MULLARD SPACE SCIENCE LABORATORY

Department of Physics, University College, London

WORK OF THE LABORATORY

The First Ten Years.

The Department of Physics, University College, London, were pioneers in British scientific space research. Sir Harrie Massey, F.R.S., was responsible for the start of scientific space research in 1953. The first formal announcement of a British space research programme was made in a letter published in "Nature" on April 7, 1956, entitled "Rocket Exploration of the Upper Atmosphere". It was signed jointly by Sir Harrie Massey and Dr. F. E. Jones, then deputy director (Equipment) at RAE. Dr. F. E. Jones is now managing director of Mullard Ltd.

The group responsible for the work was led by Professor R. L. F. Boyd who still leads the present greatly enlarged team of scientists.

Because no satellite vehicles were available to British researchers most of the early work on ionospheric studies was conducted on sounding rockets, initially the Skylark, which gave observation times of the order of minutes. Rocket-borne experiments continue to play a large part in the research programme and newer types of rockets are now becoming available.

A significant year in the history of British space research was 1959 when the US National Aeronautics and Space Administration (NASA) offered co-operation in providing launch vehicles and facilities for carrying experiments on earth satellites. British scientists, including several from UCL visited the United States for discussions in 1960. As a result, on April 26, 1962, the first British satellite, Ariel 1, was launched by NASA from Cape Canaveral (now Cape Kennedy) and placed in an elliptical orbit with an initial perigee of 390 km and apogee of 1212 km.

The data transmission was on a frequency of 136.41 MHz with a power output of 250mW and it was received at thirteen NASA Satellite Tracking and Data Acquisition Network (STADAN) stations throughout the world and at two

British DSIR stations. A small magnetic tape recorder was carried to store data when out of range of any of the tracking stations and the stored data were recovered by ground command when in range. Ariel 1's payload included UCL experiments measuring ionosphere electron densities and temperatures and ion concentrations and temperatures; solar X-ray and ultra-violet intensities and solar aspect.

By mid-April 1963, 922 hours of data had been digitized in the US and passed to the UK. At that date the data obtained equalled some 180 million data samples. Transmission ceased in mid-1964 and although some minor data has yet to be fully analysed the main results, throwing new light on electron temperatures and positive ion concentrations in the top-side ionosphere, have now been published.

Since Ariel 1 a full co-operative programme with NASA has been implemented and UCL experiments were carried on Explorer XX, launched in 1964, and DME-A (Explorer XXXI) launched in November 1965. The latter was placed in orbit together with the Canadian Alouette II topside-sounder in a pick-a-back launch. The UCL experiments are still operating and supplying information on electron temperatures and ion mass spectra which is the main data source for the laboratory today.

The time scale of space research is necessarily long. It has taken a decade to develop and perfect what may be called first generation experiments. The techniques of measurement in a very difficult environment and interpretation of results have now been learnt and are being applied to current work. Even so, quick or dramatic results cannot be expected. As experiments become more and more complex and equipment more refined the time scale from inception of an experiment to its successful analysis of data may still extend over a period of up to seven years.

Current Work.

The Laboratory has now embarked on a major programme involving experiments on eight satellites and over thirty sounding rockets. Launchings will be under the auspices of the domestic UK programmes, the European Space Research Organisation (ESRO) programme and the US/UK co-operative programme.

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The investigations will be a logical extension of the work already completed and will include new work on Ultra-Violet and X-ray astronomy both of the Sun and other celestial objects. The UV and X-ray studies are part of what is called the "New Astronomy" which now accounts for over 50 per cent of the current expenditure. The ionospheric studies, however, still have a greater number of individual experiments.

A list of the experiments is appended from which the range of instrumentation, the particular studies, types of vehicles and approximate launch dates where available may be noted.

In rocket technology the main advances are in the stabilised Skylarks which enable more accurate and elegant measurements to be made than in the unstabilised types and in the Petrel, a new economic British rocket, which is now in its final stages of development for the Science Research Council. Sounding rockets are of value in studying the lower regions of the atmosphere up to altitudes of 200 km, these areas being too low for satellites, and for solar studies because the high intensity of solar radiation makes short duration studies possible.

