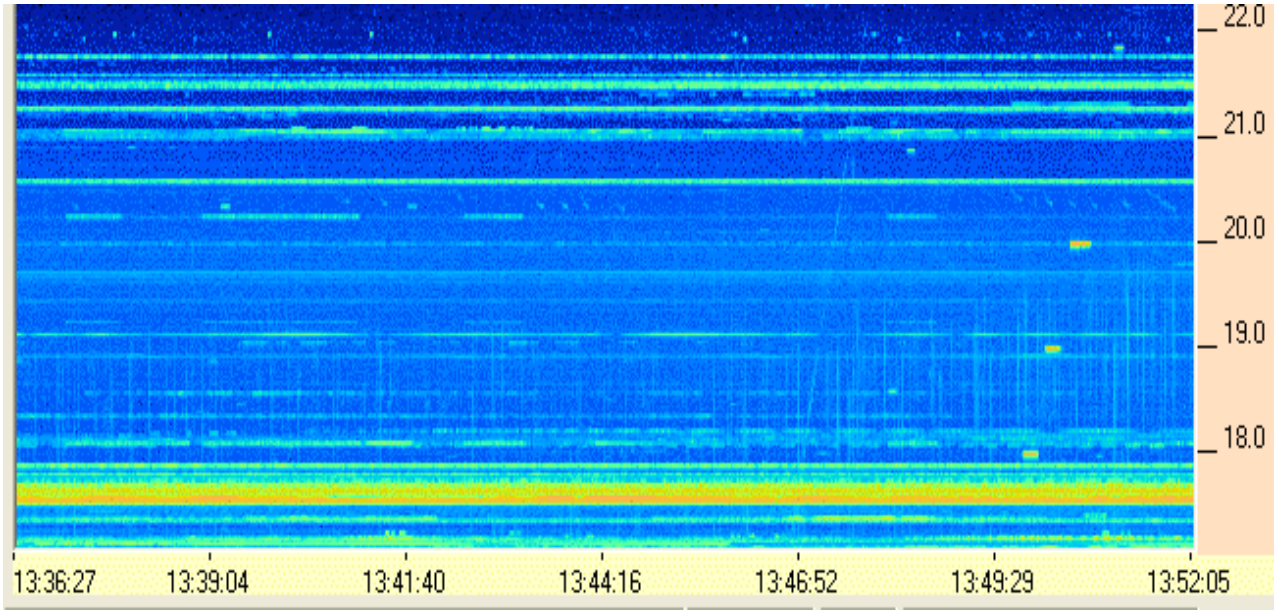
Observing Jovian DAM Emissions with a SDR Telescope

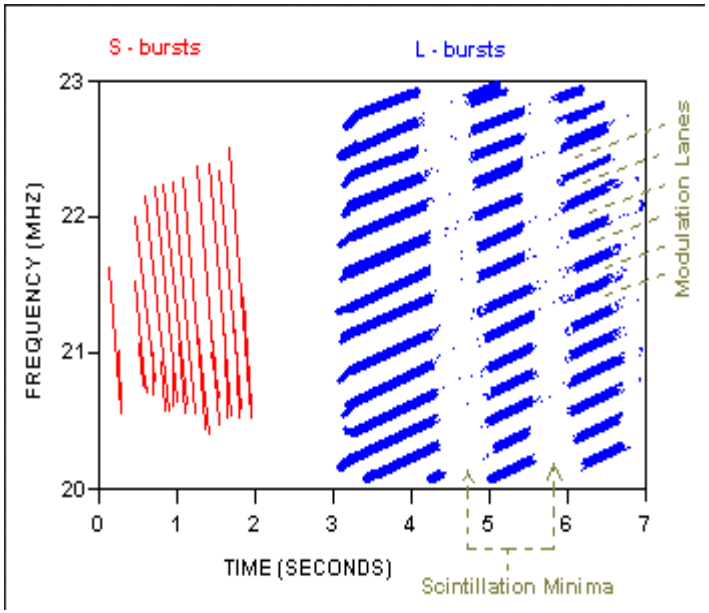
SDR what makes it interesting?

