Far-Infrared Observations of the Night Sky: Different Data

We have made rocket observations of the night sky in the far-infrared spectral region which are in apparent contradiction to those of Houck and Harwit (*1*). At an altitude of 120 km with the telescope pointed nearly toward the zenith, we observed (*2*) a zenith intensity at 63 μm of 4.5×10^{-10} watt cm^{-2} sr^{-1}, about 20 times lower than the result of Houck and Harwit. The altitude dependence we observed was consistent with an optically thin atmosphere of atomic oxygen whose pressure dependence was exponential with altitude, and the derived density of atomic oxygen is in reasonable agreement with both satellite drag and mass spectrometric measurements. Houck and Harwit base their results on an expected intensity ratio of at least 16 to 1 between 120 and 170 km. A calculation (*2*) indicates that this ratio is less than 5 to 1, the actual value depending on the atmospheric model used in the calculation.

Above 170 km, the oxygen signal was below our telemetry noise level, so that we may set an upper limit of 4×10^{-11} watt cm^{-2} sr^{-1}, referred to 100 μm, for any background radiation of astronomical origin. Our limit is significantly below Houck and Harwit's limit of 1×10^{-9} watt cm^{-2} sr^{-1}, referred to 100 μm (*1*).

As Houck and Harwit have said, the most likely causes of instrumental error in this type of equipment—accidental warming of a critical part and insufficiently baffled scattered light—may cause the apparent results to be too high. The low signal levels achieved by our payload at 170 km are evidence that baffling and cooling were adequate.

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References

1. J. R. Houck and M. Harwit, *Science* **164**, 1271 (1969).
2. P. D. Feldman and D. P. McNutt, *J. Geophys. Res.* **74**, 4791 (1969).

20 June 1969

It is difficult to compare the Cornell University and Naval Research Laboratory data for several reasons. In each case an extremely complex instrument was used which has only been flown once. The issue is further confused by other differences in the experiment. In particular, the spectral response of the detectors differed, as did the launch times, launch dates, and the regions of sky scanned during the experiment. With these differences in mind we summarize our views as follows:

1) McNutt and Feldman are correct in their statement that the predicted atomic oxygen flux at 63 μm varies by approximately a factor of 5 between 120 and 170 km (*1*). Our value of 16 was based on a very rough calculation which neglected the contribution due to oxygen above 200 km. However, this error has virtually no effect on our conclusions (*2*).

2) If we assume that both telescopes functioned properly and that the predominant signal at 120 km is due to atomic oxygen, then the observations can be summarized as follows. At the Naval Research Laboratory (NRL) the detector output was observed to decrease by a factor of 5 between 120 and 170 km. At higher altitudes the signal disppeared into the noise. Because the detector at NRL is twice as sensitive at 100 μm as it is at 63 μm, the residual signal at 170 km referred to 100 μm is less than 1/10 of the signal level due to oxygen at 120 km.

At Cornell the intensity was observed to decrease by slightly more than a factor of 2 in the same altitude range, thus implying a source of radiation in addition to atomic oxygen. Because the Cornell telescope included a filter to discriminate against radiation at 63 μm, it was ten times more sensitive at 100 μm than at 63 μm. Therefore, if we refer the residual signal to 100 μm, we would conclude that the residual signal is approximately 1/20 of the signal level due to oxygen emission at 120 km. The residual signal observed by means of the Cornell telescope is not in conflict with the NRL observations.

3) The question of absolute intensity is more difficult to settle. We have arbitrarily set an uncertainty of a factor of 2 in the absolute calibration of our detector. McNutt and Feldman do not quote an uncertainty in the absolute calibration. However, even if their error were as large as a factor of 2, our observations would still disagree with theirs by a factor of 4. The calibration problem is further confused by the technical difficulties experienced on both flights. Future flights will certainly resolve this problem.

As Kasprzak *et al.* have pointed out (*3*), it is very difficult to make absolute measurement of the atomic oxygen densities at altitudes between 100 and 200 km. These investigators have observed day-to-day as well as diurnal variations in the oxygen density which may be responsible for some of the discrepancies in the infrared intensity data. During the past 5 years various authors have quoted values for the concentration of atomic oxygen at 120 km which differ by at least a factor of 8.

4) It is impossible to determine whether our residual flux (that fraction which cannot be due to atomic oxygen) is of instrumental, atmospheric, or astronomical origin. Our observations were in the direction of the ecliptic plane and nearly in the plane of the galaxy whereas the NRL observations were far from both of these. As we pointed out (*2*), both galactic and zodiacal dust are potential sources of far-infrared radiation and the Cornell flight was planned to observe both types of dust. Hoffmann and Frederick have observed strong radiation at 100 μm coming from the galactic center (*4*). The observed flux, 6×10^{-9} watt cm^{-2} sr^{-1}, is more than six times the residual signal seen by means of the Cornell telescope. We do not believe there is sufficient data at this time to rule out the possibility that the residual signal observed by means of the Cornell telescope is astronomical.

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References and Notes

1. P. D. Feldman and D. P. McNutt, *J. Geophys. Res.* **74**, 4791 (1969).
2. J. R. Houck and M. Harwit, *Science* **164**, 1271 (1969).
3. W. T. Kasprzak, D. Krankowsky, A. O. Nier, *J. Geophys. Res.* **73**, 6765 (1968).
4. W. F. Hoffmann and C. L. Frederick, *Astrophys. J. Lett.* **155**, L9 (1969).
5. Supported by NASA contract NSR-33-010-026.

17 November 1969; 19 January 1970