Microstructure of Jupiter's decametric radio sources measured by the modulation lane method

Kazumasa Imai[1], Chie Kameda[2]

[1] Dept. of Electrica Eng., Kochi National College of Technology, [2] Dept. of Electrical Eng., Kochi National College of Technology

http://www.ee.kochi-ct.ac.jp/~imai/jupiter/

A radio telescope having an antenna of relatively large collecting area is needed for the investigation of modulation depths. We used for this purpose recordings that had been made earlier with the 26.3-MHz 640-dipole antenna array at the University of Florida. The intensity was integrated with respect to frequency for each increment of time, resulting in a curve from which typical values of Io-B modulation depth could be measured. The period between the more intense modulation lanes ranges from about 0.5 to 1.5 s. There is also finer structure on a time scale of about 0.3 s, which we suggest may be evidence for radio source structure on a distance scale as small as 20 km.

The modulation lanes in Jupiter's decametric radio spectra were discovered by Riihimaa [1968]. We have developed a model for the mechanism responsible for their production in which the free parameters have been adjusted to provide a very close fit with the observations. In our model, a grid-like interference screen composed of field-aligned columns of enhanced or depleted plasma density is located near Io's orbit close to the longitude of the sub-Earth point. The column spacing is typically about 140 km. As a band of frequency components emitted from near the foot of an excited tube of magnetic flux passes through the screen, interference patterns of slightly different orientations are produced by the different frequencies. The corotation of this set of interference patterns with Jupiter results in the sloping modulation lanes of the observed dynamic spectrum.

The modulation depth of modulation lanes is the ratio of the maximum intensity in a typical lane to the minimum intensity between that lane and an adjacent one. A radio telescope having an antenna of relatively large collecting area is needed for the investigation of modulation depths. We used for this purpose recordings that had been made earlier with the 26.3-MHz 640-dipole antenna array at the University of Florida. Although the receiver bandwidth was relatively small (500 kHz in this case), the high sensitivity of the system made possible accurate modulation depth measurements. To facilitate the measurement, the known f-t slope was used to introduce a progressive time displacement with respect to frequency that resulted in the de-skewing of the sloping lanes, rendering them nearly vertical. Then the intensity was integrated with respect to frequency for each increment of time, resulting in a curve from which typical values of Io-B modulation depth could be measured. The period between the more intense modulation lanes ranges from about 0.5 to 1.5 s. There is also finer structure on a time scale of about 0.3 s, which we suggest may be evidence for radio source structure on a distance scale as small as 20 km (making use of the fact that the relative screen velocity is 67 km/s).