
Lewis Center for Educational Research
GAVRT
GAVRT
Radio Astronomy Project
Solar System Ambassador Talk
September 26, 2023

A Unique Partnership

GAVRT

Jet Propulsion Laboratory
California Institute of Technology

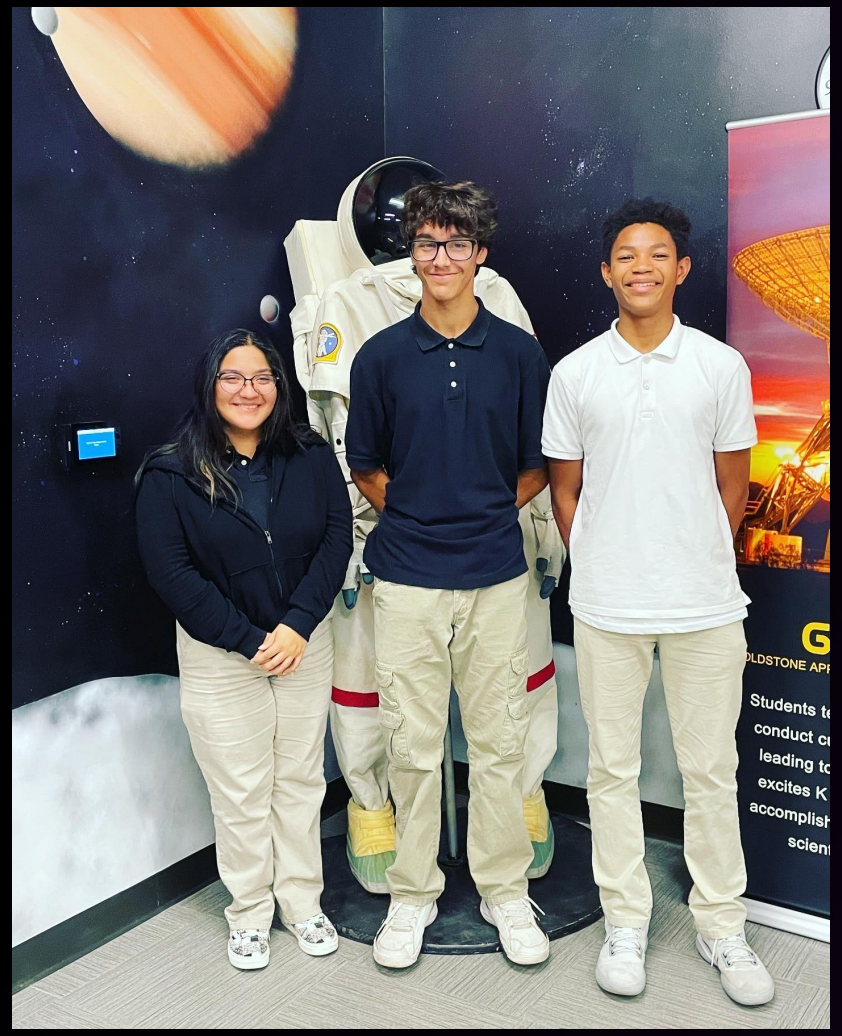
Lewis Center for Educational Research

What is GAVRT?

REAL SCIENCE, *REAL* LEARNING

OUR MISSION—

- Contribute to the scientific body of knowledge.
- Help participants learn how to think like a scientist.
- Connect students and citizen scientists directly to NASA missions like Juno.



What is the Lewis Center for Educational Research (LCER)?

- A non-profit organization that operates two TK-12 STEM charter schools in Southern California and STEM education programs locally, nationally and globally.

- A NASA/JPL educational partner through the GAVRT program since 1996.

What is the Deep Space Network (DSN)?

GAVRT

- The DSN is made up of three sites, or “complexes”
- Each complex contains multiple radio antennas, ranging in size from 34-meters to 70-meters
- The radio antennas are how NASA communicates with its spacecraft

Image credit: NASA/JPL

What is the Deep Space Network (DSN)?

- When DSN antennas aren't being used to communicate with spacecraft, they are used for radio astronomy!
- GAVRT uses a dedicated, decommissioned DSN antenna, DSS-28, to conduct astronomy research with students and citizen scientists.


