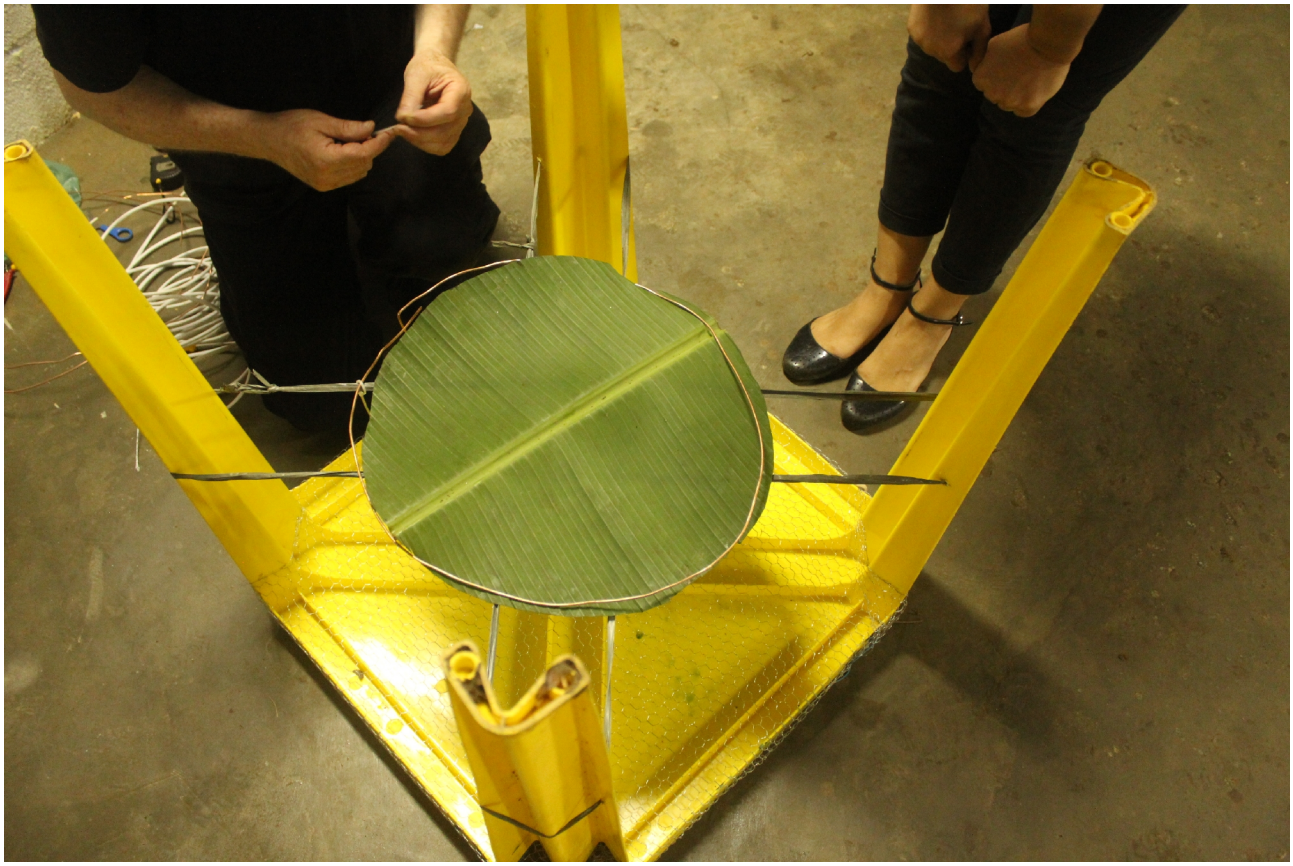
Simple radio telescope for listening to Sun/Jupiter



This **how-to** is based on http://www.ukaranet.org.uk/uk_amateurs/bobgreef/ which references 'Build a 21 MHz Jupiter Antenna' by David Rosenthal in Sky and Telescope from December 1989, itself indebted to R. Mansfield Sickels (see Biblio. below)

Parts:

