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OBSERVATION OF THE J = 5→6 ROTATIONAL SPECTRUM OF NH_3 IN JUPITER, AND ITS COMPARISON WITH EXPECTATION FROM MODEL ATMOSPHERES*

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The Fabry-Perot interferometer system described by Brandshaft et al (1975) has been used to examine the J = 5→6 pure rotational line of NH_3 at about 84 microns wavelength in the atmosphere of Jupiter. The system was mounted on the 91 cm. telescope in the Gerard P. Kuiper Airborne Observatory and the observation made on February 24, 1976.

The resulting absorption line shows no evidence of an emission core. Figure 1 shows the spectrum between 82.5μ and 88μ after division by a standard spectrum to remove variations in instrumental responsivity with wavelength. The spectrum of Jupiter resulted from ten twenty-second scans between about 81μ and 92μ, with beam switching and with beams interchanged on alternate scans to cancel beam imbalance. The vertical column of water vapor corresponded to about 10 microns of condensed water, which gave prominent absorption lines in the spectrum. However, that part of the spectrum shown in figure 1 is not significantly distorted by H_2O absorption lines. Resolution of the interferometer was approximately 1.5 $cm.^{-1}$

While the spectrum of Jupiter represented only about 3 minutes of observation, it was divided by the spectrum of dust in the Kleinman-Low nebula of Orion which resulted from 20 minutes of similar observation

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(taken for another purpose), since the Moon was not available as a standard. The KL spectrum shows no substantial features in this immediate region, and the different temperatures of M42 and Jupiter do not result in any important distortion of the resulting divided spectrum.

The spectrum of Jupiter in the same region has been calculated for various theoretical atmospheres, with pressure-temperature relations indicated in figure 2. NH_3 pressure was assumed to be at the saturation value below the temperature inversion in each atmosphere, and to correspond to a constant mixture above the temperature inversion. Absorption and emission of both H_2 and NH_3 were included in the calculations, which yielded the theoretical spectra shown in figure 1 for comparison with the experimental result.

It is clear that no emission core was seen at this resolution in the Jovian spectrum, in agreement with the two different atmospheric models which have an inversion temperature as low as about 110K. The other two models, having somewhat higher inversion temperatures, show emission cores which disagree with experimental results. Wide variations in temperature gradients otherwise make only rather minor variations in the results. Thus, the primary conclusion is that there is very little NH_3 above the inversion point. Dissociation of NH_3 by ultraviolet radiation may play some role in making the NH_3 abundance low above the tropopause, but very probably an inversion temperature below 115K, as in the atmospheres of Wallace et al (1974) and of Lacy et al (1975) is primarily responsible for the low NH_3 abundance observed above the inversion point.