- Availability of cheap receivers such as the DVB-T HDTV tuners and transceivers such as the HackRF has lead to explosion in popularity of SDR and allows amateur enthusiasts access to the airwaves
- SDR allows the manipulation of radio communication signals from within software. Eg: Can listen to several different frequencies at once
- I've been fascinated by Astronomy and Space in general for as long as I can remember. Jupiter is an interesting target for observation either visually or through a radio telescope, and after reading about the DAM emissions and strange interactions with its satellite Io I've been wanting to hear them for myself!

DAM Emissions

- Jupiter emits radio waves in the decametric (DAM) range (10 – 100 m wavelengths or 4 – 40MHz frequencies)

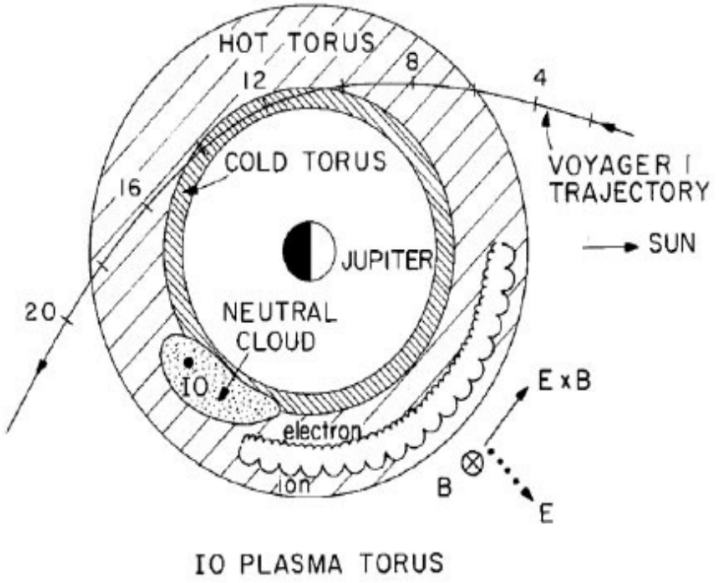




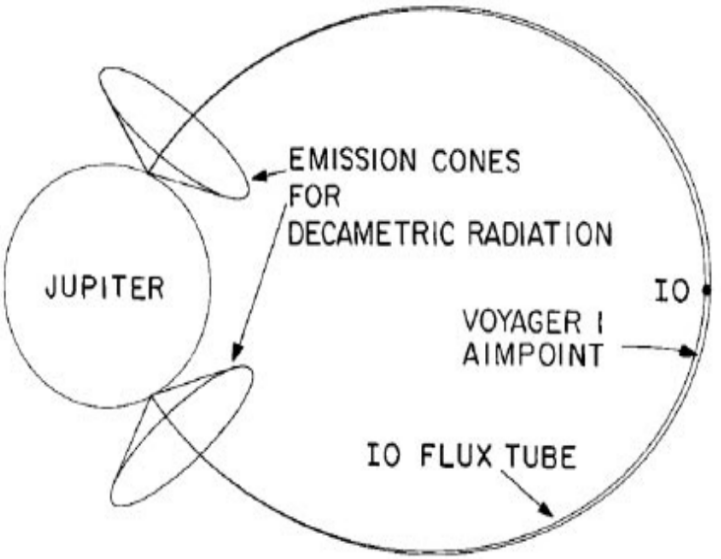
Aims

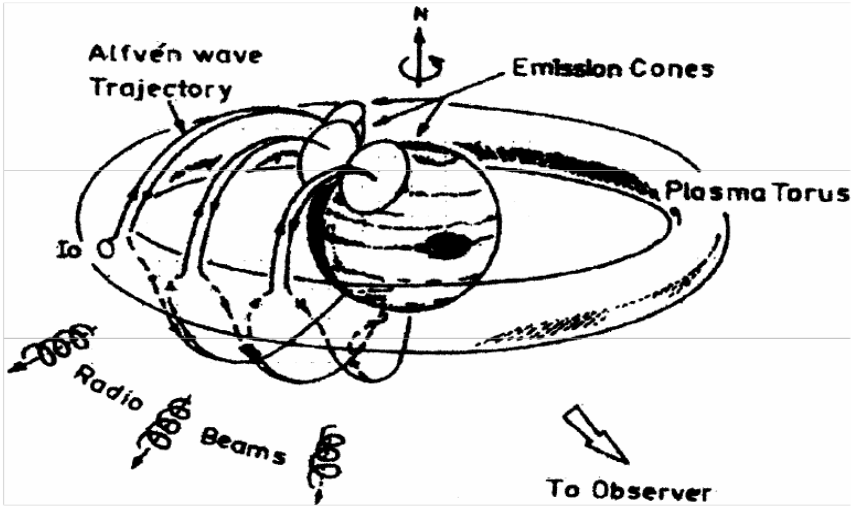
- Build an antenna which can pick up DAM Emissions
- Develop SDR Filter for interference emissions from natural and human sources
- Develop SDR solution to identify interesting Jovian DAM emissions
- Design automated listening station, and aggregation, DSP backend for multiple listening sites

