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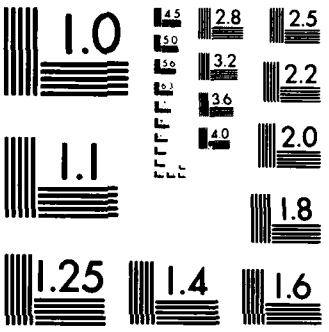

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Space Research in the United Kingdom:
An Assessment

Norman F. Ness

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This report examines the history and funding of UK space research; discusses work in disciplines such as astronomy and astrophysics, solar system studies, and terrestrial studies; and considers prospects for the future.

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SPACE RESEARCH IN THE UNITED KINGDOM: AN ASSESSMENT

Research in space science activities in the UK is an active endeavor sponsored by three funding agencies: the Science and Engineering Research Council (SERC), the Natural Environment Research Council (NERC), and the Department of Trade and Industry (DTI). Each agency has a primary goal to support, which may be inferred from its title. However, there is some overlap, as might be expected, between the various groups because of the lack of sharply defined boundaries between each of them.

While the other major space-faring nations in Europe, such as France and West Germany, have a single space research directed agency (Centre National d'Études Spatiales and Deutsche Forschungs- und Versuchsanstalt für Luft- und Raumfahrt eV), the UK has not yet created such an overall supervisory group. There was recently talk of the creation of a National Space Centre, but no definitive action has yet been taken. Nonetheless, it is a critical matter for the future of space research in the UK.

Brief History

The UK has a rich and very creditable history in the area of aeronautical and space research. Many amateur groups in the UK were active before the World War II, and subsequently the British Interplanetary Society (BIS) was set up to serve as the focal point for such interests. The *Journal of the BIS* is a well-recognized professional publication which contains learned articles by recognized authorities in the field dealing primarily with programmatics and historical aspects of space research, as opposed to original space research articles. Those interested in the history of space research, not only within the UK but throughout the world, would be wise to consult back issues of this informative publication.

The UK is a charter member of the European Space Agency (ESA), a consortium of 11 full-member states within Europe, and two associate members. It contributes approximately 12 percent of the operating budget of ESA in the several program areas. This is approximately the same amount as contributed by Italy but only half that provided by France or Germany. These four nations contribute almost two-thirds of the total budget of ESA, and as a result collectively have a controlling interest in determining the direction of ESA's activities. In addition to participating in scientific spacecraft missions of ESA, the UK has participated in a number of bilateral spacecraft missions with the US National Aeronautics and Space Administration (NASA). Among these was the series of ARIEL spacecraft, which began the early 1960s involvement of UK scientists and technologists with space research. These spacecraft were built entirely in the UK with experiments and instruments provided by UK scientists and launched on NASA vehicles.

More recently, the UK has been involved in several international programs of NASA, such as the International Ultraviolet Explorer (IUE), a joint venture between NASA, ESA, and the SERC. This highly successful mission was launched in 1978 and continues to provide unique observations. Subsequently, the Infrared Astronomical Satellite (IRAS), a joint venture of NASA, the UK, and The Netherlands, was launched in 1983; its planned period of observation ended in late 1984. Most recently, the UK has participated in the ESA X-ray Astronomy Mission (EXOSAT), culminating a decade of UK activities in x-ray astrophysics research, which the UK had pioneered with their 1973 launch of ARIEL 5. Future contributions will be made to NASA's Einstein Observatory, to be launched in 1987.

Funding Levels: 1984

Research activities, especially involving spaceflight hardware, include sophisticated and expensive equipment. At present the SERC annually spends about £20 million on space (about $28 million at £1.00 = $1.40), of which 50 percent represents the contribution

to ESA's mandatory space-science program and its general budget. The figure of £20 million represents approximately one-half of the budget of the SERC's Astronomy, Space, and Radio Panel during the past year.

The current annual expenditure on environmental remote sensing by the NERC is about £1.7 million. DTI space expenditure is £61 million, of which £49 million went to the optional applications programs of ESA as well as its general budget, while the remainder was used to fund development programs in industry. The latter effort included some work done by the Ministry of Defence establishments.

