LETTERS TO THE EDITORS

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An Investigation of Monochromatic Radio Emission of Deuterium from the Galaxy

THE possibility of monochromatic radio emission in galactic deuterium has been well known for ..e time, and the frequency of such an emission ..predicted by Shklovsky[1]. The expected maximum ..nsity is such that any attempt to detect the line ..t rely on extremely long integrations in time. In ..tice, this requires either direct electrical integra..s over a long period or the manual summation ..a series of individual records. One attempt to ..ect the line using manual methods has already ..n published[2].

The radiometer used in our experiments was of a ..e used by van de Hulst, Muller and Oort[3]. One ..jor difference was the use of a reactance tube ..ch rather than two oscillators. A filter band..ith of 16 kc./s. was used, and the spacing between .. filters was 48 kc./s. These parameters were ..ived from considerations based on the hydrogen ..profiles in the direction of the galactic centre.

The receiver input stage was a simple crystal con..ter, which was used mainly for obtaining uniform ..sitivity and maximum reliability. The single band ..e factor of the receiver was measured at 6, and ..e noise factor also checked for uniformity over ..frequency sweep. A commercial co-axial diode ..s used for checking the noise factor, and this instru..nt was in turn checked against laboratory receivers. Frequency calibration of the second local oscillator ..7 Mc./s.) was checked by an interpolation from a ..and 5 Mc./s. crystal oscillator. These crystal units

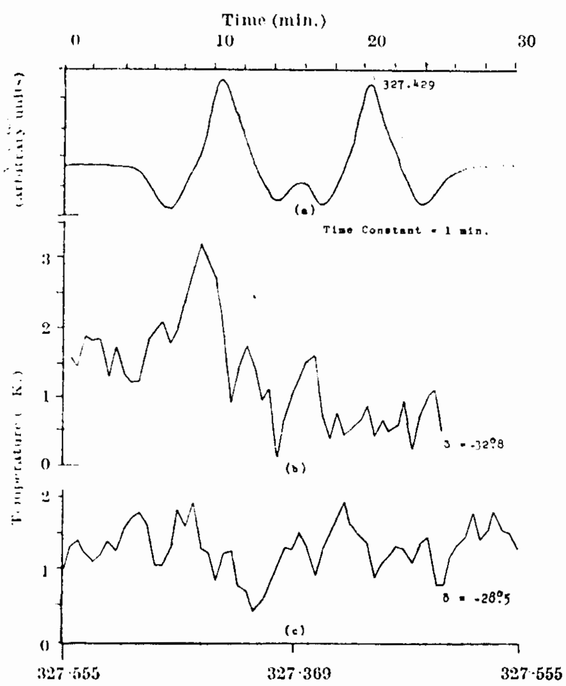

Fig. 1. Integration of five records

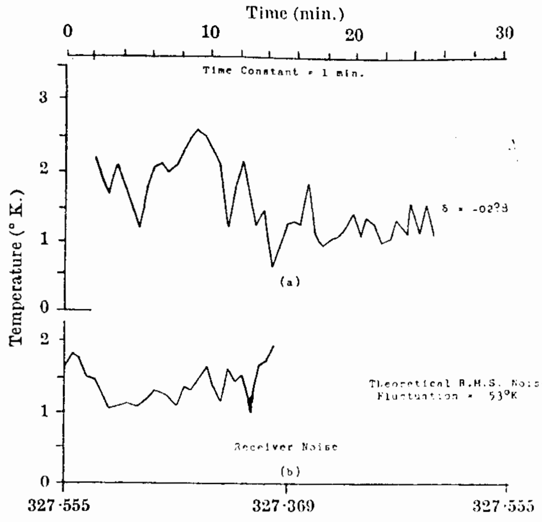

Fig. 2. Integration of eight records

were in turn checked against *WWV*. The drift of this oscillator was found to be less than 1 kc./s. over a period of a month; consequently no check was kept on it during an observation, and calibration was limited to immediately before and after a record. The first local oscillator was set on 296 Mc./s. and a constant check was kept on the heterodyne beat note during an observation with the harmonic of a 2 Mc./s. crystal oscillator.

The antenna system was a paraboloid of 80 ft. diameter, described by McGee, Slee and Stanley[4]. To maintain the frequency response as flat as possible, a cylindrical dipole was used as the primary feed. An overall calibration of the antenna system was difficult due to the limited angular movement of the beam. However, measurements of solar radiation, which were possible only near the summer solstice, were in good agreement with those made on the same day with other solar equipment. A relative check was set up at the same time, consisting of a known signal radiated from a dipole placed near the antenna.

Observations were limited to the region about the galactic centre and the region in the galactic plane at $l = 220°$. All observations were reduced to the local standard of rest.

Early observations were made by automatically scanning with the receiver through 200 kc./s. as the direction of the galaxy passed through the antenna. Such methods failed to detect any radiation. In the later records graphical integration was performed to increase the sensitivity.

A complete frequency scan occupied 15 min., and to compensate partially for the observation with a fixed antenna the phase of the frequency with respect to sidereal time was staggered on successive runs. The time constant of observing was 1 min. Fig. 1(*a*) shows the profile expected from a monochromatic line and Figs. 1(*b*) and (*c*) the results of five integrations at declinations $-32·5°$ and $-28°$. Fig. 2 shows eight integrations at declination $-32·8°$, together with a sample integration of noise alone for the same number of records.