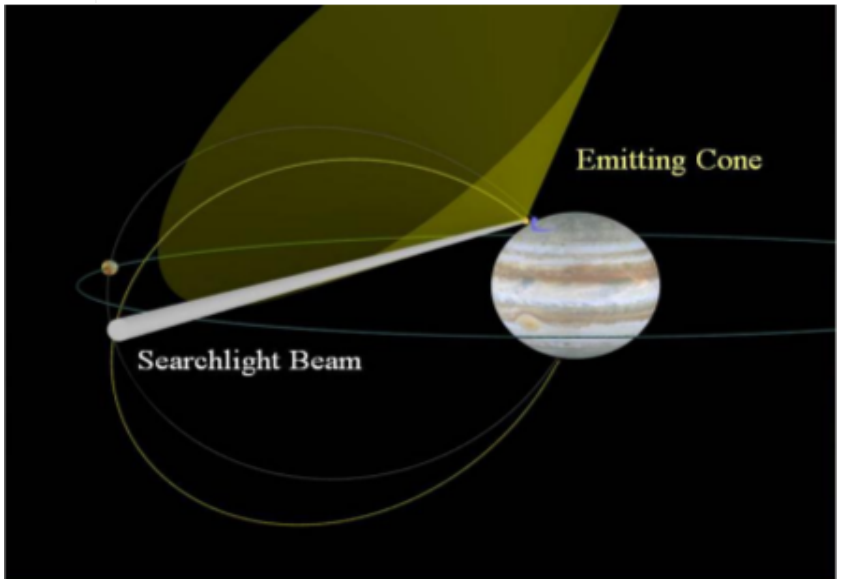
DAM Emissions, where do they come from?