The Petrel, in particular, will make a significant contribution to British space research. It is a budget price vehicle costing many times less than the Skylark and with a much simpler launching system. It will be used extensively from the new British range at South Uist in the Hebrides which will reduce costs of experiments by big savings in travel expenses. The Skua II meteorological rocket will also be used to carry some experiments from South Uist.

The Atomic Weapons Research Establishment at Aldermaston is the design authority for Petrel and the rocket is manufactured by Bristol Aerojet. The first firing of development rounds took place earlier this year and early next year Petrel will start carrying UCL experiments.

The new satellites which will carry UCL experiments again provide a major advance in payload, stabilisation and "household" facilities and services. On Ariel 1, for example, the UCL experiments were allocated only 420mW of the available electrical power. In contrast, the power allocation on the US OSO-D

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Orbiting Solar Observatory is almost a watt. Command facilities are also much improved allowing calibration sources to be carried in the satellite and controlled from the ground and the telemetry system has a higher data rate enabling more data to be collected in a given time and rapidly changing phenomena to be more accurately observed.

With the technical advances in space craft there has been a parallel development in detectors and measuring devices, the whole technology of experimental hardware and in methods of data analysis. Many of the newer techniques are on view and some will be demonstrated in the laboratories.

Practical work in Holmbury House is largely devoted to originating new measurement methods, including detection devices, and to calibration of the experiments before flight. A great deal of development work and mechanical, optical and electronic hardware is put out to contract at Government establishments and industry to relieve the load on the Group's own support services. The really scientific, as distinct from technological, work is in the interpretation and analysis of the data obtained.

Data analysis will be eased by the installation at the Laboratory of an IBM 1130 computer which will be data-linked on-line to a large IBM 360 computer at University College. The data link is expected to be in operation next year.

Among the more advanced projects now in preparation are a telescope-spectrometer combination to be launched in a Skylark stabilised star-pointing rocket for UV Spectroscopy; the first ever satellite X-ray telescope study on non-solar sources which will be carried on the US OAO-C satellite; and an experiment measuring the distribution on the solar disc of sources of intense chromospheric and coronal emission lines in the wavelength range 150-600 Angstroms.

Members of the Group have also been involved with UKAEA in preparing the UK design study for the experimental package of the ESRO Large Astronomical Satellite. This study was completed last year and, in competition with the entries from other ESRO nations, was judged the best entry. The Group will continue to be involved in this project which is expected to take five years to complete.

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National and International Co-operation

Research in the space sciences is a truly international operation because of the need to gather data from tracking stations overseas, the need to use launch facilities in other countries, and the overriding necessity to correlate British data with that obtained by other scientific institutions working in associated fields of research.

UCL not only gratefully acknowledge the valuable co-operation of NASA but also ESRO and many individual countries and institutions who have afforded assistance on special occasions.

One example of international co-operation is the launch from the ESRO range at Kiruna in northern Sweden of a set of experiments in a pair of unstabilised Skylark rockets. The E - region electron temperatures were measured using the UCL electron temperature probe in conjunction with the inverse Seddon experiment (Briesach), a neutral mass spectrometer (University of Bonn) and pressure gauges (Laboratorie de Physique, Paris).

Another example is Explorer XXXI carrying UCL experiments and the Alouette topside-sounder, already mentioned, which are complementary to the complete experiment.

At national level full liaison is maintained with other space programmes such as those at Imperial College and Birmingham, Leicester and Southampton Universities. Professor Hutchinson's Group at Southampton University, for example, are involved in studies of gamma rays from extra-galactic sources and particle measurements which are related to the magnetospheric studies of UCL.

The Future

Britain's long interest in the ionosphere has placed her in a commanding position in this and associated areas of study. In fact ionospheric studies have been dubbed "a British institution". Being so well established in this field, it is probable that future research at UCL will continue on logical extensions of the current work.

The next two years work is already clearly defined and planned but, working on a time scale of seven years, future experiments are already in the planning stage. The new laboratories, the acquisition of expensive capital

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equipment, and the promise of continuing finance reflects at UCL the new order of stability now appearing in the British space research programme.

The new UK and ESRO rocket programmes give promise of many vehicles available for research in the immediate future and ESRO satellite launchings are planned to increase after 1970.

In the longer term, the full development of the US Apollo Extension Programme will provide large working platforms in orbit which will be able to carry large scientific payloads and an invitation to propose experiments in this programme has been received from NASA.