Image credit: NASA/JPL and VLA/NRAO

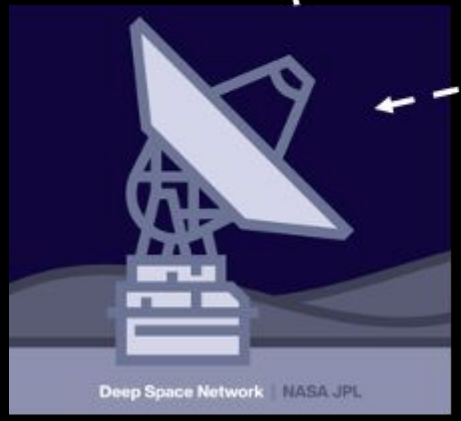
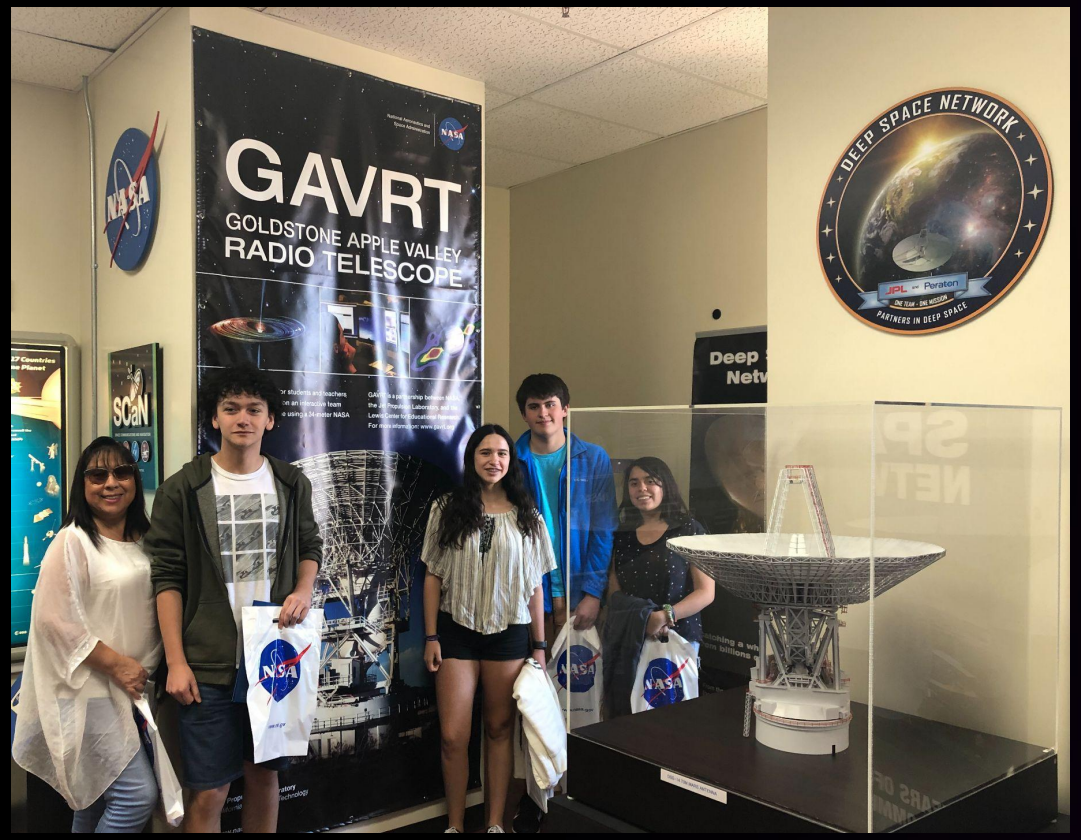


Image credit: NASA/JPL

GAVRT's Reach

- Current GAVRT Statistics:
  - 600+Trained Teachers
  - 450+ Participating Schools
  - 22 Informal Education Agencies
  - 48 States Represented
  - 17 Countries Represented
  - 3 U.S. Territories Represented
  - 60,000+ Students/Citizen Scientists Who Have Participated



By joining the GAVRT Radio Astronomy team, facilitators and participants:

- Work together with participants and professional scientists from around the world to uncover new knowledge about the universe.
- Remotely control a 34-meter radio telescope belonging to NASA's Deep Space Network (DSN).
- Receive support from Lewis Center and JPL every step of the way – from initial training through making sense of the collected data.

Current Science Campaigns

GAVRT

DSS-28 and DSS-13

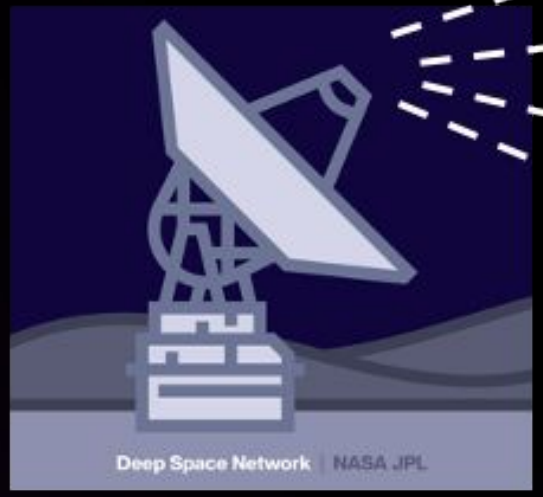


Image credit: NASA/JPL

Jupiter Quest

Image credit: NASA/JPL and VLA/NRAO

Solar Patrol

Image credit: NASA/SDO/AIA

Black Hole Patrol

Technosignatures

Image credit: NASA/JPL-Caltech/Lizbeth B. De La Torre

Jupiter Quest/Juno

Campaign Goals:

- Improve our understanding of the high-energy electrons in Jupiter's radiation belts.
- Contribute GAVRT ground-based data to the Juno Mission for comparison of data collected at Jupiter.

