support of ESO's La Silla staff. I would like to mention especially E. Matamoros, J. Roucher and U. Weilenmann. This campaign was particularly difficult because of day and night-time observing since TIMMI was usually observing 18 hours and more per day. The author appreciates also valuable discussions with K. Zahnle.

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Near-IR Spectroscopy of Jupiter at the Time of SL-9 Impact Using NTT-IRSPEC: Emissions of CH_4, H_3^+ and H_2

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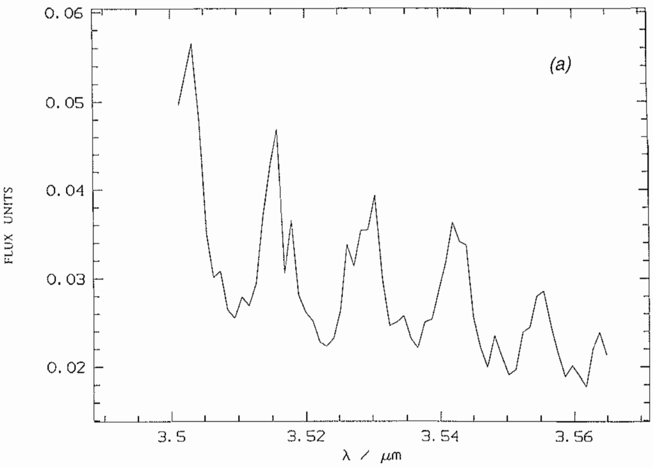
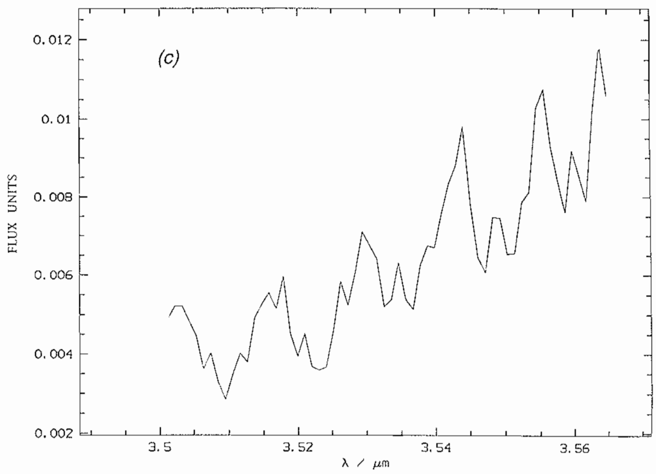
Near-infrared observations of the Jovian disk, using IRSPEC at the 3.5-m NTT, have been performed continuously from July 16 to July 28, 1994, with a final observing night on July 30/31. Data were recorded every night, with the exception of the three nights of July 18–22, lost because of bad weather.

The IRSPEC instrument is an imaging spectrometer working between 1 and 5 μm, with a resolving power ranging from 1300 to 3000. Its 4.4 arcsec slit was aligned along the parallel of impact sites (l = −44°) to monitor these sites as they were rotating with the planet. After the impacts, in the second part of the run, we monitored the entire Jovian disk by shifting the slit (still aligned with the parallels) in 9 different positions to cover the whole latitude range from pole to pole. This method allowed us to monitor systematically the impact regions and the corresponding emission regions detected at the same longitude in the northern hemi-





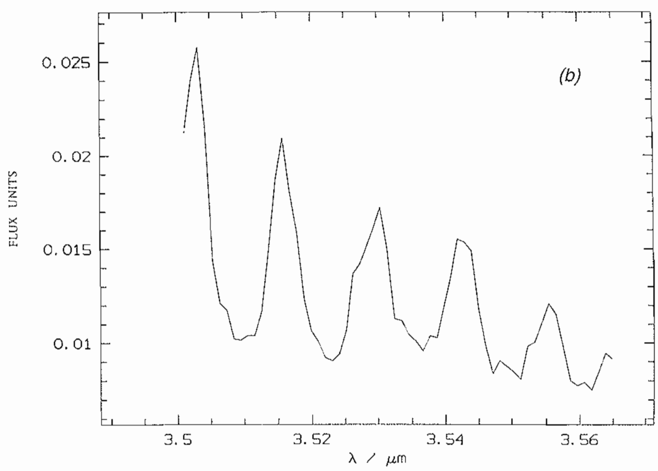


Figure 1: *CH_4 emission above the H impact site, 20 minutes after impact (July 18, U.T. 19:50). The peaks correspond to P multiplets of the ν_3 band of methane, centred at 3.3 μm (J = 14 to J = 18). (a) Central region (maximum of intensity); (b) Intermediate region (2.2 arcsec from central region); (c) Leading side of the H impact (4.4 arcsec from central region.)*

sphere at $l = +44°$ (see the article by R. Schulz *et al.* in this issue) as well as the equatorial and polar regions.

In order to monitor the stratosphere of Jupiter at the time of the impacts, our observations were focused on two spectral ranges: (1) the H_2 emission at 2.12 μm and (2) the H_3^+ emission at 3.53 μm. Both emissions occur very high in the Jovian stratosphere. Under nominal conditions, the H_2 quadrupole line is formed at a pressure level of about 0.1–1 microbar, while the H_3^+ emission occurs at even higher levels (P = 10–100 nanobars). In the two spectral ranges, the expected emissions were recorded above the impact sites, and the spectra exhibited drastic differences in and out the impact regions. The most surprising result was the detection of a very strong emission of methane in the 3.53 μm range, just after impact H.

