FURTHER RADIO OBSERVATIONS OF THE FIRST SATELLITE

The radio signals from the first Russian Earth satellite were recorded at the University of Illinois Observatory during the period October 5–24 on 40 Mc./s. and on 20 Mc./s. This communication deals with the observations on 40 Mc./s. made with two-element interferometers, one with a north-south base-line of 5·45 wave-lengths, the other with a north–south base-line of 1 wave-length. The first instrument was constructed during the night of October 4–5, the second on October 11. The latter was fed out of phase for lobe-ambiguity resolution. The results were recorded on Esterline-Angus graphic recorders running at 1 ft./min.

The interpretation of the records was complicated by the fact that all the eleven lobes of the pattern of the main north-south interferometer never appeared on the record of any one passage of the satellite. However, it proved possible to overcome this difficulty, particularly after October 11, when the second instrument came into use. The instruments were located on the parallel N. 40° 1·1′. The times at which the first artificial Earth satellite crossed this parallel, together with estimates of the altitude above the horizon at the moment of closest approach, were communicated as rapidly as possible to the Smithsonian Astrophysical Observatory, Cambridge, Mass., and the Naval Research Laboratory, Washington. The mean absolute error in the times of crossing was 3s.

Since the radio-signals ceased, the computations have been refined. The period of the satellite and the regression of the nodes of its orbit can be deduced from our observations. The best representation of the period (P) during the interval October 5–24 is:

$$P = 96\text{m. } 09{\cdot}8\text{s.} - 0{\cdot}1293\text{s.}n - 7{\cdot}797\text{s.} \times 10^{-5}n^2 \quad (1)$$

where n is the number of revolutions since our adopted zero, which was the southbound crossing of our parallel on October 5d. 13h. 30m. 01s. U.T. The regression of the nodes can be expressed as follows: the local mean solar time at the point of southbound crossing of our parallel is:

$$(8\text{h. } 11\text{m.} \pm 2\text{m.}) - (1{\cdot}100\text{m.} \pm 0{\cdot}006\text{m.})n$$

The probable errors shown are calculated from internal consistency. The observations were made under the direction of George W. Swenson, jun., and the interpretation of the re ults was carried out by Ivan R. King with the assistance of Stanley P. Wyatt, jun.

These formulæ are based on the records obtained at our station alone. On October 26 a radio broadcast from Moscow mentioned that the period was 95·31m. During that day, n would increase from 313 to 318 between 9h. and 18h. U.T. Thus formula (1) would give periods ranging from 95·36m. to 95·35m. On October 28, the Smithsonian Astrophysical Observatory released a statement that, on October 25d. 2h. 25m. U.T., the period was 95·44m., and the daily variation of the period was − 2·4s. It is not known whether our results entered into the computation of those of the Smithsonian. October 25d. 2h. 25m. corresponds to $n = 294$ and this gives $P = 95{\cdot}42$m., with a daily variation of − 2·6s.

Records on 20 Mc./s. were also obtained under the direction of Edgar C. Hayden and these, together with the 40 Mc./s. results, are expected to furnish considerable information about the ionosphere. These records have not yet been analysed.

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The 40 Mc./s. frequency of the first Russian Earth satellite has been measured at Chelmsford for the condition of zero Doppler effect.

The method adopted presupposed that the signal might be modulated at the source or during propagation in such a way as to make fully automatic measurements difficult, so the fine component of local comparison frequency was obtained from an audio oscillator steered manually to follow the Doppler variations. For a high percentage of the time the 'steering' error was held less than 2 c./s. by using a circular time-base on a cathode ray oscilloscope. The audio oscillator output was connected to a frequency recorder having scales of 4·5 in. per 1,000 c./s. and 1 in. per 30 sec.

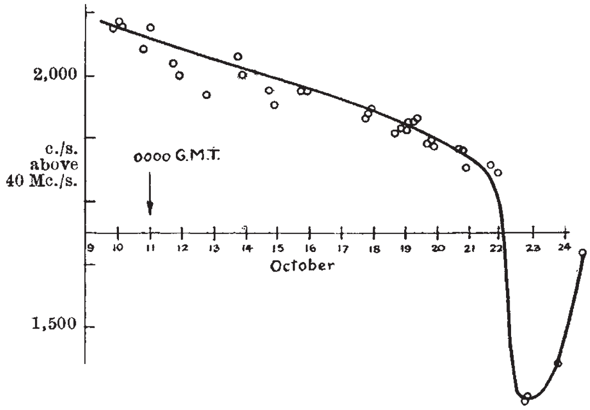

Fig. 1

The S-shaped Doppler curves obtained were remarkably clean and symmetrical, so that the frequencies and times corresponding to nearest approach (zero Doppler effect) could be read off with useful accuracy. Fig. 1 shows the frequencies of zero Doppler effect deduced in respect of 37 orbits observed between October 9 and 24, 1957. Signals were not heard after 1843 G.M.T. October 24.

The maximum rates of change of frequency observed for the various orbits covered the range of 33–4·5 c./s./s., corresponding to approximate slant-range values of 224–1,500 km. respectively.

The datum of the local 40 Mc./s. comparison frequency was known to within 1 part in 10^9.

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