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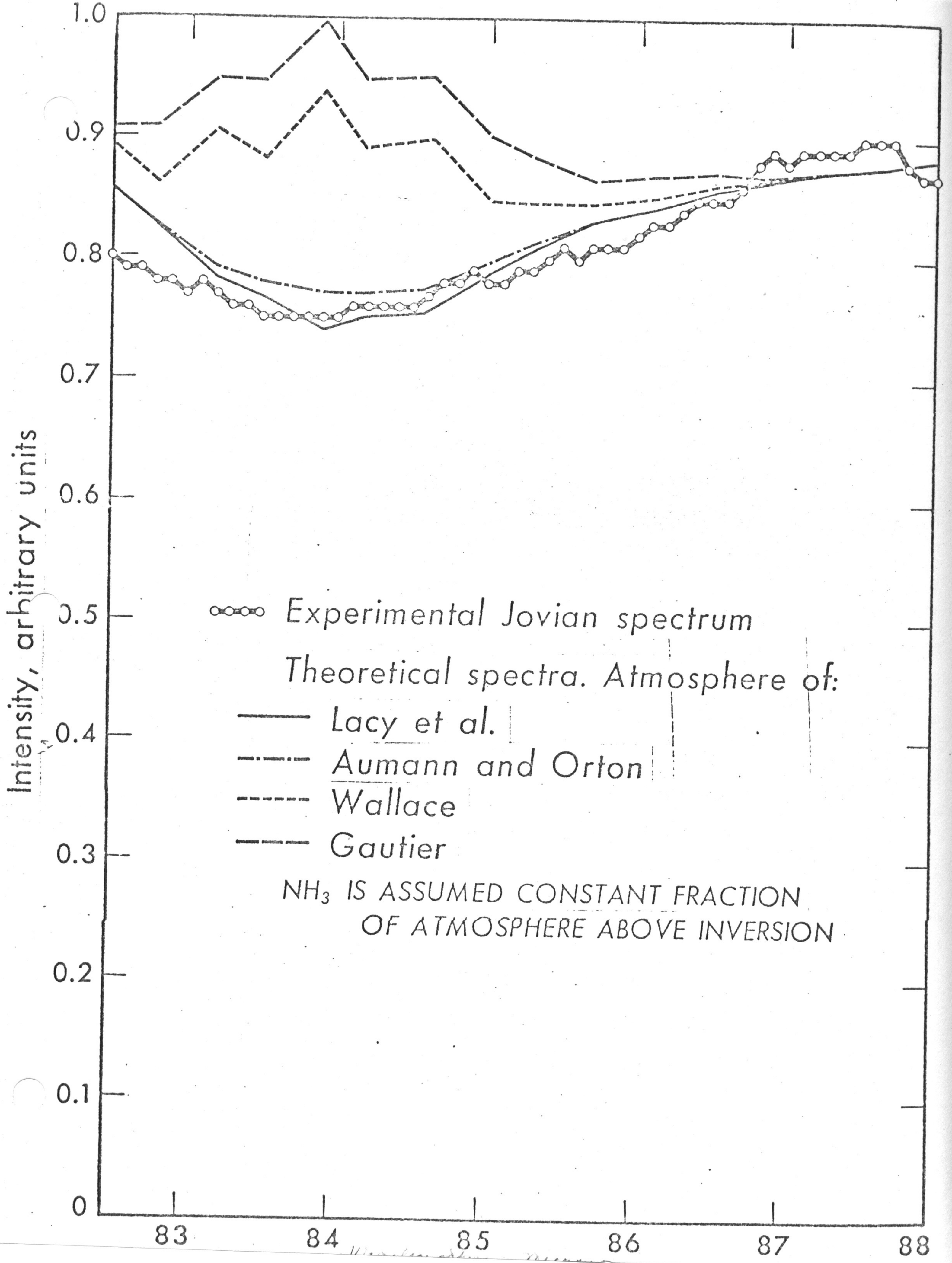
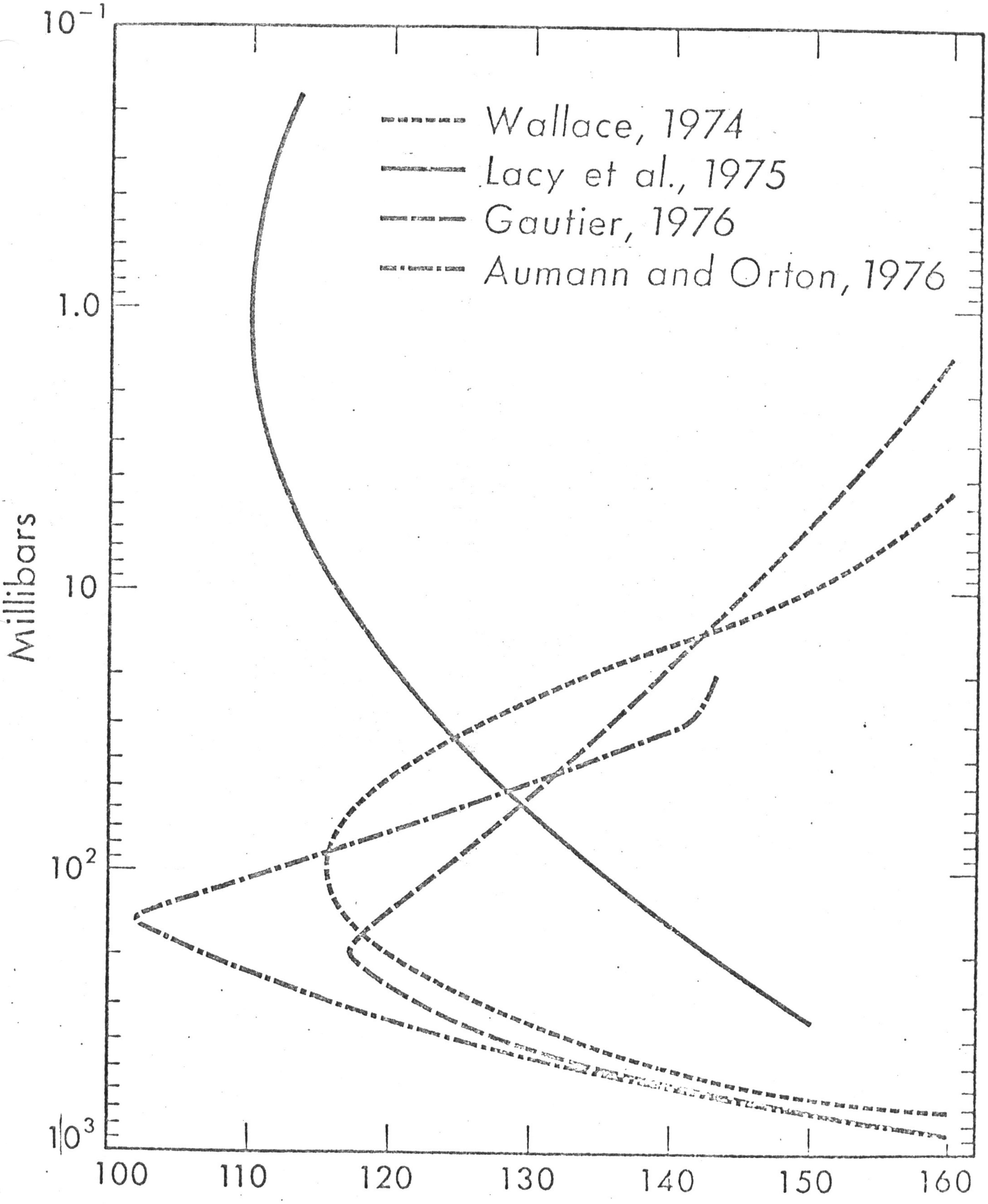
FIGURE CAPTIONS

Figure 1. The spectrum of Jupiter in the region of the J = 5→6 rotational line of NH_3. The NH_3 line, which is complex, is centered at approximately 84 microns. Spectra calculated from four atmospheric models are compared with the observations. The jagged nature of these calculated spectra is in part because calculations were made at discrete and coursely separated wavelengths.

Figure 2. Four atmospheric models used for calculation of the theoretically expected spectrum of Jupiter between 82.5μ and 88μ.


Intensity, arbitrary units
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
83
84
85
86
87
88
Experimental Jovian spectrum
Theoretical spectra. Atmosphere of:
Lacy et al.
Aumann and Orton
Wallace
Gautier
NH3 IS ASSUMED CONSTANT FRACTION
OF ATMOSPHERE ABOVE INVERSION



Wallace, 1974
Lacy et al., 1975
Gautier, 1976
Aumann and Orton, 1976
Millibars
10^{-1}
1.0
10
10^2
10^3
100
110
120
130
140
150
160
Temperature, °K

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