Well-suited for the following (and based on Jupiter’s rise/set times):

- Middle/High School classes
- After school, intersession, or summer programs

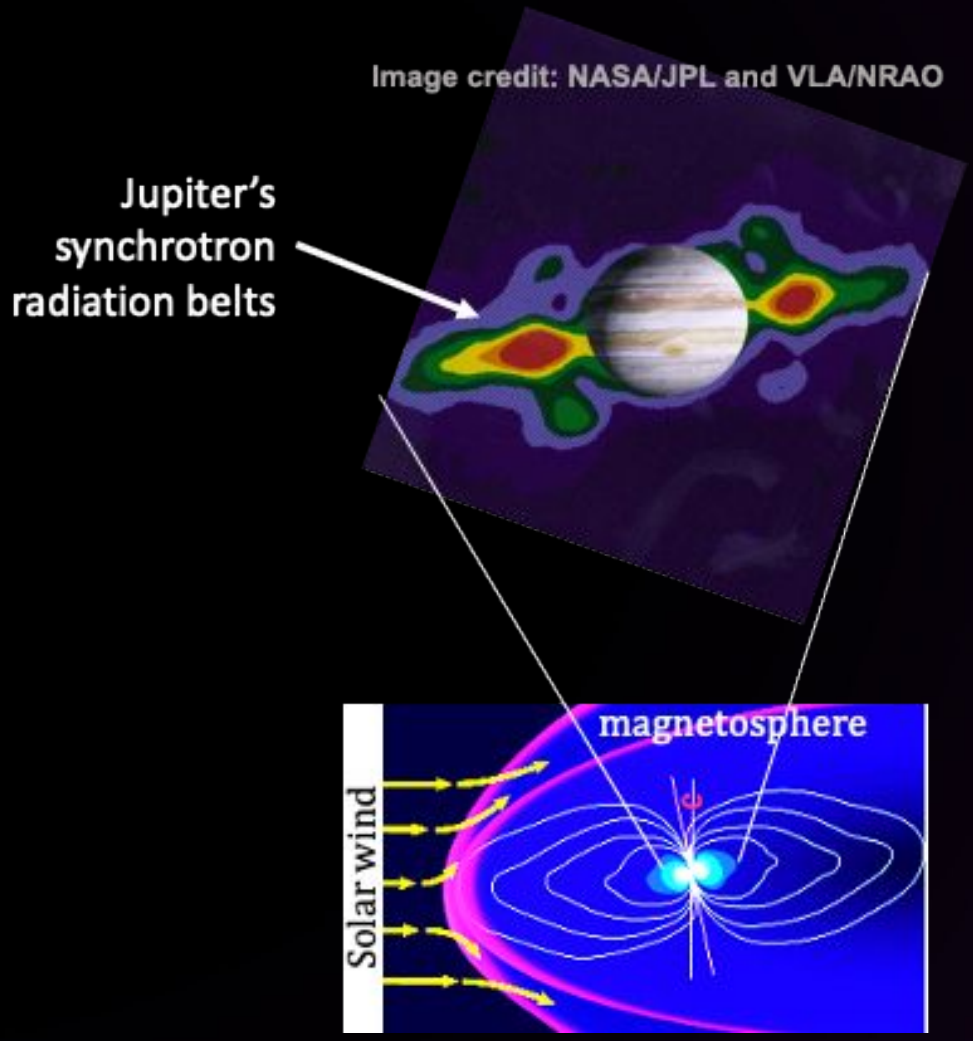
Jupiter Quest/Juno

Science context:

- Jupiter has the strongest and largest magnetic field in the solar system (except for the Sun).
- That strong magnetic field creates a cavity in the solar wind around Jupiter, called the magnetosphere.
- Charged particles get trapped in the magnetosphere, interacting with the magnetic field and producing bright synchrotron radiation.

