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Scientific Programme of the European Space Agency

Part 1

ESA Today

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At the beginning of 1960, a few scientists from Western Europe, meeting at Nice for a Cospar conference, reviewed the knowledge recently acquired from the research that had been made possible by the development of modern rockets. They discussed the consequences of Western Europe's delay in entering into this new field, in particular the "brain drain" which could result from a lack of facilities comparable to those available to research workers in the USA.

It appeared that only by exercising a concerted effort and deploying considerable financial means could scientists in Western Europe continue to make a significant contribution to scientific work at an international level. This had already been experienced in the field of nuclear physics and led to the setting up of the European Organisation for Nuclear Research and the building of a centre which made available to scientists the major facilities they needed.

ESRO

The idea of a European space research centre was thus born, and, a few months later, on 1 December 1960, an agreement was signed at CERN in Geneva, setting up a "European Preparatory Commission for Space Research", with the task of establishing the structure of a "European Space Research Organisation". ESRO came *de facto* into existence in 1961 and *de jure* in the spring of 1974, the time needed for political deliberations accounting for the difference. The first ESRO launch sounding rocket was launched from Sardinia in July 1964 and the first ESRO satellite (ESRO 2) in May 1968.

To begin with, the programme of ESRO was entirely devoted to science, based on a technical centre (ESTEC, Noordwijk) and an operational centre (ESOC, Darmstadt) established by the Organisation.

During the early 1970s, the Member States (Belgium, Denmark, France, Germany, Italy, the Netherlands, Spain, Sweden, Switzerland and the United Kingdom) agreed that the scope of the Organisation should be enlarged by adding an applications programme in the fields of meteorology and telecommunications. The scientific programme was nevertheless considered to be the backbone of the Organisation and participation in this programme remained mandatory for all Member States, while participation in the applications programmes was optional and subject to a special agreement for each particular project. More recently, the Spacelab programme was added to the activities of ESRO, Spacelab being, so to speak, the "passenger cabin" of the US space shuttle system.

ESA

In 1973, it was decided by a Ministerial Conference of the Member States to merge ESRO and the European Launcher Development Organisation (ELDO) into the European Space Agency, which came into existence on 31 May 1975. (The Republic of Ireland signed the ESA Convention on 31 December 1975 and will become the 11th Member State when the Convention has been ratified by the 10 existing Member States.) One of the consequences of the substantial increase in the activities entrusted to ESA was a restructuring of the Agency in such a way that individual members of the Directorate were made responsible for the different programmes, e.g. science and meteorology, Spacelab and telecommunications. These programmes are supported by technical, administrative and planning directorates.

Although, at the present time, the direct expenditure on the scientific programme represents only a moderate fraction of the overall annual expenditure of ESA (11.3 % = 50.091 MAU = 162.62 MSwF), it is not without reason that this programme is mandatory within the framework of the ESA Convention; without it, ESRO/ESA would never have been able to propose an applications programme to the Member States, and

Contents

Scientific Programme of the European Space Agency
- ESA Today 1
- ESA's Eight Scientific Satellites 2
- Satellites under Development 6
- Future Scientific Projects . . 7
- Transition Period for ESO . 10
- Society News 12

it was only because of the experience gained with the complex scientific projects that the applications satellites could be built. Apart, therefore, from making a valuable contribution in its own right, the science programme also provides the technological basis from which applications programmes can evolve.

The scientific programme of ESA will also contribute to a better understanding in other fields of science and technology. An example is the interdisciplinary research which relates space science and energy studies. The greatest bar to achieving controlled nuclear fusion is the confinement of a hot plasma for a sufficiently long time, a feat which has not so far been managed in the laboratory. Nature, however, does this job on a grand scale : the magnetosphere around the earth is an almost perfect magnetic bottle, to which spacecraft give access. It can safely be assumed that space missions to be flown within the next few years, such as the Geos and ISEE projects, will further enhance the cross-fertilisation between earth-bound plasma research and space research. Active plasma experiments in space, as foreseen for early Spacelab missions, will also make a contribution.

Even if the means for carrying out space research in Western Europe have in the past been modest as compared with other space agencies, the success of all the satellites has been gratifying. ESRO/ESA has put eight scientific spacecraft into orbit, and has obtained from them scientific results that compare favourably with those of any other space agency. These results would never have been achieved without the enthusiasm and competence of the approx. 30 institutes which have supplied, sometimes under very difficult circumstances, experiments of outstanding quality to the Agency. It should also not be forgotten that national agencies have themselves flown many highly successful spacecraft and large numbers of experiments have been flown on the spacecraft of other agencies.

It would go beyond the scope of these articles to describe the Spacelab project which is being developed at the moment by the Agency but readers who are interested in this subject can obtain the relevant information from the Public Relations Office of ESA, 114, Avenue Charles-de-Gaulle, 92522 Neuilly-sur-Seine, France.

Part 2

ESA's Eight Scientific Satellites

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Before the launch of COS-B in August 1975, ESA (then ESRO) had flown seven very successful scientific satellites — and COS-B looks like being yet another success. Of the 51 experiments so far flown, none has experienced catastrophic technical failure and the vast majority have achieved the expected scientific return.

What we talk about below is a rather arbitrary selection of the results obtained under the headings " Sun-Earth Relationships " and " Astrophysics ". Also it should be noted that there has been excellent cooperation between experimenters in the various projects and fruitful exchanges with US and USSR scientists.

SUN-EARTH RELATIONSHIPS

While the study of distant astrophysical objects is very exciting, the investigation of sun-earth relationships is, in a way, more compelling because of the immediately observable response of the earth's environment to changes on the sun. This is particularly true in northern Europe when, for example, the auroral lights in the sky every night oblige the observer to wonder what gives rise to such a dynamic multicolour display. It is hardly surprising then that ESA's first seven satellites have carried a large number of experiments to study the earth's magnetic surroundings and their response to changes on the sun and in the interplanetary medium between sun and earth.

Less than 20 years ago, it was believed that the earth was surrounded by a dipole magnetic field which gradually weakned uniformly in all directions away from the earth into the vacuum of space. Spacecraft measurements have shown, however, that the sun continuously blows out a stream of plasma (the solar wind) at speeds around 400 km/s, and this plasma squeezes the earth's field into a shape someting like that shown in Fig. 1. There is a continuous struggle for supremacy between the wind, which may briefly reach speeds as high as 1500 km/s, and the magnetic field. The region close to the earth where the magnetic field remains in control is the magnetosphere, and its boundary with the solar wind is the magnetopause. When the sun produces a strong gust in the wind, the resulting change in the shape of the magnetosphere manifests itself on the earth as auroral lights, as disturbances in radio communication, and as magnetic field changes, which can, on occasion, be large enough to trigger safety devices in national electricity grids. There is too a growing suspicion that the sun exerts a very direct control on the earth's weather patterns.

Although many satellites have been flown through the magnetosphere in recent years, allowing the broad picture to be constructed, new fea-

	Launch date	End of useful life	Mission
ESRO-II	May 1968	May 1971	Cosmic rays, solar X-rays.
ESRO-IA	October 1968	June 1970	Auroral and polar cap phenomena, ionosphere.
ESRO-IB	October 1969	November 1969	As ESRO-IA.
HEOS-1	December 1968	October 1975	Solar wind, interplanetary magnetic field, bow shock.
HEOS-2	January 1972	August 1974	Polar magnetosphere, neutral point, interplanetary medium.
TD-1	March 1972	May 1974	Astronomy (UV, X- and γ-ray).
ESRO-IV	November 1972	April 1974	Neutral atmosphere, ionosphere, auroral particles.