Radio JOVE Citizen Science Project 1.

Determining the Quiet-Day Curve of the Galactic Radio Background

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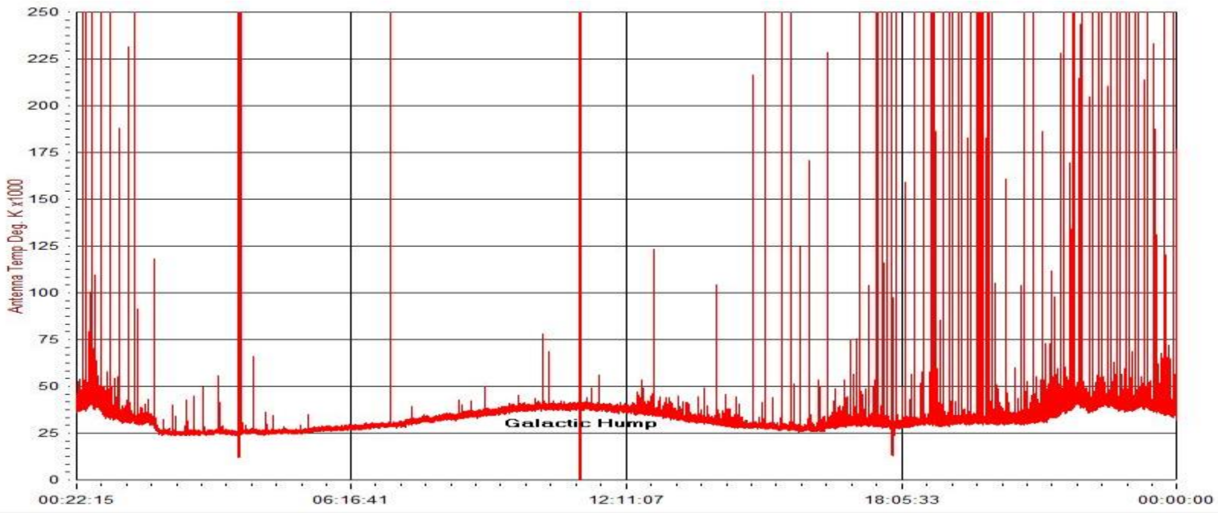
Background

We are all familiar with going to the countryside at night to watch meteor showers, the Milky Way, or just the night sky full of stars. That is because the countryside, being far away from city lights, has less ambient light or light pollution that can overwhelm the relatively dim starlight. Without ambient light, the night sky is a dark background for stars and galaxies to appear bright. The fact that the night sky is dark is another story (see Olbers' Paradox).

A radio telescope used to observe Jupiter and the Sun in the radio wavelengths can also pick up ambient radio noise, which can be sporadic, impulsive, episodic, random, or relatively constant. The radio noise characteristics depend on whether the noise source is artificial or natural. Radio frequency interference (RFI) due to household radio and electrical systems can be minimized, even avoided, by setting up our radio telescope at a "radio-quiet" location (see Experimental Setup below). The naturally occurring cosmic and galactic radio noise background is due to the combination of radio signals from all the cosmic and galactic radio sources. It permeates the radio sky so it cannot be avoided. Although the radio sources within our own Milky Way Galaxy are intrinsically weaker than some of the cosmic radio sources like QSOs and radio galaxies, the galactic radio sources are much closer to us, so they appear stronger to us. Consequently, the natural radio background that we have to deal with is primarily due to the galactic radio sources concentrated in the Galactic plane and near the Galactic Center.

Since there is no escaping from the Galactic radio background when we make radio observations of Jupiter and the Sun, the signals received by our telescopes at any time are always the sum of the background signals and the signals from our target, Jupiter or the Sun. Luckily, the emissions from either the Sun or Jupiter are generally stronger (perhaps due to their proximity) than the background signals and they are easily distinguishable. But to be able to ascertain the intrinsic strengths of the observed emissions (so that we can gain better understanding of the physical processes at the Sun and Jupiter), we need to remove the contamination of the background radiation levels from our raw data.

The figure below shows an example of raw Radio JOVE observations at 20.1 MHz over a 24-hour interval on April 10, 2020. The horizonal axis provides the observation times in UTC, so for the particular Radio JOVE station, 5-10 UTC corresponded to 0-5 AM when both the local RFI and the Sun should be relatively quiet such that the remaining signals are primarily due to the galactic radio background. The interval labeled "Galactic Hump" indicates the times of transit of the Galactic Center over the observing location or through the antenna beam. The strong signals above the background during daytime hours are caused by significantly higher levels of RFI and solar radio emissions detected during the day. So in order to obtain the full 24-hour "quiet-day curve" of the galactic radio background, an extended interval of night-time observations is required so that the entire quiet day curve could be obtainded under low noise conditions.



Objectives

The goal of this observational project is for every Radio JOVE station in our citizen science network <**needs CS network link**> to determine the diurnal radio background levels at its location. In doing so, every participating station (and their operators) will become proficient in making observations and in taking scientifically useful data with their equipment. The specific objectives to be accomplished are:

(1) Successful setup of the Radio JOVE hardware (receiver and antenna);

(2) Successful operations of the Radio JOVE system (hardware and software) to make observations and take/record raw, but ***calibrated*** **data**;

(3) Successfully identify, isolate, and to the extent possible, minimize their local RFIs (e.g., by relocating their setup to a more radio-quiet location); and

(4) Obtain (over an extended observation interval) an as clean as possible net 24-hr radio background level curve for your station location.

Experimental Setup

As described in the Radio JOVE kit instructions and the Radio JOVE website <**provide RJ telescope link**>.

Procedures

(1) For each observing run,
  (i) Check environment conditions (e.g., weather) to ensure safety during observation run,
  (ii) Check to make sure that all equipment is functioning properly,
  (iii) Apply the calibrator to obtain the best calibration of the instrument to measure signal strengths in antenna temperature or other physically meaningful units, and
  (iv) Set up the Radio SkyPipe (RSP) software to take measurements for 24 hours, producing a plot like the one above for each 24-hr observing run;

(2) Repeat the steps in (1) to obtain additional 24-hour data records for as long an interval as possible (for a minimum of 6 months; the longer the better); and

(3) Submit the daily data files with proper metadata to the Radio JOVE archive, keeping a copy for yourself.

Data Collection and Submission to the Radio JOVE Data Archive

The observer needs to record the system configuration, including the gain setting in Sky-Pipe or in a separate log file. The log file should be uploaded with the datafile. Details in this topic could be covered in periodically scheduled Radio JOVE help sessions.

Data Reduction

If data are taken by properly calibrated instrument, then there should be little or nothing to do to reduce or process the data in order to produce physically meaningful dataset.

Analysis

See Quiet Day Curve Analysis by Typinski

Results

Post and keep quiet day curve result for future reference and science analysis.