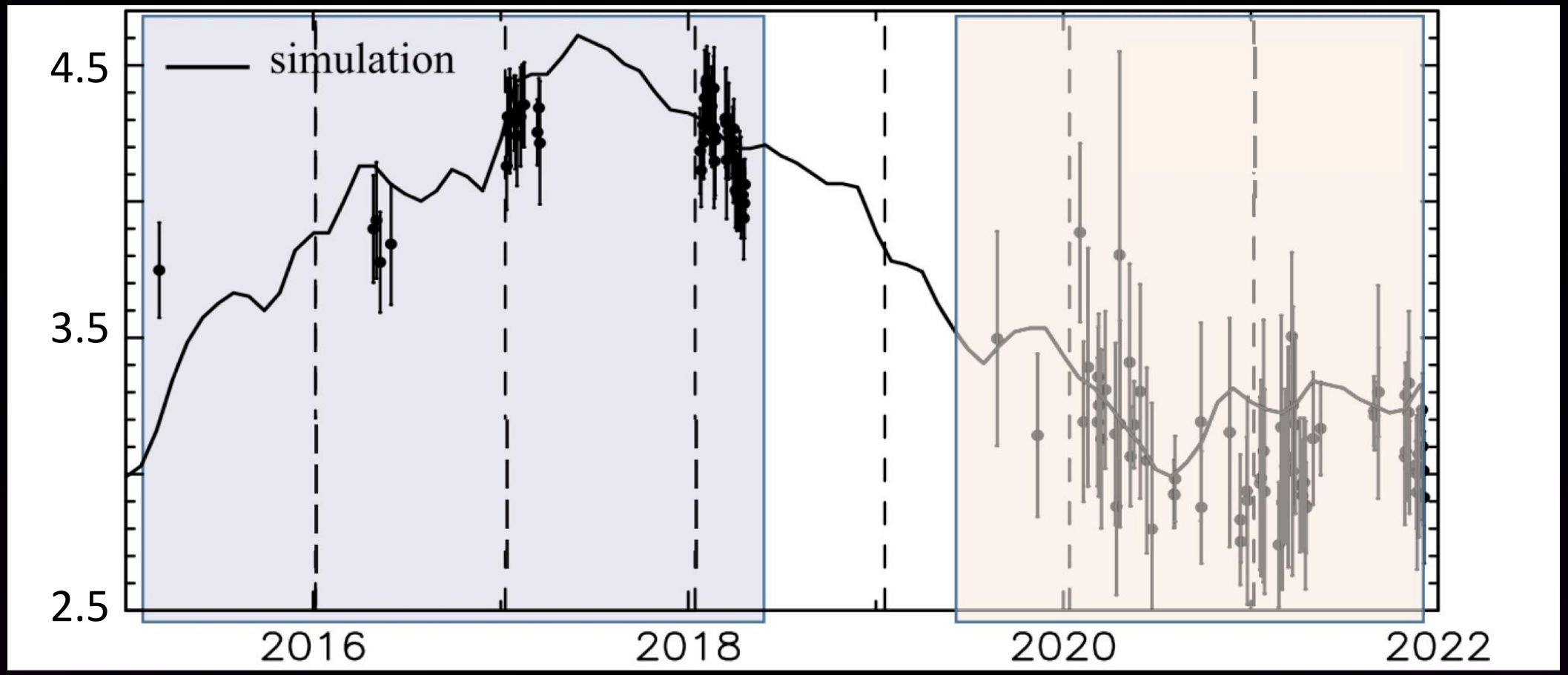
Science Goals:

- Monitor Jupiter's synchrotron radiation for variability in order to understand how electrons are transported in the magnetosphere and the effects of the solar wind.



Jupiter Quest/Juno

Monitoring for variability in Jupiter's synchrotron radiation belts



Matuszewska et al. 2022

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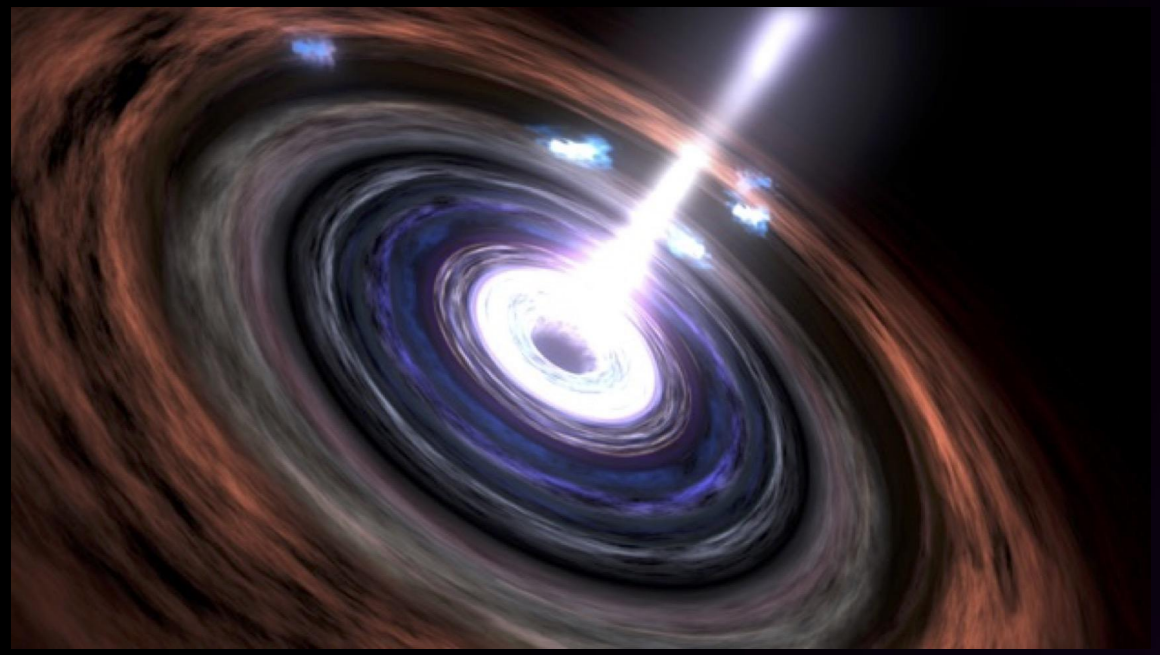
Black Hole Patrol

Campaign Goals:

Monitor radio emission generated by black holes to understand how they affect and are affected by their environment.