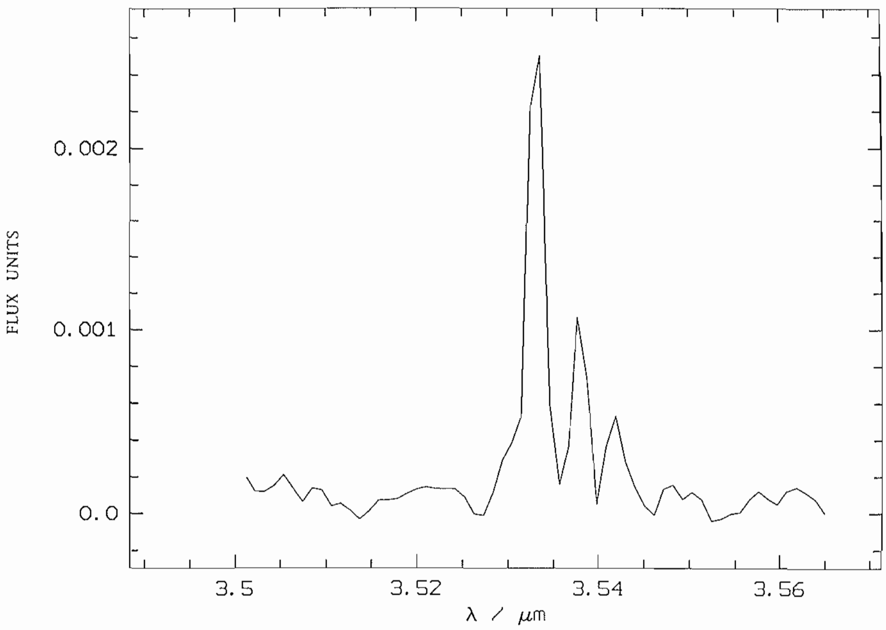


Figure 2: *H_3^+ emission above impact G, measured on July 18, U.T. 19:46, i.e. about 12 hours after impact.*

Methane Emission at the Time of Impact H

Our observations, covering the range 3.501–3.566 μm with a spectral resolving power of 1700, started on July 18 U.T. 19:46, i.e. 13 minutes after the impact, at a rate of 1 spectrum per minute. A very strong emission was detected over the whole spectral range; it was soon identified as high J-value multiplets of the CH_4 ν-3 band centred at 3.3 μm (J = 14 to 18). The signal intensity decreased exponentially with a time scale of about 5 minutes and was detectable for about half an hour.

A spatial analysis of the emission was performed along the slit, with a pixel size of 2.2 arcsec. At the beginning of the sequence, the CH_4 emission extended over about 10 arcsec. The slope of the spectrum shows spectacular variations of the CH_4 multiplets. In a preliminary report of these observations (Encrenaz *et al.*, 1994), we obtained a first-order estimate of the rotational temperature, assuming that the lines are not saturated (i.e. the observed intensities are proportional to the strengths of the multiplets). However, this assumption is probably crude, and a complete radiative transfer modelling will be required. In the first image, the peak of intensity, at the centre of the emission, corresponds to a rotational temperature of about 700 K. On the edge (leading side), a very different spectrum is observed, with a much weaker intensity, which may indicate different temperature profiles in the centre and on the wedge (Fig. 1).

The observed emission, which has never been seen on Jupiter before, is probably the result of a strong and rapid increase of the temperature in the Jovian stratosphere, possibly coupled with an upward ejection of methane at these levels. A modelling of the spectrum of the central region can be fit with a nominal methane abundance, if a hot temperature profile (typically with temperatures of the order of 500 K) is used at pressures lower than 10 microbars. Such profiles should be hotter than the profiles measured in the auroral regions, as CH_4 has never been observed in the 3 μm ν_3 band in the Jovian aurorae.

Emissions of H_3^+ at 3.5 μm

A few years ago, stratospheric emissions of H_3^+ were first detected at 2 μm, and later at 3.5 μm, in the polar regions of Jupiter (Drossart *et al.*, 1992). During our observing run, emission spectra of H_3^+ were recorded on many impact sites (Fig. 2). In several cases, a multiplet was observed over a weaker continuum; this multiplet will allow a measurement of both the stratospheric temperature and the H_3^+ column density, following the method used by Drossart *et al.* (1989, 1993). As a general rule, the observed H_3^+ emissions were more intense above more evolved impact sites, as compared to the fresh impact sites. As an example, H_3^+ was not detected on impact site H less than an hour after impact, when the methane emission disappeared. This result seems to suggest that there is a time delay of at least several hours between the impact time and the formation of H_3^+.

After July 22, 1994, H_3^+ emissions were discovered in the northern hemisphere. As discussed by Schulz *et al.* (this issue), they were clearly associated to regions located at $l = +44°$, and at the same longitude as the impact sites. Spectra of the northern "image sites" exhibited a strong H_3^+-line emission, but no continuum. In the equatorial region, a weak H_3^+ emission was detected, associated to two other unidentified lines; their analysis is in progress.

The 2.12 μm Spectra

Impact sites and their images in the northern hemisphere were also easily detectable at 2.12 μm. Shortly after the impacts, spectra recorded in the 2.107–2.135 μm range with a resolving power of 3000 show a drastic increase of the signal and a change in slope, with a maximum peaking towards shorter wavelengths. The simplest explanation is that there is a very strong scattering over a newly-formed stratospheric haze. This component sometimes hides the H_2 quadrupole line. From the slope of the spectrum, we hope to be able to retrieve information about the particle size; from the intensity of the quadrupole emission an estimate of the stratospheric temperature will be obtained.

In conclusion, the present observations should provide unique and precious information about the behaviour of the Jovian stratosphere, its temperature and chemical composition, just after the impacts, as well as its evolution during the following hours and days.

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