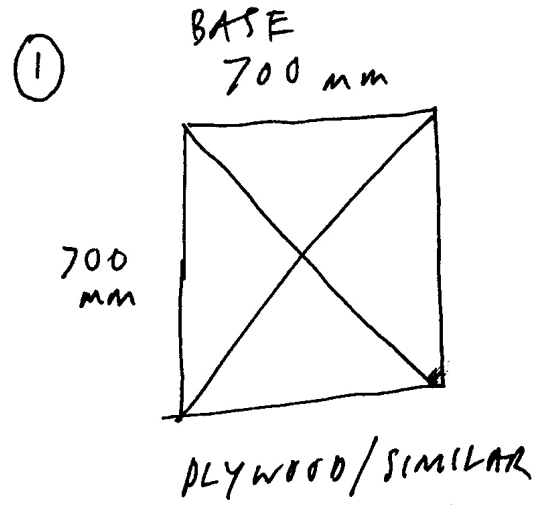
Chicken wire (approx 80 x 80 cm)
Base of 70cm² (wood or similar)
Short wave radio receiver (with range at least from 20mHz)
1-2m coaxial cable
4 x 30cm sticks/wood
connector block
staple gun/string or similar
2 metres of single core bare copper wire (approx. Ø 2+mm (14 swg))
Soldering iron/solder

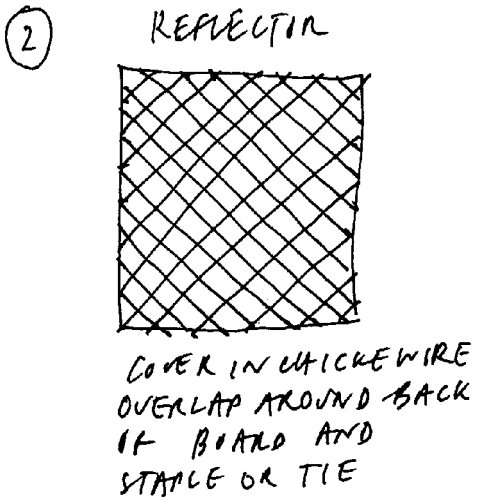
The Sun and Jupiter are the most active radio sources in our solar system. Radio waves that can penetrate Earth's atmosphere are in the range of frequencies from about 5kHz to over 300GHz with wavelengths from a few millimetres to nearly 100 metres. Although these wavelengths have no obvious effects on humans, they do induce a very weak electric current in a conductor such as an antenna.

Jupiter's radio emissions are primarily due to the orbit of one of its moons, Io through the nearby ionized gas and magnetic fields. Jupiter is also the site of electrical storms. The Sun is naturally a very strong emitter of radio waves and its solar flares and sunspots also cause bursts of radio energy to be projected into space.

Emissions in the range 3–40 MHz (with wavelengths of 10–100 m) are referred to as decametric radiation (decametric means tens of metres) and both the Sun and Jupiters emissions may be detected in un-used portions of the shortwave bands at anywhere from 18 to 28 MHz. At frequencies below 18MHz or so radio waves can't be detected at the Earth’s surface because the Earth’s ionosphere reflects them back into space. At 18 MHz strong interference from manmade radio emissions and lightning discharges also reduces the chances of detecting the emission. At frequencies higher than 24 MHz, the probabilities of detection drop sharply because of the drop in intensity of the emission. So somewhere around 21 Mhz is commonly thought to be the best band for listening as it is well above the ionospheric cut-off frequency and generally free of man-made interference.

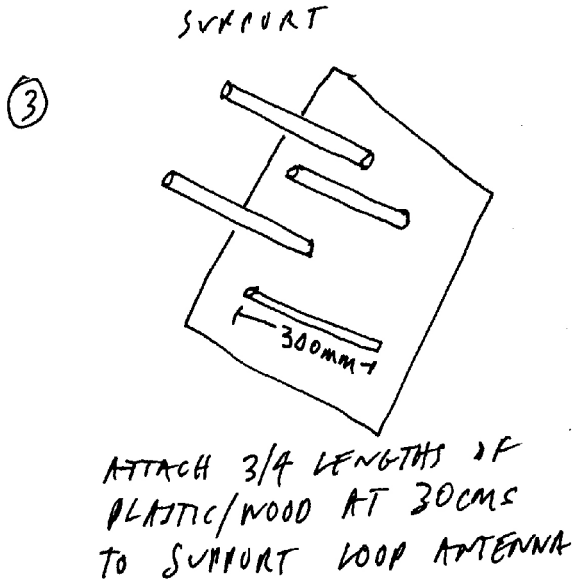
Jupiter and the Sun can be listened to at any time of the day: however, between midnight to 7am the earth's ionosphere is said to be less dense. Also Jupiter listening is seasonal as at times it is invisible behind the sun for several months in the year (see links below re. Jupiter's radio season). Furthermore Jupiter's activity is dependent on the position of its moon Io.



