

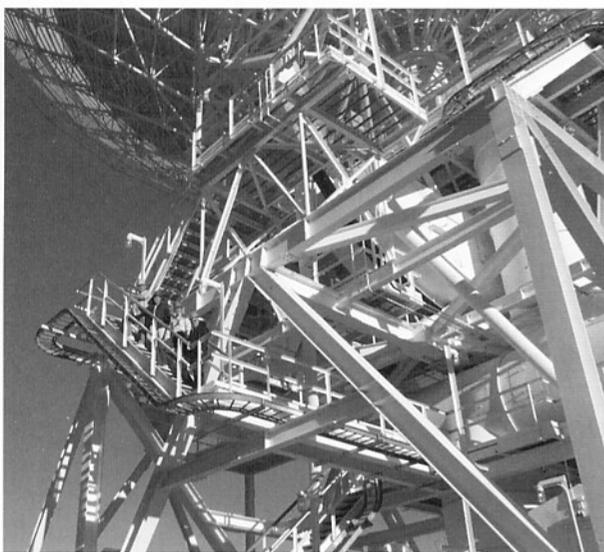


Goldstone Apple Valley Radio Telescope

The Goldstone Apple Valley Radio Telescope (GAVRT) project is a K–12 science education partnership involving NASA, the Jet Propulsion Laboratory (JPL), and the Lewis Center for Educational Research (LCER). This educational program uses a 34-meter (111-foot) dish antenna at NASA's Deep Space Network Goldstone Complex for classroom radio astronomy observations via the Internet. GAVRT partners students with scientists to conduct cutting-edge scientific research leading to discovery, while accomplishing educational and scientific objectives.

What GAVRT Offers Teachers

Teachers attend a 4-day training course at LCER in California or at a regional training center. There they learn the fundamentals of radio astronomy, 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 LCER's Mission Control and travel to Goldstone to inspect the antenna close up. Once they return to their classrooms, teachers receive ongoing



During the California training course, teachers visit the Deep Space Network complex at Goldstone. This group got a close-up look at one of the antennas.

support from LCER to answer questions on curriculum issues and when their students are on line gathering data.

What GAVRT Offers Students

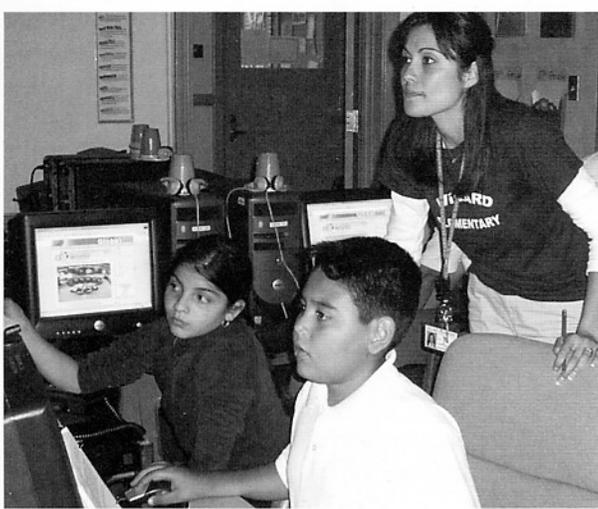
Children of all backgrounds are provided the unique experience of commanding the telescope to seek new knowledge and share their results with the world. Students remotely control the GAVRT telescope via the Internet by connecting from their classroom computer to Lewis Center's Mission Control, which then passes control of the antenna to the students.

Students learn how to gather data, understand what the data mean, and follow through with analysis. They work together, learning team participation and problem-solving skills. Their measurements are forwarded to JPL for inclusion in a database of scientific knowledge. Much of the GAVRT student data are included in scientific papers published in professional journals, so students soon realize how much their contributions are valued by scientists worldwide.



One GAVRT study observes quasi-stellar radio sources — quasars. A quasar is believed to be a galaxy, similar to this one, with an immense black hole in the middle. (Visible-light image of spiral galaxy M51, Kitt Peak National Observatory)

NASA Facts



Students learn how to remotely control the GAVRT radio telescope from their classroom computers via the Internet.

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 as well.

GAVRT in the Classroom

The GAVRT project is more than simply collecting data from space. Elementary, middle, and high school teachers receive training in using GAVRT to meet their essential individual State Core Science Education Standards. GAVRT offers a broad-based, multidiscipline, adaptable curriculum designed to meet National Science Education Standards.

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 — Curriculum Projects, which are long-running observing programs requiring the collection of large amounts of data; Special Projects, which typically consist of short-term or infrequent observing campaigns, often tied to unique events such as the arrival of a spacecraft at a planet; 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, focusing on collecting thermal and nonthermal

radio emissions from 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 also measuring the atmospheric temperature and composition of Uranus to study the planet's "seasons," and are studying distant black holes at the centers of quasars. The Quasar Variability Study (QVS) measures changes in quasar brightness, which teaches us about the black holes powering them as well as the interstellar medium between Earth and the quasars. GAVRT has also been selected to conduct teacher training and develop curriculum for NASA's future Juno mission. Juno will explore Jupiter and provide insights into the formation of the solar system.

Data Collection and Analysis

Students in the GAVRT project are making real contributions to the body of scientific knowledge. 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 telescope. Typically, they get to take a preliminary look at their data in real time and make comparisons with other observations. After some processing at the Lewis Center for Educational Research, the data are sent to scientists for detailed interpretation. The scientists then share their results with the students, and eventually the data are published in the scientific literature.

The GAVRT Radio Telescope

The radio telescope, recently named the Michael J. Klein Radio Observatory, 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 website at <http://www.lewiscenter.org/gavrt>.

National Aeronautics and Space Administration

Jet Propulsion Laboratory
California Institute of Technology
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For More Information

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