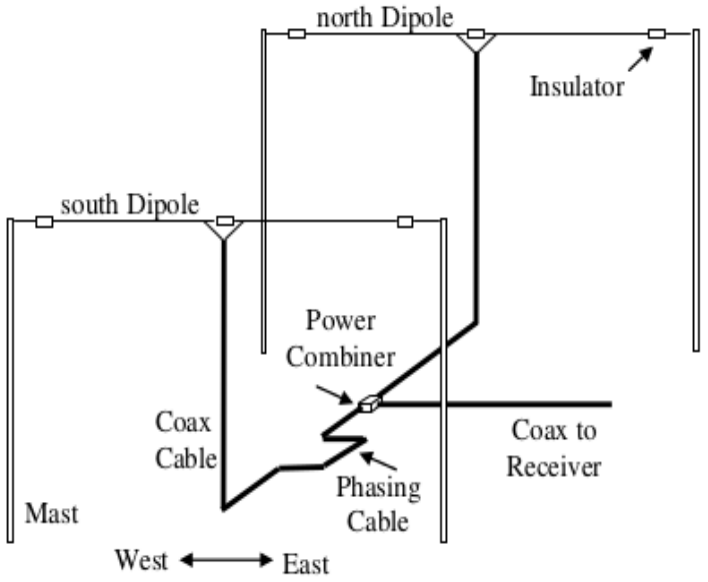
IO PLASMA TORUS

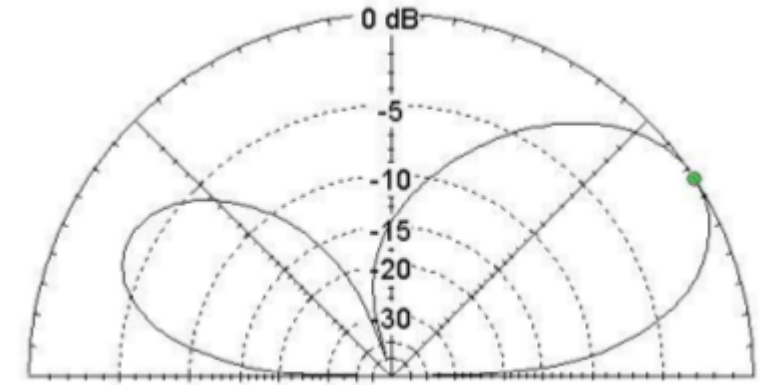




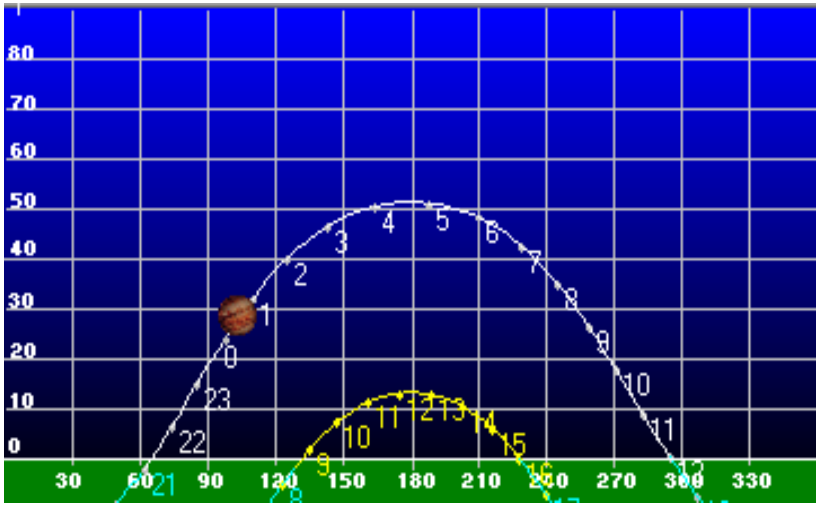


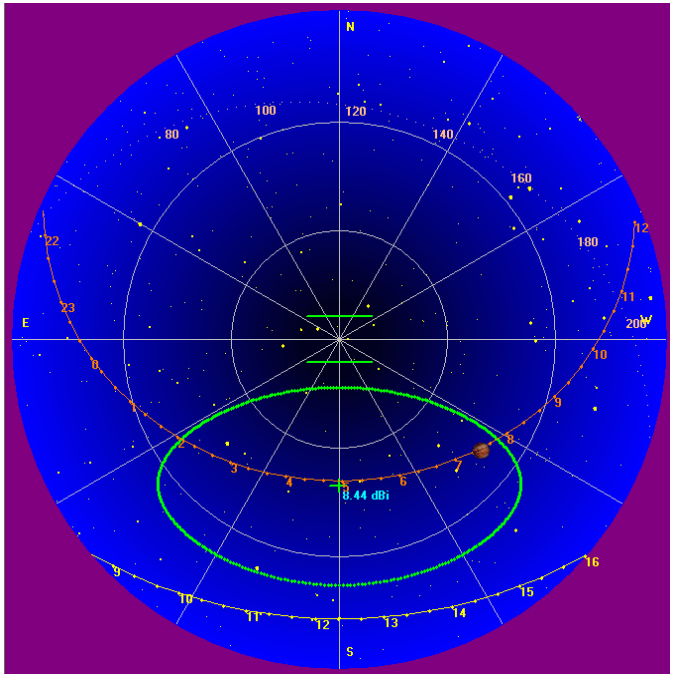
How can the DAM emissions be Observed?



