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VLA OBSERVATIONS OF JUPITER AT 1.3 - 20 cm WAVELENGTHS

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In order to study the vertical distribution of ammonia as a function of Jovian latitude, high resolution images have been obtained with the VLA at 1.3, 2, 6 and 20 cm wavelengths. Although the interpretation of the data is quite complicated due to Jupiter's synchrotron radiation, which in fact is the dominant source of radiation at 20 cm, the belt-zone structure is clearly present at 2 and 6 cm wavelengths. At 1.3 cm near the center of the ammonia band, the structure is less pronounced, and at 20 cm it is absent. I am currently trying to fit the data with model atmosphere calculations. Since one probes in and through the visible cloud layers at these wavelengths (temperatures of 135-400 K), and the opacity is likely all provided by ammonia gas, a detailed vertical distribution of this gas can be obtained as a function of Jovian latitude. This ought to give insight in the formation processes of the white cloud layers in the zones and their absence above the belts.

Over the past few years I have obtained much data on Jupiter at radio wavelengths between 1.3 and 20 cm. The various images were constructed from data obtained with the VLA in different array configurations, so that both the small and large scale structures on the disk are visible. The resolution typically is between 1 and 3.5 arc seconds.

At radio wavelengths one typically probes Jupiter's atmosphere between 0.5 and 10 bars, which is precisely the region of cloud formation. Since observations at these wavelengths are only sensitive to ammonia gas, which presumably is the main constituent of the various cloud layers, the radio data provide an excellent means to give additional data on Jupiter's cloud layers.

At 1.3 cm, two bright bands can be seen on the disk, roughly at the position of the NEB and SEB. The brightness contrast is rather weak, however. At 2 cm, the image shows many bands across Jupiter's disk. The brightest coincides with the NEB; this band is about 15 K warmer than its surroundings. At 6 cm, two bands can be seen: the one coinciding with the NEB, and one to the south. The latter, however, is mainly due to Jupiter's synchrotron radiation, which becomes more and more pronounced at the longer wavelengths. At 20 cm, most of the emission is due to Jupiter's synchrotron radiation. No thermal features in excess of about 8 K are visible on the disk. The latitude of the bright bands agrees very well with the latitude of the belts observed at optical and infrared wavelengths. Undoubtedly, they are the same features.

I investigated two different possibilities for explaining the brightness contrast between the zones and belts observed at radio wavelengths: (1) there are either different temperature-pressure (T-P) profiles in belts and zones, or (2) there is less ammonia gas above the belts than for the zones, which allows one to probe deeper, hotter, levels in Jupiter's belts. Since there are hardly any latitudinal variations at 1.3 and 20 cm, the T-P profiles at $P < 0.5$ bars and $P > 5$-6 bars should be equal. If the belt-zone difference is due to a difference in T-P profiles, the profile should be superadiabatic high up in the atmosphere (0.5-1 bar) in the belts, and subadiabatic deeper down (4-6 bars); or the zones should be subadiabatic high up, and superadiabatic deeper down in the atmosphere. This seems quite unlikely, certainly when taking the dynamics of Jupiter's atmosphere into consideration.

The second possibility, less ammonia gas above belts than zones, is more realistic. Some detailed model atmosphere calculations, when compared to the radio data show that ammonia gas should be depleted by a factor of about 5 high up in the atmosphere above zones as well as belts ($P < 1$-2 bars), and overabundant by a factor of 2 deeper down in the atmosphere ($P > 2$ bars), compared to the solar value. In addition, the depletion above the belts is larger by a factor of about 2 than above the zones, and extends to deeper levels in the atmosphere (zones: down to 1 bar; belts: down to 1.5-2 bars).

A complete comparison between model atmosphere calculations and the data has recently been submitted for publication in *Icarus*.

DR. PILCHER: Does the image at 6 cm exhibit limb darkening, particularly in the upper region?

DR. DE PATER: No, I don't believe that is actually limb darkening.

DR. POLLACK: What altitudes and pressure levels does that factor of 2 less ammonia refer to?

DR. DE PATER: That's between 0.5 and 2 atmospheres.

DR. POLLACK: If you reach the deeper portion of that, the number no longer follows the saturation curve, and a uniform, latitude independent mixing ratio should be achieved.

DR. DE PATER: At $P < 0.6$-0.7 bars ammonia follows the saturation curve.

DR. BELTON: You made a point of the belts not being parallel. Did you have something in mind?

DR. DE PATER: At 6 cm the lower "belt" is actually due to the radiation peaks, and I think it is really a remaining artifact of the synchrotron radiation. I tried to subtract that radiation from the maps.

DR. FLASAR: I don't understand why you ruled out the intrinsic temperature difference of the bright regions.

DR. DE PATER: The temperature profile differences can only occur between 0.5 and 6 bars, otherwise the 1 cm and 20 cm belts don't match the models. It would seem that atmospheric dynamics rule out super- and sub-adiabatic

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regions of the sort required to fit the data.

DR. FLASAR: So the actual observations require keeping deep levels at which there are very small temperature contrasts.

DR. DE PATER: Yes.

DR. BAINES: Isn't this one time when radio wavelengths agree with optical wavelengths? Our analysis of visible ammonia lines gives us about the same abundance. Also, from the width of the lines we find the pressure at the bottom of the visible atmosphere to be about 2 bars.