As there was still some doubt about Fig. 2, a further series of four observations with a time-constant of 3·5 min. and a scan of 50 kc./s. was made at declination $-32·8°$, and the results are given in Fig. 3.

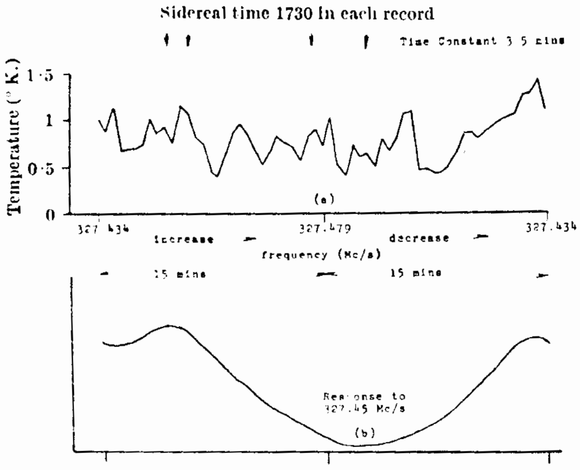

Fig. 3. Integration of four records

We conclude that a monochromatic radiation from deuterium could not be detected at the galactic centre to a limit of better than 1° K. aerial temperature. Shklovsky has estimated that 1/500 of the aerial temperature of the continuous radio radiation from the galaxy at this frequency seen in absorption corresponds to a concentration of deuterium equal to 10^{-3} of the concentration of hydrogen in the galaxy. For the antenna used the aerial temperature of the central source is approximately 800° K. The abundance of deuterium should therefore be less than 10^{-3} that of hydrogen.

This work was carried out during 1954 at the Radiophysics Laboratory of the Commonwealth Scientific and Industrial Research Organization, Sydney, Australia.

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A Simple Method of studying Winds in the Ionosphere by using Continuous-wave Radio

SYSTEMATIC study of horizontal movements in the ionosphere has been made during the past few years by using the spaced-transmitter technique developed by Munro[1], which is applicable only for the F_2 region, and the spaced-receiver method first employed by Mitra[2]. However, both these methods require elaborate and expensive ionospheric pulse-sounding equipment. We present here a simple method of studying winds in the ionosphere using continuous-wave transmissions and a simple receiver with a recording system.

The method is essentially similar in principle to the spaced-receiver pulse technique and involves the use of continuous-wave transmissions from a distant short-wave transmitter arriving at the receiving site by way of single reflexion from the ionosphere. Simultaneous records of the variations of signal strength at three spaced points due to these transmissions showed fading patterns which are almost identical but displaced in time. The wind velocities and directions are then estimated from these time displacements using a method of calculation similar to that in the spaced-receiver pulse method.

Continuous-wave transmissions from Madras on the 31-metre band have been used in this investigation for obtaining the simultaneous records of variation of signal strength at the spaced-receiver points. Three simple vertical aerials R_1, R_2 and R_3 each of length 8 ft. are placed at the corners of a right-angled triangle such that R_1 and R_2 and R_1 and R_3 are along the north–south and east–west directions with separations of 64 and 60 metres respectively. The signals induced in all these aerials are brought to a central recording station by using coaxial shielded cable. In the earlier part of this investigation we used three galvanometers which are suitably damped, and three communication receivers connected to these aerials, for obtaining the simultaneous record of the variations of signal strength. Light spots reflected from these three galvanometers trace out the variations of signal strength side by side on the same photographic paper moving with a speed of 12 in. per min. The photographic paper is rolled on a special drum recording-camera driven by a synchronous motor at the rate of one revolution per min. With the view of eliminating the variations, if any, in the signal-strength records for all the aerials, we afterwards simplified the technique still further by using only one communication receiver, National *HR* 07, and a specially designed two-pole three-way rotary switch driven at 1,420 r.p.m. by a 1/8 h.p. motor. The switch consists of two sections each of which has a rotating vane moving over three insulated brass contacts of equal length arranged in a circle. The input and automatic volume control terminals of the receiver are connected to the movable vanes of the two sections of the rotatory switch in such a way that during the rotation each galvanometer is connected to the amplified signal from one of the aerials only during one-third of the rotation. The rate of rotation of the movable vane of the switch being quite high, a smooth fading record is obtained though it is an interrupted signal that is fed to each galvanometer.

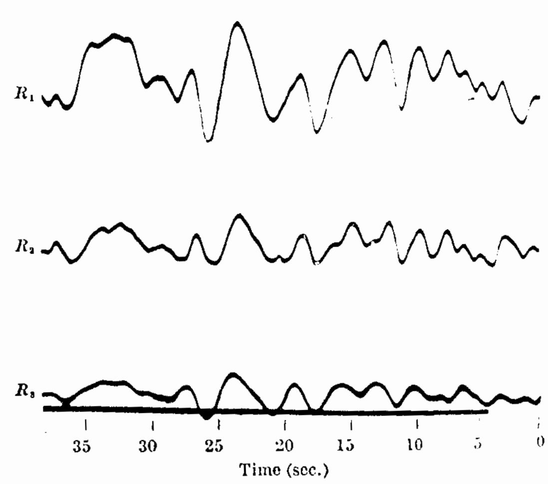

Fig. 1