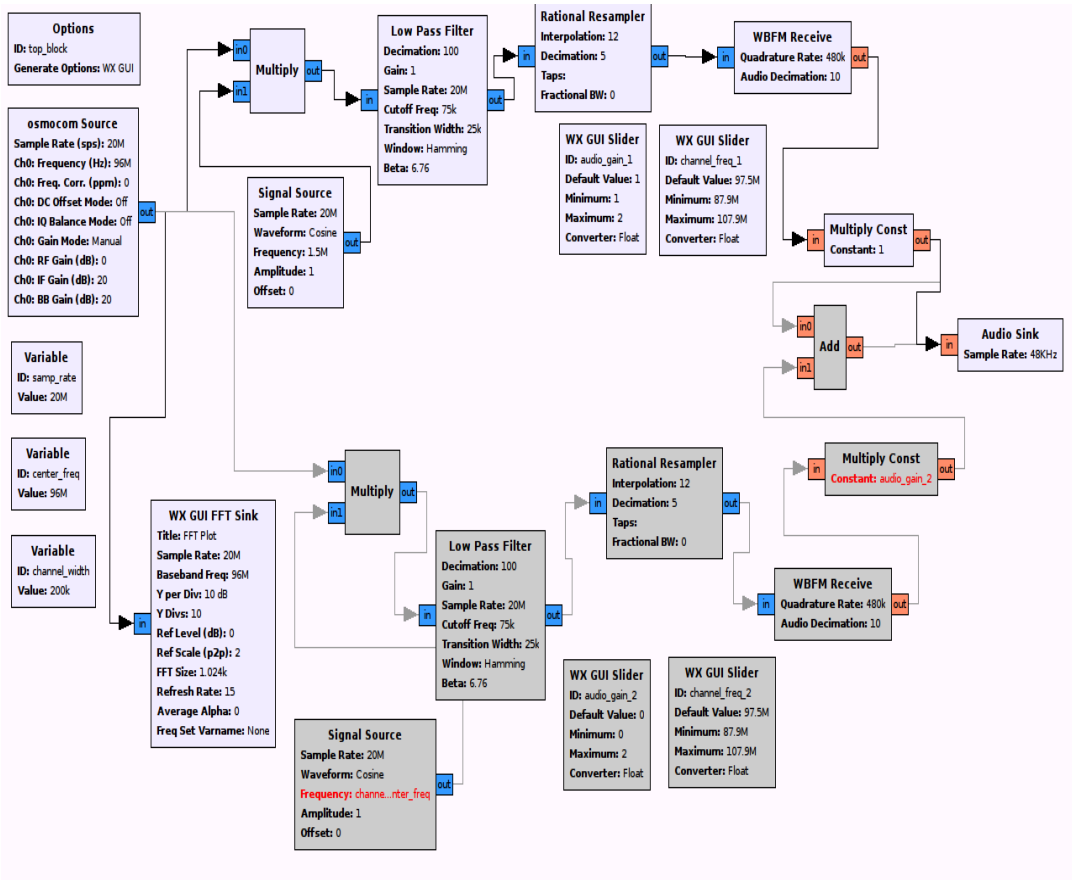


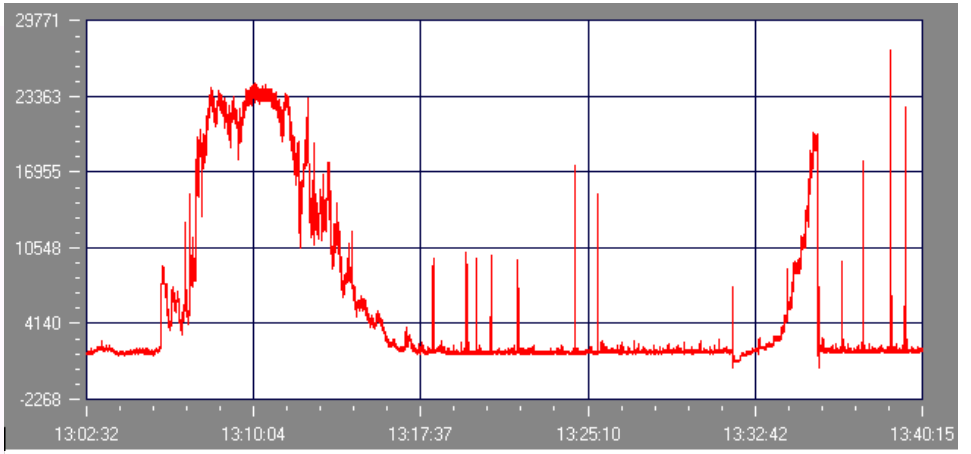
Dual dipole, 20 ft, 135 deg phasing, gain = 9.5 dBi at el = 33