Thus, the total current UK annual expenditure on civilian space research is about £80 million. This compares with the £200 million budget of West Germany and £300 million of France. The total ESA budget was about £550 million. By comparison with the US budget, these numbers are quite small. The corresponding budget of NASA--including both civil as well as Department of Defense activities--was more than £4500 million. Of this, £700 million was utilized in space science and applications.

As these numbers show, most West European-based missions have to be conducted either as multinational collaborations through ESA or as bilateral or multilateral collaborations with NASA. Since 1979, when the last of the ARIEL satellites was launched, the UK has been unable to maintain an independent spacecraft program and is currently restricted to participation in ESA and NASA programs. As a result of its excellent scientific efforts, it has been possible for the UK to negotiate partnerships on other countries' satellites or to participate in open competitions to place instrumention on such satellites. At present, one of the main features of the proposed future program in space research of the UK is to launch a spectrometer on an x-ray astronomy payload.

The usual pattern of SERC involvement is for university research teams to initiate specific projects or identify specific experiments in which they can participate. If these are approved by the SERC and sufficient funds are available, university staff members design and build the instruments and interpret and analyze the data so obtained. The continuing need for involvement in hardware production provides the experimenter with the necessary initiative in developing new instrumentation and experimental techniques.

Scientific Disciplines

Although x-ray astronomy is the premier area of space research in the UK, other fields of astronomy such as astrophysics, solar system and terrestrial studies are also active--as well as the developing area of remote sensing, sponsored by the NERC. In the past decade, 90 percent of the total expenditure of the space research projects of the UK was devoted to areas of astronomy and astrophysics. In this case, the ARIEL 5 and 6 spacecraft played a major role.

Astronomy and Astrophysics

A basic physical problem which UK scientists are addressing is the identification of the physical processes which give rise to the various observed emission spectra, which span most of the electromagnetic spectrum from radio frequencies to gamma rays. These investigations are one segment of the entire range of physical science research, including laboratory-based efforts in atomic and plasma physics.

This global characteristic of contemporary astronomy provides a means of testing basic theory under extreme physical conditions--a regime which, in most instances, cannot be duplicated entirely in any laboratory. As it turns out, the UK is also mounting a vigorous ground-based program in astronomical research with the completion of unique facilities in the Canary Islands, at Moana Kea in Hawaii, and the joint Anglo-Australian observatory in Australia (see *ESN* 39-6:281-283 [1985]). It is expected that, in the future, priority will be given in the short term to the completion of these ground-based facilities

and their operation remotely with sophisticated computer networks throughout the UK.

Solar System Studies

Most of the work supported by the SERC in the area of Sun, Moon, planets, asteroids, the solar wind, and the terrestrial magnetosphere and ionosphere is conducted at the Rutherford Appleton Laboratory. The total annual budget of the SERC in this area was £1.4 million. Begun with the Skylark rocket series in late 1950, most were launched at Woomera, Australia, but also an appreciable number from Kiruna, Sweden, and Andoya, Norway. There is no active rocket research program at this time.

The UK has been involved in a wide range of studies in this general area. They currently have instruments on board the joint ESA-NASA International Solar Polar Mission (ISPM, recently renamed Ulysses), to be launched in 1986, and provided instruments on the ESA-NASA International Sun-Earth Explorers (ISEE) launched in 1977 and the ESA satellite GEOS 2 launched in 1978. The current ESA mission GIOTTO, which will intercept Comet Halley in March 1986, will carry UK instrumentation. And finally, in the area of magnetospheric studies, the UK has participated with the US and West Germany in the Active Magnetospheric Particle Tracer Explorers mission (AMPTE) by providing a small, specialized spacecraft (UKS) which was launched in August 1984 (see *ESN* 38-12:625-627 [1984]).

Terrestrial Studies

Remote sensing of the Earth's middle atmosphere has been a principal topic of study for UK scientists involved in the NASA Nimbus series of spacecraft. The atmospheric physics group at Oxford has played an important role in these developments and is currently responsible for a radiometer which will be included in NASA's Upper Atmosphere Research Satellite (UARS) to be launched in 1989.