Well-suited for (and always available):

- Ongoing sessions over a period of time
- Classrooms, science fair projects, school clubs
- Single sessions for large groups
- Before/after school programs
- STEM camps
- Support of space weeks
- Scout programs
- Astronomy nights



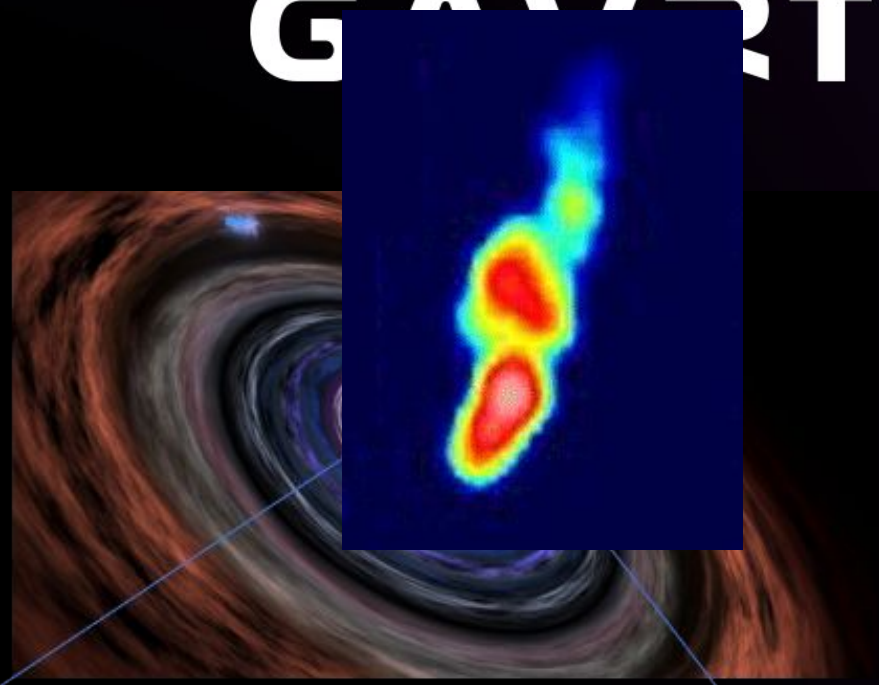
Black Hole Patrol

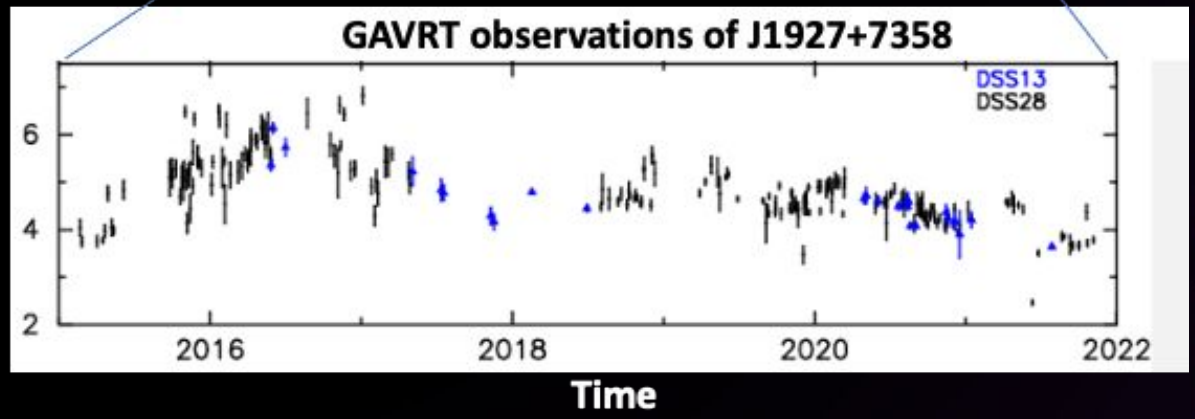
Science context:

- Supermassive black holes (SMBHs) are found at the center of most galaxies.
- They can launch highly relativistic jets, which are long columns of material moving close to the speed of light, that produce extremely bright synchrotron radio emission.

Science Goals:

- Long-term variability monitoring of the radio emission from these jets probes their structure, launching and dissipation mechanisms.





Kreuser-Jenkins et al. 2023

Animation credit: VSOP/Murphy et al. 2000

SETI/Technosignatures

Campaign goals:

- Discover extraterrestrial intelligence by searching for narrow-band radio signals originating from the galactic plane
- Analyze waterfall plots looking for signals and identify patterns computers find difficult to analyze due to random noise and interference
- Teach students how to examine and report relevant data to scientists for follow up observations to confirm extraterrestrial signals

Well-suited for (and also good for off-line activity):

- Upper elementary through high school grade levels for single sessions or within a shorter-range of time
- Participants working on a project independently over time

