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Observations of the Orion nebula at 100µm

WE observed the Orion nebula at coarse spectral resolution during flights on March 13 and 14, 1974, using a cooled grating spectrometer carried on NASA's Lear jet.

The instrument covered the spectral range from 80 to 125 µm at a resolution of 8 µm. It used a Ga: Ge photoconductive detector with an instrinsic long wavelength cut-off at approximately 130 µm, and radiation shortward of 70 µm was blocked by black polyethylene and a Yoshinaga filter. The field of view was roughly 5′ square, which is large enough to include most of the brighter portions of the Orion 100 µm source, according to D. A. Harper (unpublished).

To obtain a spectrum the grating was rotated to throw light of different wavelengths on to the detector. At each grating position measurements were made on and off the source, and the difference taken to be the source signal level. Several runs through the spectral bandpass were completed, taking steps of about 5 µm, and a raw spectrum was obtained by averaging the values for a given grating position weighted according to the reciprocal of their variances.

Calibrations took two forms. The spectral calibration came from observations of the Moon which had to be taken on separate flights, since the elevation angles accessible to the Lear telescope are restricted and useful observing time is limited to about one hour per flight. But lunar spectra obtained on the mornings of March 11, 12 and 13 and the evening of March 7 are nearly identical. These spectra were used to correct for instrumental profile and atmospheric water vapour absorption, and for this purpose the moon was assumed to radiate as a 390 K blackbody[1].

The intensity calibration is based on a temperature for Venus (289 ± 20 K) from Armstrong *et al.*[2], and utilises Venus observations from March 11, 12 and 13.

Our Orion nebula spectrum corrected for instrument profile and atmospheric water vapour absorption is shown in Fig. 1 (left hand). Figure 1 (right hand) shows the lunar spectrum obtained on the morning of March 13. The water vapour absorption feature at 100 µm is relatively weak, and this is expected to be the case for all our observations, since they were made from several kilometres above the tropopause.

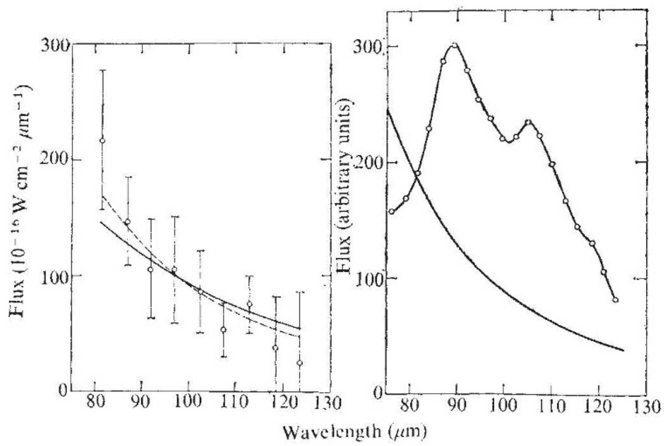

Fig. 1 Right-hand side, Orion nebula spectrum at 8 µm resolution. The blackbody curves are diluted by factors of 83 for 100 K (- - -) and 2 for 60 K (—). Error bars are one standard deviation. Left-hand side, Calibration spectrum of the Moon (○—○), with superposed 390 K blackbody (—). Errors are too small to plot (<2%).

Superposed on our Orion data are 60 and 100 K blackbody curves diluted to give the right intensity, since the source does not fill our beam and may not be optically thin. Both curves fit the data, although grain emissivities of the form λ^{-n} give a better fit. Thus the best fits at 60 and 100 K are given by $n=1.7$ and 0.9 respectively, but in view of the low signal-to-noise ratio the difference from a blackbody is not statistically significant. Pure blackbody curves for temperatures below 40 K do not fit the data well, and the fit improves steadily for higher temperatures. Although our spectrum is somewhat steeper, our results are in good agreement with those of Erickson *et al.*[3]. Our flux calibrations also agree with the photometric data of Low and Aumann[4] and Hoffmann, Frederick and Emery[5]. The error bars in Fig. 1 represent our standard deviation, and are derived from the standard deviations of the individual readings.

Our main conclusion is that our results are consistant with a thermal emission spectrum produced by cool interstellar grains radiating at a wavelength much longer than the grain size. If atomic or molecular lines dominate the 100 µm flux, our spectral resolution is too coarse to detect them, but in any case there would have to be some conspiracy of lines to produce the apparently rather smooth spectrum we detect.

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Bathonian volcanicity and North Sea rifting

SEVERAL years ago[1,2] we proposed that the Bathonian and Aptian fuller's earths of southern England, which are montmorillonitic clays, are true bentonites and, therefore, of volcanic origin (see also ref. 3). With the evidence[4] of Bathonian volcanicity associated with rifting in the North Sea, we can now develop the story a stage further.

Two new publications[4,5] outline the pre-Tertiary structure of the North Sea region in terms of a series of troughs separated by upstanding massifs or 'platforms'; we here adopt the more detailed reconstruction of Naylor *et al.*[5] (Fig. 1). They have proposed a model in which thermal expansion of the crust and topmost mantle, perhaps consequent on the rise of a plume, leads to updoming and tensional collapse in the central region. This gives rise to trilete junctions at which three potential spreading ridges diverge. The Forties, Ekofisk and Northern North Sea (or Viking[4]) troughs form such a rift–rift–rift