Royal Society meeting

Sputniks I and II—25 years ago

from F. Graham Smith

TWENTY-FIVE years ago, in October 1957, the launch of Sputnik I took radio scientists everywhere by surprise. To mark the anniversary, Sir Harrie Massey and the British National Committee for Space Research brought some of the British observers together in a nostalgic review meeting at the Royal Society on 3 December.

The most exciting and momentous story came from Sir Bernard Lovell, who recounted the few hectic days when the 250-ft radio telescope was rapidly adapted for radar observations of the rocket launcher¹, with such success that the financial crisis of the telescope was resolved very soon afterwards. The Cambridge radio astronomers worked on the satellites themselves, using interferometer and Doppler techniques to find the orbits of Sputnik I and Sputnik II. They were able to start with a simple re-tuning of a 38 MHz receiver to pick up the 40 MHz telemetry. All over the world there were similar responses to the bleep-bleep of Sputnik I, an event which was at the same time so easily predictable and yet so unexpected.

There was, of course, a deeper understanding in military circles. The general ignorance in the universities before the launch, followed by intense interest afterwards, could probably be documented through the sudden proliferation of examination questions on satellites and their orbits. In contrast, the Royal Aircraft Establishment had for several years studied the design and possible performance of a one-ton Earth Satellite reconnaissance vehicle, to be launched by a British launcher. Desmond King-Hele gave an account of his work with Doreen Walker (or Gilmore as she then was), which showed that the Royal Aircraft Establishment already had theories for the effect of air-drag and for the gravitational effect of the Earth's oblateness on satellite orbits.

There was, of course, a good appreciation by the space research groups of the potential usefulness of artificial satellites for atmospheric research and for

astronomy. In fact the chief protagonists were, at the time of launch, at a meeting in Washington DC, along with their colleagues from the US and the Soviet Union. There is a story that misreporting of this meeting in the Soviet Union, leading to a belief that the US was just on the point of launching a satellite, was responsible for the actual date of launch being advanced by some weeks. In the event, the announcement in Washington of the successful launch had a stunning effect. Doubtless the military in the US made their own observations, but these were not published. It was left to Cambridge to publish the first orbit², followed soon after by the Royal Aircraft Establishment³. Within four weeks, the radio techniques had been developed from scratch, and the observations had yielded useful values for the rate of change of orbital period, which could be related to air density.

King-Hele showed an interesting comparison between the two published sets of orbital parameters and a more accurate set derived in retrospect (see the table). The agreement is remarkably good, considering especially the lack of expertise in orbital theory at Cambridge. Here some help should be acknowledged: the then science reporter of the Guardian, one John Maddox, contributed a copy of an American work on orbits, which helped us understand the subtleties of precession round an oblate spheroid. The Royal Greenwich Observatory also helped, although their preference was to wait for the more precise data that could be expected from visual observations.

Both groups used the rate of change of period to obtain a value of air density. King-Hele showed at this meeting that the high value (2×10^{-10} of sea-level density at a height of 241 km) published by the Royal Aircraft Establishment required only a small correction (25 per cent) for an underestimate of the cross-sectional area of Sputnik I, and that it has a unique importance in atmospheric physics. By coincidence there was an exceptionally high value of solar activity at the time, and it now

Sputnik I

appears that the high value for air density, which is about 20 per cent higher than the standard COSPAR International Reference Atmosphere, was correctly determined.

Sputnik II was observed optically, enabling the Royal Aircraft Establishment to obtain a very much more accurate orbit by the use of kinetheodolites. This led to several remarkable discoveries concerning the rotation rate⁴ and density variations⁵ in the atmosphere, and the oblateness of the Earth⁶. The era of precise orbital analysis had begun.

Looking back on those few months, which ended with the spectacular fireworks display made by Sputnik II as it came down over the Caribbean Sea on 14 April 1958, one sees significant consequences for all the British protagonists. At Jodrell Bank there was a rapid switch from meteor radar to lunar radar, with its consequences in both communications and ionospheric research. The Royal Aircraft Establishment became the centre of the National Prediction Service and a world leader in the analysis of the gravitational field of the Earth. At Cambridge there was a rapid return to the more serious business of determining the structure of the Universe; there was, however, a notable publication soon afterwards, which proved to be the first note on the use of satellites for navigation through the Doppler effect⁷, and the seeds had been sown for low-frequency observations from satellites. For many others, the Sputniks will be remembered as heralds of a great age of space exploration, which in Britain centred on the very successful series of six Ariel satellites. □

Orbital parameters of Sputnik I

	Cambridge	Farnborough	In retrospect
Epoch	1957 October 15.0	1957 October 15.0*	1957 October 15.0
Nodal period	95 min 50.0 ± 0.3 s	95 min 49.6 s	95 min 49.6 s
decreasing at (s per day)	2.2 ± 0.1	2.3	2.3 ± 0.1
Eccentricity	0.053 ± 0.001	0.048 ± 0.002	0.050 ± 0.001
Perigee height (km)	197 ± 10	230 ± 13	224 ± 5
Perigee latitude	36°N ± 3°	41°N	47°N ± 2° (?)

*Royal Aircraft Establishment values converted from October 15.5. The parameters were originally determined in October 1957 by the Mullard Observatory, Cambridge and the Royal Aircraft Establishment, Farnborough; they were redetermined later.

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2. Staff of Mullard Observatory *Nature* **180**, 879 (1957).
3. Staff of Royal Aircraft Establishment *Nature* **180**, 937 (1957).
4. Merson, R.H., King-Hele, D.G. & Plimmer, R.N.A. *Nature* **183**, 239 (1959).
5. King-Hele, D.G. & Leslie, D.C.M. *Nature* **181**, 1761 (1958).
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