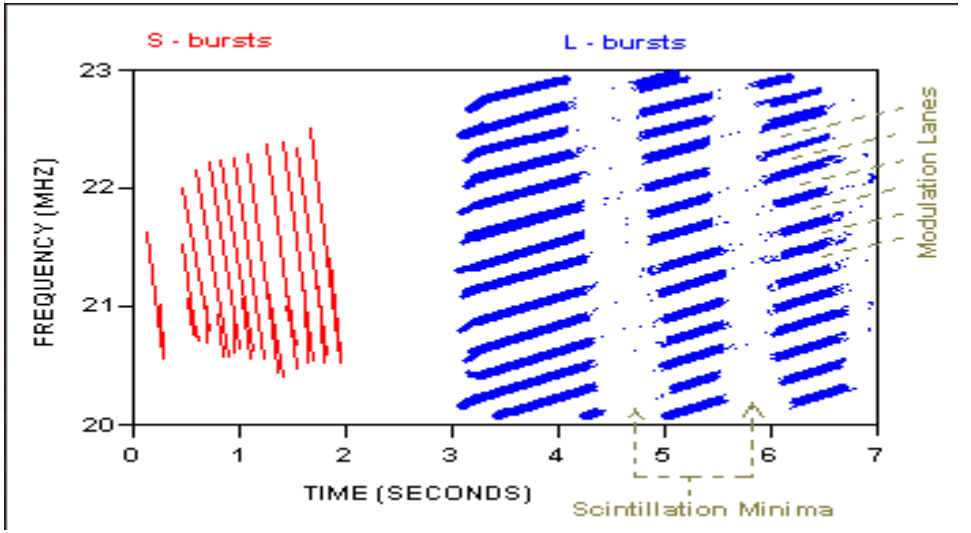




How can SDR be leveraged to process signals observed?







Hypothesis

- What IOT technologies would lend themselves to develop a scalable self sufficient listening platform for radio communication
- Is it possible to develop an Opensource SDR data processing solution to detect interesting DAM events such as S-Bursts, L-Bursts or N-Bursts
- Can an Opensource SDR solution in be developed to process the observation data to flag or filter natural or human created interference

Methodology

- Build antenna: Dual Dipole antenna as described in the NASA Radio Jove project
- Perform site survey with a spectrum analyser to determine if the Antenna is suitable to capture DAM emissions either from Jupiter or the Sun
- Develop an automated system to Collect data from the antennae
- Develop a SDR solution to perform digital signal processing on the captured data

Project Plan

Deadline	Start	End	Summary
Antenna Build	October 14	December 14	Settle on a design for the telescope, source the parts for the build and finally construct the prototype antenna which will act as a template for the second dipole.
Site Survey	January 15	January 15	Perform a site survey using a spectrum analyser connected to the prototype antenna.
Deploy Dual Dipole Antenna	January 15	January 15	Deploy the antenna array at a suitable location and begin to collect data for analysis.
Interim Report	January 15	24th April 15	Interim Report presentation to review panel and supervisor on 29th April
Data Collection	January 15	June 15	Once the antenna is deployed begin collecting data for analysis.
Data Analysis	January 15	June 15	Develop analytical SDR tools to filter or flag interference. Develop algorithms to detect the various DAM emission.
Evaluate IOT Technologies	January 15	June 15	Experiment with the various IOT technologies which could potentially be used to create a self sufficient listening array.
Final Report Submission	June 15	September 15	First draft to supervisor due in early June 15. Complete draft due 24th August. Final submission 4th September

Conclusions

- While it is still early in the process, there are a number of limitations of the study already identified
- Solution geared towards a telescope listening site with a Latitude of 53.3 Degrees N
- An embedded computer such as the Raspberry Pi, Beaglebone Black or Intel Gallileo is unlikely to be powerful enough to perform serious signal processing on site.
- Might require more powerful system such as an Intel Atom or i3/i5/i7 system due to intensive USB transfer rates at high bandwidths with the transceiver