The principal interest of the NERC is in the construction and flight of a sensitive infrared radiometer called the Along Track Scanning Radiometer, which will provide measurements of sea surface temperature on the ESA spacecraft Earth Remote Sensing (ERS 1), to be launched in 1989. The synthetic aperture radar system to be flown on ERS 1 is being fabricated within the UK by an industrial contractor. Since the NERC is primarily a user of remotely sensed data and does not provide its own requisite instrumentation, its role differs drastically from that of the SERC, which is both a source as well as user of such instruments. While the two councils have been encouraged to evolve a joint program in remote sensing, and to that end have established a National Remote Sensing Center at the Royal Aircraft Establishment at Farnborough, there still remains some confusion over the various areas of responsibility between the participating agencies.

Other Disciplines in Space Research

Thus far, UK scientists have not participated significantly in those areas of research related to experiments that can be carried out under microgravity conditions in the space shuttle, SPACELAB, or in the space station. Such experiments would be relevant to the life sciences, medicine, material sciences, and technology. The lack of interest in the UK may not be simply due to lack of funding but may also reflect an assessment by UK scientists that research in this area is not as profitable in space as might be considered and appears to be hoped for by other countries.

Engineers and Technology

There is clearly a unique opportunity for UK engineers to contribute both hardware and software in many space projects. And, indeed, UK industry is active: for example, British Aerospace is the prime contractor for the GIOTTO spacecraft project. What future direction the involvement of industry will take clearly depends on opportunities made available to it by the European space community and on the thrust provided by UK funds. It is clear also that

were a national space council to exist, it could provide the necessary guidance to stimulate synergistic interactions between the engineering and the scientific communities of the UK.

Assessment

At the present time, it appears that UK space research will continue in the same way it has been progressing--namely, cooperative ventures with ESA or NASA. There has not been in the past, and there is not expected to be in the future, any attempt to participate with the USSR in joint space activities. Of the two partnerships possible, it is anticipated that the UK will direct its efforts to enhancing its ESA collaboration in order to favor joint efforts with the European community. As an example of this, note should be made that rather unexpectedly, at the recent ESA ministerial council meeting held in Rome in late January, the UK approved full participation in the initial studies for the US manned space station.

However, like many of its European member states, the UK is concerned about the possible inherent lack of cost effectiveness of ESA space programs. A number of reasons exist for this concern. One that grates on the professional staff is the much higher salary levels of ESA employees and the permanent nature of their appointments, although all of these are being reconsidered by ESA and some changes have already been made.

Another reason for higher costs than thought necessary is the principle by which the industrial contracts sponsored by ESA are distributed among the member states in such a way as to approximately be proportionate to the individual member states financial contributions. This does not lead to low-cost choices in many cases. And finally, there is the question about the high administrative costs associated with an international organization, only some of which may be considered unavoidable.

Notwithstanding these reservations, the UK appears set on a policy of encouraging and supporting vigorously ESA spacecraft projects so as to provide the appropriate opportunities for its scientists and technologists. To a certain degree, ESA is looked upon as a national space agency for the European community. It is felt that the UK does not have sufficient funding available both to vigorously support and participate in ESA space missions as well as to conduct bilateral programs with the US.

In 1980 the Royal Society recommended that an interdepartmental body such as the National Council for Space be set up to overview all space activities. Since there has not been a single council or administrative body concerned with space-research-at-large in the UK, an overview of the relationship between space activities and UK industry has not been possible. In addition, the relative roles of the universities, the government and industry have yet to be fully articulated.

Conclusion

As the UK approaches its third decade in space research, it will be critically important that these areas of concern receive considered attention. It can be expected that the UK will continue to try to maintain its preeminence in space research in the European and world community in selected areas, such as x-ray astronomy and solar system investigations.

The policy of the UK for the future appears to be directed toward strengthening UK involvement in ESA by supporting ESA in a vigorous program (see *ESN* 39-4:169-173 [1985] and 39-5:226-229 [1985]). Should additional funds be made available for space research, it can be correctly assumed that they would, in the large, be very wisely spent by the capable workers in the UK.

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