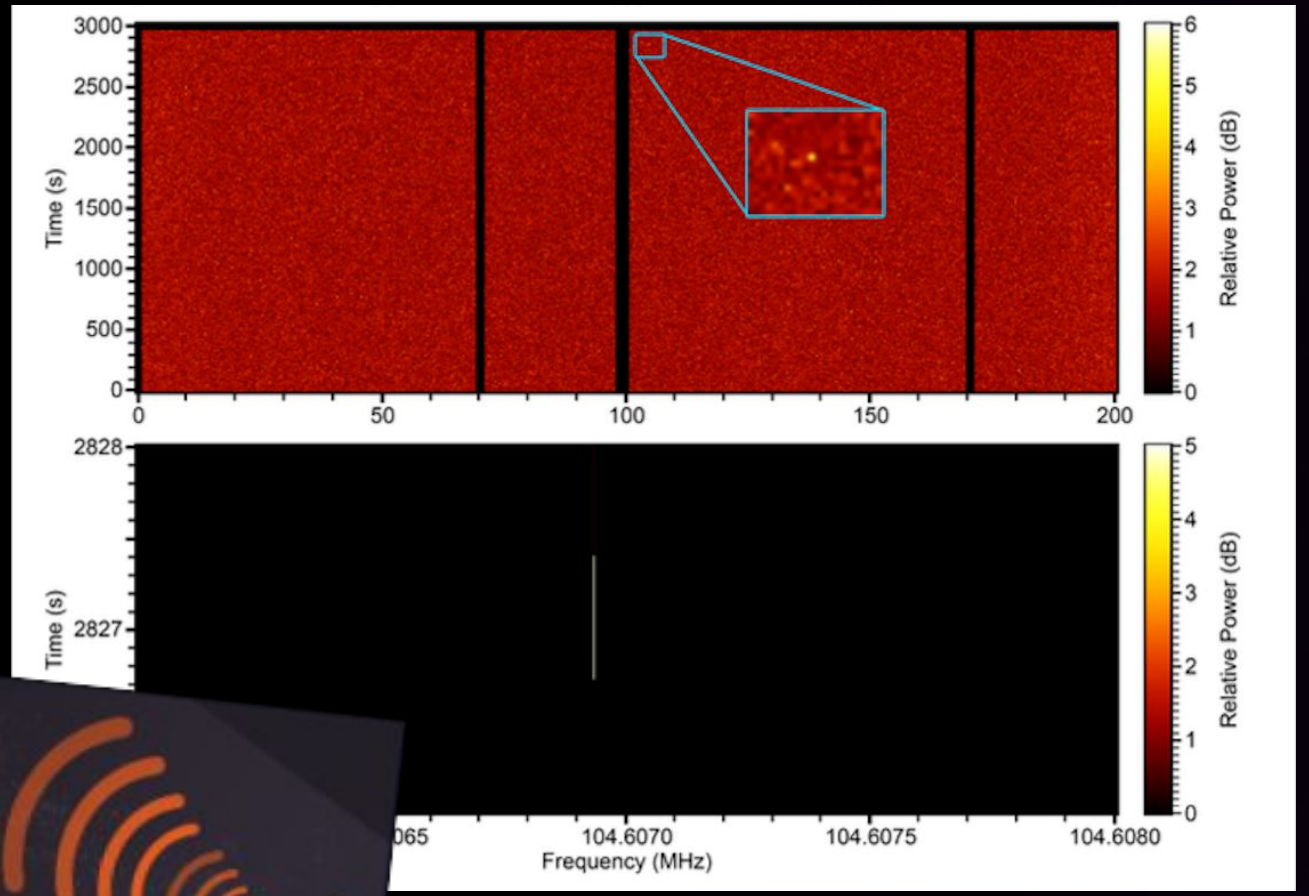
SETI/Technosignatures

Science context:

- Humans produce a wide range of radio emissions that would be detectable from nearby stellar systems.
- Astronomers search for similar radio emissions from other stellar systems, as a means of searching for signs from other intelligent civilizations.
- “Technosignatures” are often distinguished from natural / astrophysical sources via their time and frequency behavior.

Science Goals:

- Monitor the plane of the Milky Way for radio emission that exhibits the behavior of an artificial or engineered signal, thereby indicating the presence of ET.



Gorjian et al. *in prep*

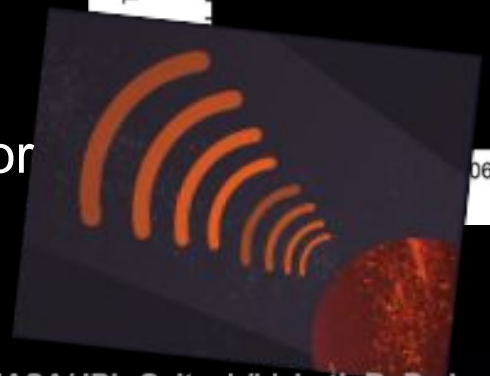


Image credit: NASA/JPL-Caltech/Lizbeth B. De La Torre

Solar Patrol

Campaign Goals:

- Use GAVRT data in concert with other datasets to improve broad understanding of how the Sun generates space weather and its impact on the Earth.
- Teach participants how to collect and analyze data on the Sun and use those data to make predictions about space weather.

