PHILOSOPHICAL TRANSACTIONS OF THE ROYAL SOCIETY A MATHEMATICAL, PHYSICAL & ENGINEERING SCIENCES

Submillimetre Astronomy: Results and Prospects

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Submillimetre astronomy: results and prospects

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The new submillimetre results presented here consist of extensions of work originally carried out in 1957 at Hochalpine Forschungstation Jungfraujoch (altitude 3500 m) (Gebbie 1957) which showed the following:

(1) That there were two clearly defined atmospheric 'windows' in the wave-number regions 21–24 and 27–30 cm^{-1}.

(2) That a number of pronounced absorption features existed which could not be attributed to atmospheric water vapour.

The window between 27 and 30 cm^{-1} has been extensively studied using the maser source (Gebbie, Stone & Findlay 1964) at 29·7 cm^{-1} (337 μm) and the value

$$\alpha = (10{\cdot}4 \pm 0{\cdot}5)\ \mathrm{dB\ km^{-1}\ (g\ m^{-3})^{-1}}$$

obtained for the attentuation in the atmosphere at normal pressure and a temperature of 278 °K, where the water-vapour content is measured in grammes per cubic metre.

From this value, which is considerably greater than the value predicted from known strengths and line shapes of water lines, an estimate of the variation of atmospheric transmission with altitude can be made after correction for pressure and temperature. At 3500 m with 2 mm of precipitable water in the observation path a transmission of the order of 5 % can be expected in the centre of the 27–30 cm^{-1} window. Hence, solar observations such as centre to limb measurements and blackbody temperature estimates in this window are quite feasible at this altitude. The unidentified features in the solar spectrum (Gebbie 1957) have now been identified as due to the pure rotation magnetic dipole spectrum of molecular oxygen (Gebbie, Burroughs, Robb & Bird 1966), a result which has been confirmed by long-path laboratory measurements.

Recently, observations have been made from an aircraft flying at 12000 m (Bader, Cameron, Burroughs & Gebbie 1967) and it was shown that by measuring the exchange of radiation between a hot detector and the cold sky, the transmission of the upper atmosphere could be measured. This work showed that at this altitude the atmosphere was relatively transparent in the regions 42–46 and 48–52 cm^{-1} and that these regions give possible extensions to the wave-number range of astronomical observation.

From these results we feel confident in predicting the following developments. At Jungfraujoch the recently installed 76 cm telescope will provide a factor of 10 increase in light grasp over the earlier installation, and hence should prove invaluable for both solar and atmospheric studies. The aircraft experiment is being extended so that solar observations can be made in conjunction with the sky work, and here again the improved spectral resolution gives the prospect of revealing weaker features.

Looking further ahead, recent work with the 337 μm maser has shown the possibility of using this source as a local oscillator in a homodyne experiment (Gebbie, Stone, Putley &

Shaw 1967). With the development of wide band-width point-contact diodes that have been shown to work tolerably well as detectors in the submillimetre region there is a distinct possibility of using the 337 μm maser for a heterodyne detection system, and the potential of such equipment is to provide a submillimetre equivalent of present radio frequency and microwave techniques.

References (Gebbie & Burroughs)

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