PARTNeR

PARTNeR. Practical Radio Astronomy for Students

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General Goals

PARTNeR (Proyecto Académico con el RadioTelescopio de NASA en Robledo) will allow students to make real Radio Astronomy observations using a 35 meter antenna, located at the NASA Deep Space Communication Complex in Robledo de Chavela, near Madrid (Spain).

Our project is similar to the successful *Goldstone-Apple Valley Radio-Telescope (GAVRT)*, which uses an antenna in the Goldstone (California) NASA complex, identical to the one we will use for PARTNeR.

The students will learn about Astronomy, and science in general while involved in real Radio Astronomy research.

Our project is aimed to three kinds of users:

• High-schools.

We would like PARTNeR to be a new educational experience for high-school students, not only about Astrophysics, but about science in general. To achieve this, students will be able to participate in a research project of international scientific relevance, so that they feel they are part of a research team, and that their observations have an actual scientific interest. We will provide teachers with a set of practical lessons for their classes, based on the observations they will make.

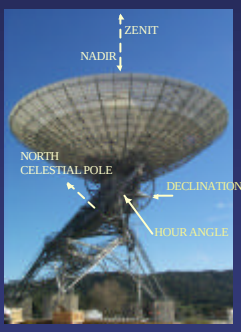
• Universities.

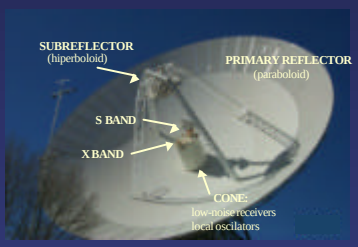
PARTNeR will be a tool for college students to perform practical lessons proposed by their teachers. Our project offers higher-education institutions many possibilities to develop practical lessons, about a wide range of topics, from purely technological ones, to basic science including, of course, Radio Astronomy.

• Amateur astronomical associations.

These associations could use PARTNeR to make real observations, either being our collaborators in our monitoring of X-ray binaries or proposing their own scientific projects of relevance.

Technical details



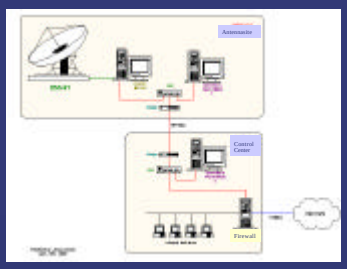


The telescope has main dish of 35 m diameter, with cassegrain focus and equatorial mount.

By means of a dicroic mirror, it can simultaneously observe radiation at two different wavelenght bands:

S (12 cm) and X (4 cm).

Connectivity Scheme



The antenna will be operated remotely by the students, via Internet.

The control center will be located in a building next to the NASA communication complex, in Robledo.

Schools will connect to the control center computer, that will then route the operation commands and data received.

The **angular resolution** of the telescope (i.e., the minimum distance between two sources that can be separated) is a function of wavelengh and telescope size. Thus, it depends on the observing band

$$HPBW^* \cong 58^\circ.4 \, \lambda / D$$

S band: 0.2° (12 arc min)
X band: 0.06° (3.6 arc min)

Sensitivity estimates

Time necesary to detect different sources in X band (rough estimate):

3c84 (quasar), Jupiter, Orion nebula	A few seconds
Young low-mass stars	5-50 hours
γ-ray burst sources	3 months

User interface

The user interface should be easy and attractive for students. A radio astronomical detection does not look as spectacular as an optical image, so to develop an appropriate interface is an important challenge.

Our ultimate goal is a multi-user platform with the possibility of more than one school collaborating in a single observation.

Learning program

We expect that most of the teachers (and amateur astronomers) will not have a deep knowledge of Radio Astronomy. Therefore, a comprehensive learning program will be necessary before they can use PARTNeR as a teaching tool for their own students.

We will offer to the users four different courses, previous to the use of the telescope:

Physical Bases of Radio Astronomy

A web based course, to be taken at distance.

It covers topics like properties, emission processes and behavior of electromagnetic radiation.

This course is based on the one offered by GAVRT, and is available at our web site

An Introduction to Radio Astronomy

A course on how a radio telescope works, what are the usual observational techniques and how radio sources will look like when pointing a telescope towards them.

It is also a distance, web based course, publicly available at our web site.

Science Program

Of course, there are many different kinds of radio sources that one can observe. However, an important basis of our project is to provide the students the possibility to contribute to real scientific research, not just pointing the telescope to any well-known source.

Our first scientific project will be the monitoring of radio emission of X-ray binaries.

X-ray binaries are believed to be composed by a "normal" star and a compact object (a black hole). The latter accretes matter from the star, releasing a large ammount of gravitational energy in the form of high-energy radiation.

These sources also show variable radio emission. Occassionally, there are flares of radio waves, when the release of energy is higher.

Our plan is to monitor such flares in several selected sources.

Until 2000, the Green Bank Observatory (NRAO) had a program to monitor radio sources, similar to the one we would like to undertake with PARTNeR. Since then, no radio telescope in the world is used to perform this kind of monitoring in a regular basis. Therefore, the proposed observations will be of real scientific relevance.

High-school students and amateur astronomer would then make observations of a few selected targets, to gather a long-term data set of their radio fluxes, searching for flares. Students will then participate in a "patrol of radio explosions".

Results of the observations will be placed in our web page, publicly available, so that any scientist in the world can use them for their own research.

Therefore, students will be providing a service to the international scientific community.

Curriculum material

We will offer a set of lessons that can help teachers bring to their students different science concepts, from the exclusively astronomical, to more general science. A great deal of physics is behind of a Radio Astronomy observation, so PARTNeR has many posibilities as a learning tool, taking advantage of the motivational drive that the opportunity to get involved in a real observation will provide.

Some lessons will necessarily be on general Astronomy, and Radio Astronomy in particular. Students should be able to understand what they are doing when they manage the antenna.

Other lessons should address the particular science project in which they are involved.

Lessons on binary stars will then give the teacher the opportunity to bring to the students concepts like circular motion, center of mass, gravitation, etc.

Always within the framework of Radio Astronomy observations, most lessons will cover the official educational standards for different age levels. As an example, our first lessons will cover the Spanish standards for the Physics course in 4th grade of secondary school (ages 14-15), including topics like:

- Motion and acceleration
- Force
- Newton laws
- Pressure in a gaseous medium
- Work and energy
- Heat and temperature

Use of the PARTNeR Antenna

A course on how to perform the observations with our system.

It will include a visit to the antenna and a thorough explanation of its technical aspects.

The use of the control program will also be covered. We will end with some real observations with the antenna, to get some experience with how it works.

This course will be completely (or at least in part) taught in a classroom.

PARTNeR as an Educational Tool

In this course, we will present the curriculum material that we offer to the teachers, to be used by them to teach their students different science topics.

It will also cover a detailed explanation of the scientific project in which they will participate (monitoring of x-ray binaries).

This course is aimed only to high-school teachers.

PARTNeR is the result of a collaboration between the National Aeronautics and Space Administration (NASA, USA) and the Instituto Nacional de Técnica Aeroespacial (INTA, Spain)

For further information:

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