Well-suited for (and always available during daylight @ Goldstone):

- Broad citizen science audiences
- Informal education settings
- Middle and high school classrooms
- Adaptable to single session or ongoing study

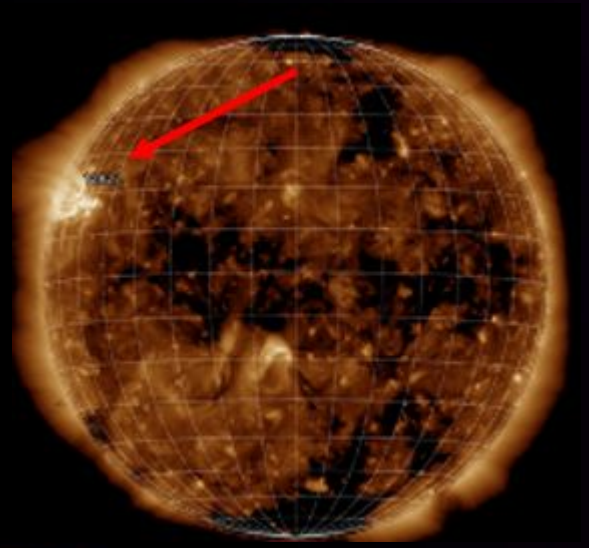
Solar Patrol

Science context:

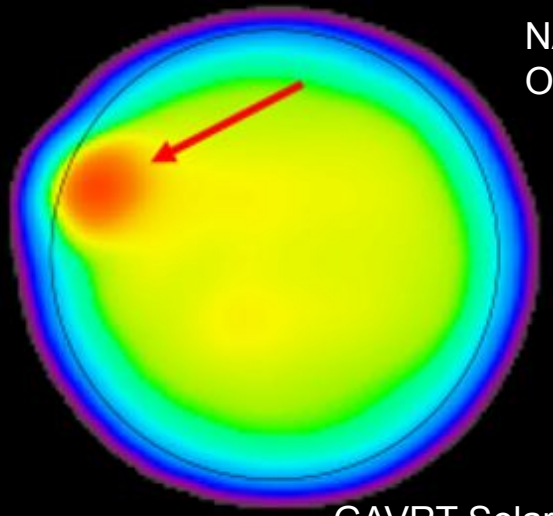
- The Sun is extremely magnetically active, producing flares, coronal mass ejections (CMEs), solar energetic particle events (SEPs), and other phenomena which broadly fall under the category of “space weather”.
- Space weather can be harmful to humans, spacecraft, and infrastructure on Earth, so monitoring and predicting space weather events is critical.

Science goals:

- GAVRT daily maps of the Sun are used to identify and track active regions in the solar corona, and associate them with explosive events identified at other wavelengths.



