SPACE PHYSICS

Developing Cohesion

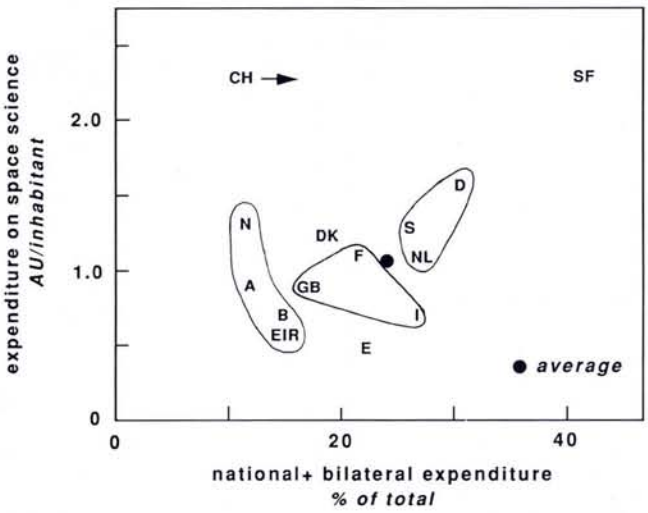
Delegates from national space science programmes in the 14 European Space Agency (ESA) Member States (MS) met in Capri in 1988 and again in May 1990 at special colloquia organised by ESA's Science Programme Committee (SPC) which aims to promote harmony between activities — both at the national level and between disciplines. In spite of considerable progress since 1988, some problems persisted in 1990 in standardising reports. Nonetheless, a reasonably clear picture is presented in a review of the results [*ESA/SPC(91)* **36** (Paris) 11 Oct. 1991] of the 1990 Capri colloquium.

A typical MS spent in Europe in 1990 per inhabitant some 1.1 Accounting Units (AU) or $ 1.3 on space science, with 60 % of the 353 MAU (430 M$) total representing mandatory ESA Science Programme (SP) contributions, 15% supporting ESA SP payloads and 25% covering national and bilateral agreements. NASA's Office for Space Science and Applications in the USA had a much larger budget in the same year (1250 M$) for equivalent programmes, a sum that outstripped inflation to 1432 $ in 1991 and to a requested 1768 M$ for 1992 (a slightly lower figure was approved by Congress last month). The budget for Japan's Institute of Space and Astronomical Science was a modest 132 M$ in 1990.

Year-to-year fluctuations in expenditures inevitably arise in programmes involving major space projects so it is difficult to confirm trends for the short period covered by the two Capri colloquia. The 1992 colloquium will probably not improve the situation: Germany is threatened by budget cuts for space science following unification. Secondly, owing to the upheavals in the USSR, changes to the Soviet space programme will affect many USSR-European collaborations, especially as most involve satellites, which account for 75% of MS space science spending, as opposed to balloon- and rocket-borne experiments with a combined 25%. However, there appeared to be a reduction in spending on space science in Europe of about 20 % in real terms from 1988 to 1990 while total space expenditure increased by 16.5% from 3909 MAU to 3354 MAU. The pressure comes largely from increased spending on manned spacecraft (the Columbus laboratory, one of Europe's contributions to the International Space Station, and the European spaceplane Hermes – ESA ministers having decided last month to maintain these programmes but without commiting long-term spending).

National Programmes

The 1990 Capri data for MS suggests four different national spending patterns depending on a country's size, resources and objectives (see figure), with national programmes constituting a vital component. They complement generally much larger international collaborations by helping to keep alive communities in particular fields during the lean years between major missions: smaller countries unable to support national programmes thus feel disadvantaged. Hills and valleys are accentuated by the intermittency of major international programmes leading to resources being concentrated for a period in some areas. Astronomy missions, for example, are presently being squeezed by ESA's up-coming solar system missions. Sources of friction can be reduced by having institutes or countries provide instrumentation to a central collaboration responsible for basic hardware (*e.g.*, the launcher and optical system) — a high energy physics model epitomised by ESA's IR Space Observatory (ISO, 1992 launch) and its X-Ray Spectroscopy Mission (XMM Cornerstone, 1998 launch). But collaboration takes additional effort so individual countries are inclined to expand national, and eventually bilateral, schemes.



National expenditures on space science in ESA Member States in 1990. The expenditure per inhabitant is plotted as a function of the percentage of the total expenditure (see text) spent in national and bilateral programmes. Three large countries (France, Italy and the UK) represent the average; The Netherlands, Sweden and Germany have a higher than average national expenditure and several small countries (Ireland, Belgium, Austria, Norway) less than the average. Spain is an understandable exception with a low per capita spending but a well-developed (average) percentage for national programmes. In lieu of a national activities, Switzerland uses two-thirds of its contribution to ESA's PRODEX à la carte programme to channel funds for space science to institutes, thus appearing to spend a small percentage nationally. Together with Finland, it has a relatively high per capita expenditure reflecting the cost of building up technologically advanced space activities in a small country. Source: ESA/SPC (91) ***36*** *(Paris) 11 Oct. 1991.*

The summary report notes that the pattern of expenditures implies, first, that as the *per capita* GNP of the average MS is more than $ 5000, a country's space industry is sub-critical if the GNP is too low: ESA contributions are themselves insufficient to support such an industry, especially one large enough to ensure some competition in a system demanding geographically distributed industrial return. Two European Community countries (Portugal and Greece) which are obvious candidates for ESA membership thus find it difficult to join. