



# Goldstone Apple Valley Radio Telescope – GAVRT

## Deep Space Network

*The Goldstone Apple Valley Radio Telescope (GAVRT) project is a partnership involving NASA, the Jet Propulsion Laboratory (JPL), the Lewis Center for Educational Research (LCER), and the Apple Valley Unified School District. This educational program uses a 34-meter antenna at NASA's Deep Space Network Goldstone Complex for classroom radio astronomy observations via the Internet. The GAVRT project introduces students in elementary, middle, and high school to the process of science with the goal of improving science literacy among American students.*

### What GAVRT Offers Teachers

Teachers attend a 5-day training course at LCER in California, or at a regional training center. There they learn the fundamentals of radio astronomy. The teachers receive guidelines on the use of the curriculum provided and learn how to operate the GAVRT antenna. In California, they meet the GAVRT staff at the Operations Control Center and travel to Goldstone to inspect the antenna up close. Once they return to their classrooms, teachers receive ongoing support from LCER to answer questions on curriculum issues and when they are on line gathering data.



Teachers climbing the GAVRT antenna.

### What GAVRT Offers Students

Children of all backgrounds are provided the unique experience of commanding the telescope to seek new knowledge and share their results with the world. Students remotely control the GAVRT telescope via the Internet by connecting from their

classroom to the Operations Control Center at LCER, who then pass control of the antenna to the students.

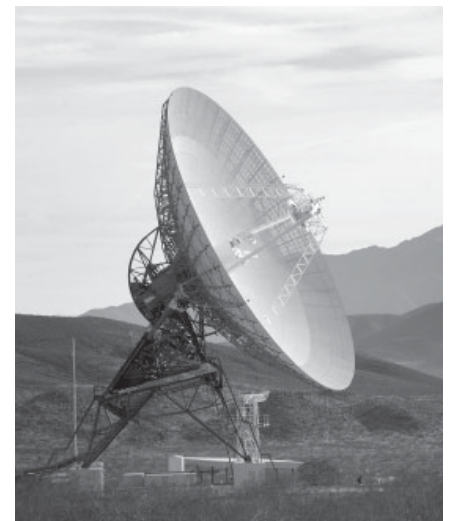
Students learn how to gather data, understand what the data means, and how to analyze and record it using a computer software program. They work together, learning team participation and problem-solving skills.

The results of the data analysis are forwarded to JPL for inclusion in a database of scientific knowledge. Much of the GAVRT student data is included in scientific papers published in professional journals, so students soon realize how much their contributions are valued by the scientists.

Students are excited by the opportunity to control the enormous antenna and they are motivated by their responsibility to the team. Teachers are reporting improvements in student behavior and greater enthusiasm, not only for science but for other subjects, too.

### GAVRT in the Classroom

The GAVRT project is more than simply collecting data from space; elementary, middle, and high school teachers receive training and a broad-based, multidiscipline, adaptable curriculum designed to meet National Science Education Standards and tailored for each teacher to meet their State Science Education Standards.



The GAVRT 34-meter antenna, DSS-12, at Goldstone, California.

GAVRT supports teachers and students before, during, and after their on-line experience with the radio telescope, maintaining personal contact as well as providing teaching materials and technical support. The GAVRT education delivery model offers three options for participation: *Pre-designed Modules*, such as Jupiter Quest; *Special Projects*, such as the Cassini–Jupiter Microwave Observing Campaign, whereby GAVRT observations contributed to new discoveries about the radiation belts of Jupiter derived from measurements made by the Cassini spacecraft and with ground-based radio telescopes; and *Contributed Projects* submitted by teacher–student teams and selected through a peer review process.

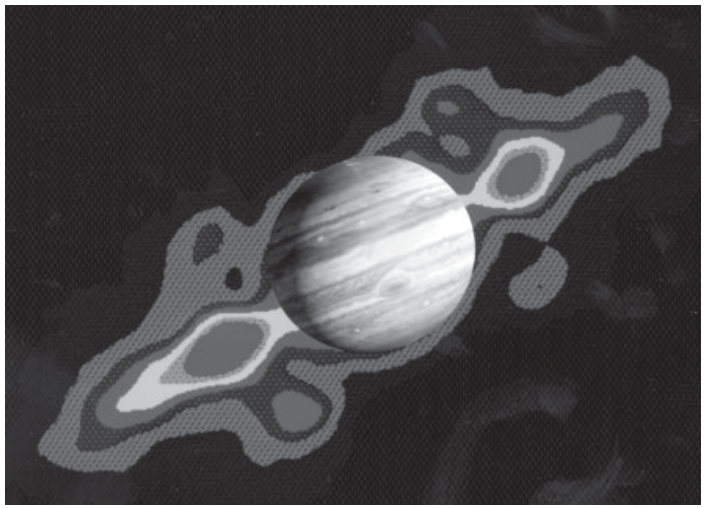
### Curriculum Projects

The most widely used curriculum project is Jupiter Quest, where students plan a hypothetical mission to the Jovian system. The telescope is used to measure the temperature of Jupiter’s atmosphere and study variations in the radio emissions from Jupiter’s intense radiation belts.

GAVRT teams are measuring the atmospheric temperature of Uranus to study the effect of the planet’s “seasons,” which last 21 Earth-years. The Quasar Variability Study (QVS) is a new project to study changes in the brightness of distant quasars at radio frequencies. GAVRT offers a solar project of shorter duration called EarthStar, which monitors the day-to-day changes in the “radio sun” caused by the dynamic activity of solar storms and the natural rotation of the Sun.

### Data Collection and Analysis

During their time on the GAVRT radio telescope, students calibrate the antenna, direct it to specific targets, and use computers to record the extremely faint radio waves collected by the



An image of Jupiter seen in visible light is superimposed over a radio brightness map of the planet’s radiation belts, which are not visible through optical telescopes. (The radio brightness map is from the Very Large Array and is used with permission of the National Radio Astronomy Observatory [NRAO] and Associated Universities, Inc.)

telescope and to analyze the data. Sometimes the data collected are plotted as a graph and sometimes as a “false-color map.” Students can manipulate the data using software programs to provide different delivery styles. For Jupiter Quest, students point the telescope at Jupiter for specified periods of time, conducting radio astronomy observations of the planet at two microwave frequencies. The processed GAVRT data are sent to JPL scientists who interpret the information and add it to the knowledge database. Improving our understanding of the Jovian radiation environment is extremely important for future missions that plan on sending spacecraft to the Jupiter system. Students in the GAVRT project are making real contributions to the known body of scientific knowledge.

### The GAVRT Radio Telescope

The radio telescope is located at the Goldstone Deep Space Communications Complex in the Mojave Desert, near Barstow, California. It has a dish 34 meters (110 feet) in diameter, is nine stories high, and weighs 850,000 pounds. Known as Deep Space Station 12 (DSS-12), the antenna was used by NASA’s Deep Space Network to track robotic planetary missions such as the Mariner missions, Voyagers 1 and 2, Galileo, and other spacecraft exploring the solar system.

### How to Participate

For current information on how to become involved in the GAVRT project, technical requirements, and cost, visit the GAVRT Web site at [gavrt.org](http://gavrt.org).

### For More Information

<http://deepspace.jpl.nasa.gov/dsn/applevalley>

<http://www.lewiscenter.org/gavrt>



Middle school students remotely operate the GAVRT antenna from their classroom.