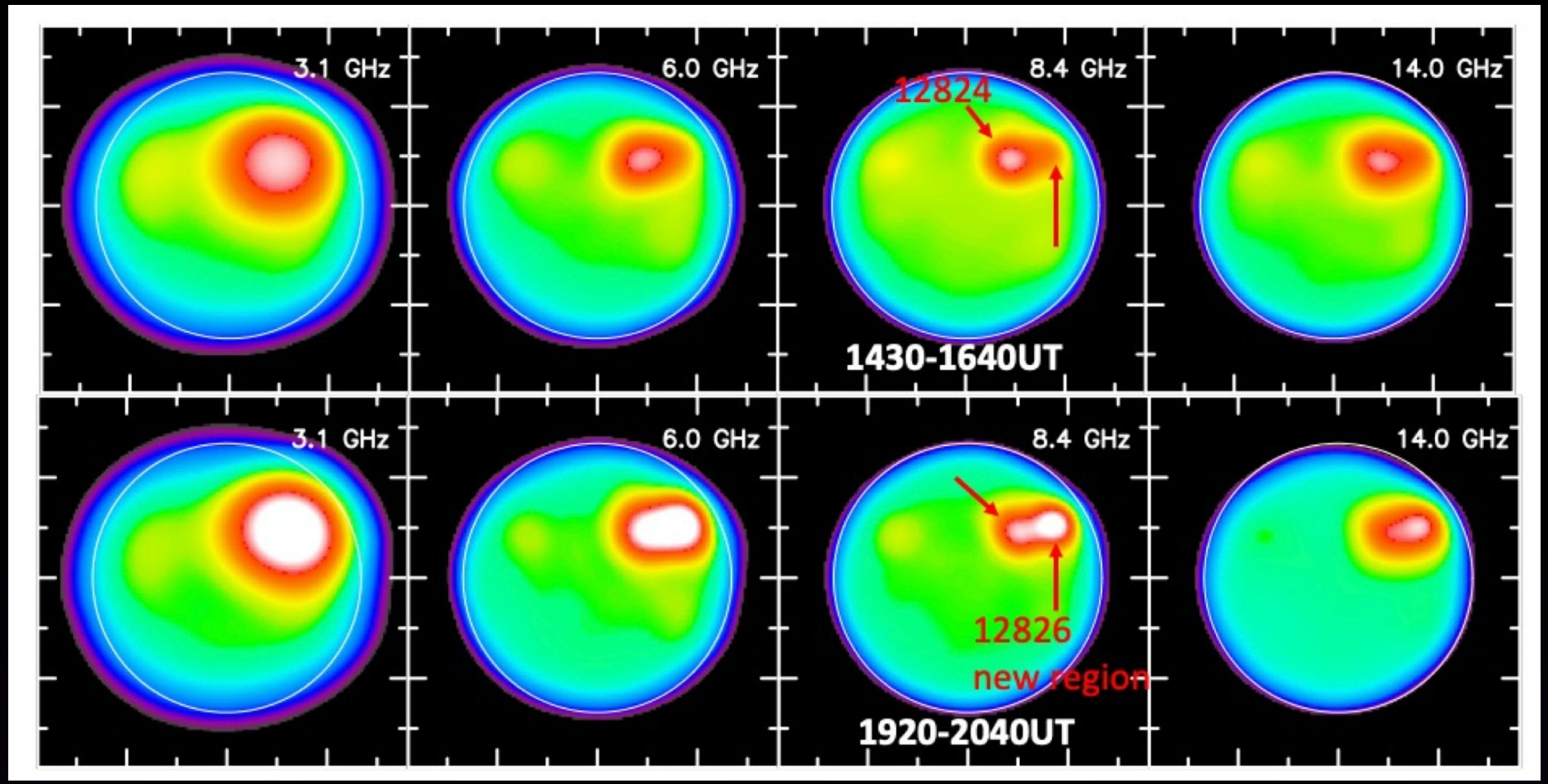
NASA Solar Dynamics Observatory @ 193 Å



GAVRT Solar Map @ 6 GHz

Solar Patrol

GAVRT observing an emerging active region



Lamb et al. 2021

Call for Partners

We are always looking for support in the following areas:

- Authentic opportunities to engage our participants in contributing to current missions and campaigns
- Mentors for a class, small group, or individual conducting specific research
- Giving a science talk to our students
- Joining proposals that need outreach or citizen science

Please connect with us at mc@lcer.org so that we can collaborate!

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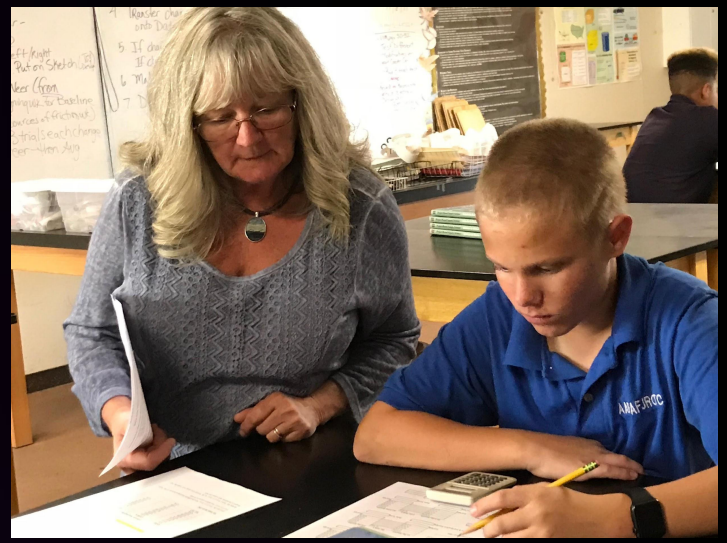
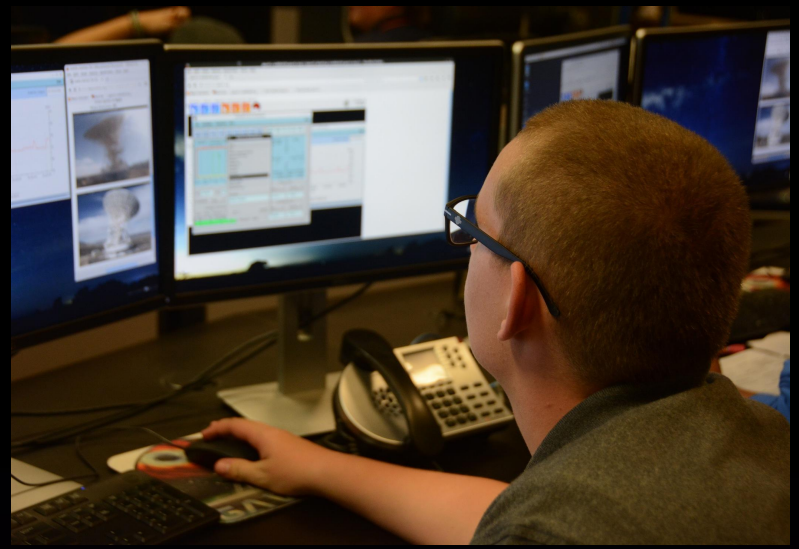
CHARLES ELACHI MISSION CONTROL CENTER
DATA CONTROLLER
DEEP SPACE NETWORK
DATA CONTROLLER





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GOLDSTONE APPLE VALLEY RADIO TELESCOPE
Students team with scientists to conduct cutting edge research leading to discovery. GAVRT excites K - 12 students while

Resources

GAVRT – Results & Publications

- https://gavrt.lewiscenter.org (Home > Media > Academic Journal Publications / Presentations)

Deep Space Network

- https://eyes.nasa.gov/dsn/dsn.html **(DSN Now)**


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Educational Research
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THANK YOU