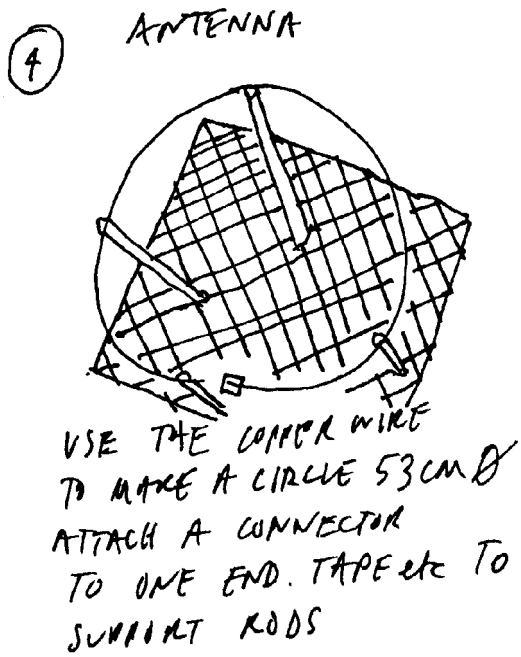


The reflector is made with a base of wood or similar about 70cm² (in Ubatuba the yellow plastic table was 68cm²). This is then covered in chicken wire (or even aluminium foil) that is overlapped and stapled or tied to the board.

The reflector is used to focus transmitted waves into a narrower beam to collect and concentrate the received RF signals.



The four 30cm lengths of wood or plastic are screwed to the board to support the copper loop antenna (in Ubatuba we just drilled through the legs at 30cm and fixed the copper ring to the supporting cords with cable-ties).



Cut a length of copper of 170cm and make into a circle of 53cm diameter (using a template helps). Fix the circle to the tops of the rods with tape/hot glue/cable-ties or something else non-conductive. Scrape any varnish from one end of the copper before attaching the connector block and leave the other end free.

Connecting the radio receiver:

Strip a length of the co-axial cable to reveal both the ground and plastic covered signal. Twist the strands of the ground and wrap around the chicken wire. Strip the end of the signal wire and screw into the connector block.

If the radio has a co-axial adapter use it to attach the cable. If not, remove the radio's antenna and attach the coax ground to the radios case (if metal) or hold it (ie. to ground it), and solder its signal wire to the aerial stub.

If the receiver has Automatic Gain/Volume Control (AGC or AVC) - which is used to smooth the volume for manmade communications when the radio signals vary due to propagation effects) - disable it to hear signal variabilities.

Now the telescope is ready to test: point it to the Sun and hopefully hear its large radio emissions across a large part of the sky (move the telescope around). Jupiter is more difficult to hear and, as indicated, Jupiters radio visibility and Io's orbit need to be predicted for maximum effect.

For recording/playback connect the earpiece jack to a recorder/laptop with audacity/similar. Baudline is a good and free software analysis tool: http://www.baudline.com/spectrum_analyzer.html

Bibliography:

The Discovery of Jupiter's Radio Emission: http://radiojove.gsfc.nasa.gov/library/sci_briefs/discovery.htm

Nasa's Radio Jove Project FAQ: http://radiojove.gsfc.nasa.gov/help/faq1.htm

*Build a 21 MHz Jupiter Antenn*a, David Rosenthal, Sky and Telescope, December 1989 (seems unavailable)

The Radio Astronomy Handbook, R. M. Sickels, 1989 – (cited as the originator of the design and this book has apparently lots more – no downloads)

Advanced Amateur Astronomy, Gerald North, 1991. Description of his version of the telescope pp. 374 – 378 (download via. http://gen.lib.rus.ec/)

Basics of Radio Astronomy, Diane Fisher, 1998, Jet Propulsion Laboratory, California Institute of Technology, Pasadena, California. http://www2.jpl.nasa.gov/radioastronomy/

The Jovian Decametric Radio Emission: http://radiojove.gsfc.nasa.gov/library/sci_briefs/decametric.htm

Sample helix antenna plan: http://www.iceinspace.com.au/forum/attachment.php?attachmentid=16861&d=1158146700

Other untraced ref. articles:

Jupiter on Your Shortwave, Sky & Telescope, December 1989, page 628.

Backyard Radio Astronomy, Astronomy, March 1983, page 75-77.