Measurements of Jupiter's decametric source locations by LWA1 modulation lane data

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Jupiter's decametric emissions originate along magnetic field lines within auroral zones as well as field lines that pass through Io and the Io plasma torus. The radio waves at Jupiter are amplified by particle-field interactions and are generated in both the X-mode and O-mode. Due to the emission source parameters, right-hand (RH) polarized waves are generated from northern hemisphere sources (Io-A and Io-B sources) while left-hand (LH) polarized waves come from the southern hemisphere (Io-C and Io-D sources).

The modulation lanes in Jupiter’s decametric radiation, which were discovered by Riihimaa [1968], are groups of sloping parallel strips of alternately increased and decreased intensity in the dynamic spectra. Extensive systematic observations of modulation lanes have been made in the frequency range 21 to 23 MHz by Riihimaa [1970, 1974, 1978]. The frequency-time slopes of the lanes can be either positive or negative, depending on which of the Jovian sources is being observed.

In the Imai et al. model for the production of modulation lanes, the lanes are assumed to be a manifestation of interference fringes from the line source consisting of the points along the axis of the Io-activated flux tube that are emitting at the different local values of fc. The fringes are produced as a result of the passage of the multi-frequency radiation through an interference grating. This grating is a planar grid of almost equally spaced field-aligned columns of enhanced plasma density, perpendicular to the ray-paths toward Earth, located near the sub-Earth point on Io’s orbit. Radiation from each of the frequencies emitted by the line source produces a set of interference fringes when it is scattered by the plasma-enhanced columns. These sets of fringes are inclined with respect to the Jovian equator. The rotation of Jupiter sweeps the inclined interference patterns for the different frequencies across Earth, producing the modulation lanes in the observed dynamic spectra. We developed a model to explain the production of the modulation lanes [Imai et al., 1992a, 1992b, 1997, 2001, 2002]. By using our model the precise Jupiter's radio source locations and beam parameters can be measured. This new remote sensing tool is called as the modulation lane method.

The Long Wavelength Array (LWA) is a low-frequency radio telescope designed to produce high-sensitivity, high-resolution images in the frequency range of 10-88 MHz. The Long Wavelength Array Station 1 (LWA1) is the first LWA station completed in April 2011, and is located near the VLA site in New Mexico, USA. LWA1 consists of a 256 element array, operating as a single-station telescope. The sensitivity of the LWA1 combined with the low radio frequency interference environment allow us to observe the fine structure of Jupiter's decametric modulation lanes. Using newly available wide band modulation lane data observed by LWA1, we measured source locations and beam parameters. The results of LWA1 data analysis indicate that the radio emitting sources are located along the restricted range of longitude. We only receive one of the individual sources which has a very thin beam thickness (probably less than few degrees) at a given time. We show the measured locations of Io-related sources based on the modulation lanes observed by LWA1. The new components of Io-C and Io-B sources are discussed.

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