Space and Naval Warfare Systems Center Pacific

Antenna Modeling and Pulsar Distribution

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Introduction

The Space and Naval Warfare Systems Center Pacific (SSC Pacific) located in San Diego, California, is the Navy's premier Research, Development, Test, and Evaluation (RDT&E) laboratory supporting Command, Control, Communications, and Computers, Intelligence, Surveillance and Reconnaissance (C4ISR).

SSC Pacific supports the acquisition and development of communications and warfare systems, delivering knowledge superiority to the warfighter at the right time and for the right cost.

Our internship involved working in the Advanced Electromagnetics Branch and the Advanced Technology Branch, where we were exposed to the research that professional scientists and engineers are undertaking, and where we participated in projects involving Antenna Modeling and the distribution of Pulsars on the Celestial Sphere.

Large parabolic dish antennas are used to study celestial objects such as Pulsars at radio frequencies. Pictured above is a Very Large Array (VLA) interferometer in New Mexico.

Method

For Antenna Modeling, a study of the principles of electromagnetism was undertaken in order to apply physical theory to an engineering setting. Measurement techniques and antenna analysis methods were undertaken via network analyzers that were used to measure antenna characteristics such as resonant frequency, gain, impedance, and bandwidth. For antenna modeling, Expert MININEC Broadcast Professional, an advanced engineering tool for the design and analysis of wire antennas, was used.

For the Pulsar Distribution project, a study of the Australia Telescope National Facility (ATNF) pulsar database was undertaken, where pulsar coordinates are given in Right Ascension and Declination. The parameters of interest are the pulsar Period, and signal flux at 400MHz and 1400MHz. MATLAB was used to plot the pulsar database.

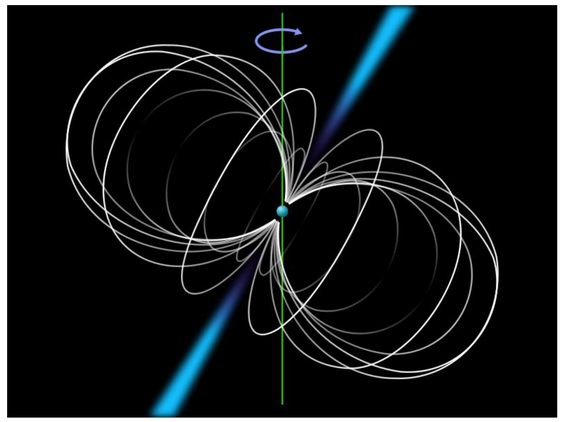
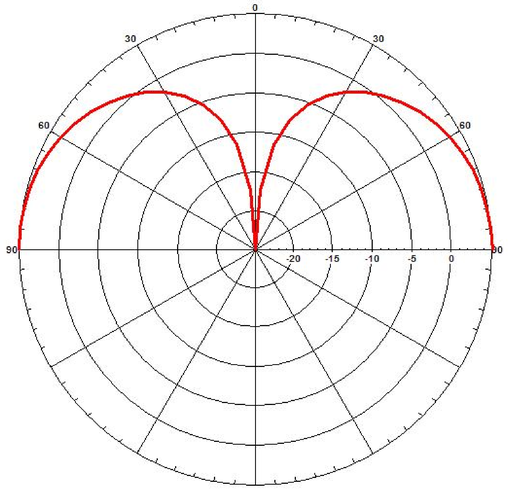


Diagram of a pulsar, showing the off-axis orientation of the magnetic field. As the pulsar rotates, electromagnetic radiation emitted along the magnetic axis sweeps out sections of space like a beacon. With the proper orientation, these signals can be detected from earth.

Results

Monopole antenna models produced via Expert MININEC were used for comparison to actual antenna characteristic measurements.



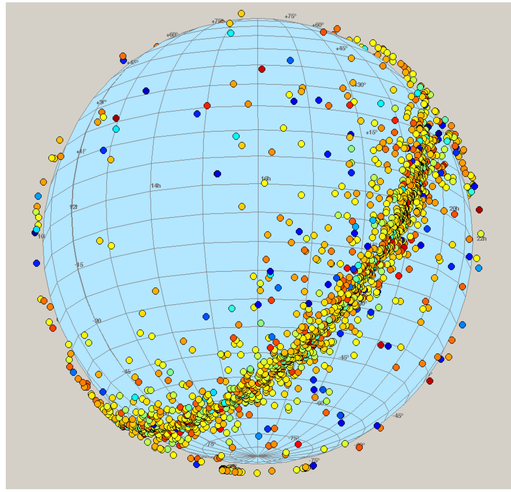
MININEC radiation pattern for a monopole antenna.

A Graphical User Interface (GUI) was designed to allow the pulsar database to be plotted selectively by coordinates or by specific pulsar properties, such as rotation period and signal flux.

The pulsars were plotted on a spherical surface using the Right Ascension and Declination coordinates from the ATNF database, with the ability to represent the magnitude of various properties in either a linear or a logarithmic color scale.

It became immediately obvious that most pulsars are found on the galactic plane, as should be expected. Also, it is apparent that most pulsars are located in the southern celestial hemisphere, in the general direction of the galactic center in the Scorpio-Sagittarius region.

NOTE: The US Navy has classified the applications of this pulsar work.



Plot of the ATNF Pulsar Database, showing the distribution of pulsars mostly along the galactic plane.

Conclusion

The knowledge acquired during our SSCPAC internship will be directly applicable to our future endeavors in both academia and industry. The skills gained through the exposure to team collaboration and project development and completion will be transferable to our respective fields in science and technology.

Acknowledgements

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