cannot see infrared, millimeter, or radio waves. Just as some objects are better seen in one color than another, observations of astronomical objects at frequencies invisible to the eye, including radio observations, may reveal new and different information.



The electromagnetic spectrum.

Revealing the Mysteries of Our Solar System For more than 30 years, the Deep Space Network has played a significant role in radio astronomy studies of our solar system, adding to our understanding of the magnetic fields and atmospheres of planets. For example, since 1972 radio astronomers have used the DSN to observe Jupiter, with its intense and dynamic magnetosphere. DSN astronomers use high-performance spectrometers to separate radio frequencies into millions of channels, allowing them to analyze the materials in comets, planetary atmospheres, and clouds of gas or dust in space. The DSN can also respond to observe unforeseen astronomical events such as the appearance of comets Hyakutake and Hale–Bopp.

The 70-meter antenna at Goldstone, California.

Studying Star Evolution in Our Galaxy The Deep Space Network’s large 70-meter antennas in California and Australia have been used to study how stars are born in clouds of gas and dust called nebulae. Radio astronomers are able to study the deep interior of a nebula because radio waves pass through the dust clouds that block visible light, much like a cloudy day on Earth. The radio waves discern the structure, composition, and relative ages of different layers of gas within a cloud that is in the process of becoming a “protostar,” the core of what will become a star when it is large and dense enough to ignite.

It is also possible to study the magnetic fields in a star-forming gas cloud using the spectrometers of the DSN to look for the di-carbon sulfide molecule. This molecule is abundant in clouds where star formation is beginning, and its spectrum is particularly affected by the molecule’s surrounding magnetic field. Magnetic forces are a significant factor in the collapse of stellar material into stardom.

Larger radio antennas produce more detailed images. By combining the outputs from several telescopes arrayed over a large area, we can produce an image with as much detail as we would get from one enormous telescope, large enough to cover the entire area. DSN radio telescopes participate in worldwide teams using this technique, which is called very long baseline interferometry (VLBI).

Finding Cosmic Clues Outside Our Galaxy Very massive stars go out in a blaze of glory called a supernova. By studying supernovae, we can learn much about how stars are born, evolve, and die. The highly sensitive 70-meter DSN antennas have contributed to VLBI studies of extragalactic supernovae that are very distant, weak sources of radio emissions. Studies of supernovae in other galaxies have led to some radical shifts in our understanding of the expansion and ultimate fate of the universe.

The high sensitivity, key locations, and special instrumentation of the radio telescopes of the Deep Space Network make them priceless tools in our quest to understand the universe — as it exists today as revealed in studies of our own solar system, as it was billions of years ago as revealed by energy finally arriving at Earth from the far reaches of the cosmos, and as it will be in the far distant future, as we try to piece together the cosmological clues to its ever-changing nature.

The Jet Propulsion Laboratory of the California Institute of Technology manages the Deep Space Network for NASA. To learn more, check our Web sites at *http://deepspace.jpl.nasa.gov/dsn* and *http://dsnra.jpl.nasa.gov/*, or write to DSN, Mail Stop 303-401, Jet Propulsion Laboratory, 4800 Oak Grove Drive, Pasadena, CA 91109-8099.

On the front — (Left) Image of a galaxy made with a radio-frequency interferometer. DSN antennas are used for radio interferometry and for studies of star formation in our own galaxy, the Milky Way. (Right) An image of Jupiter superimposed on radio maps of the invisible radiation belts. Radio images: Very Large Array, courtesy of the National Radio Astronomy Observatory and Associated Universities, Inc.

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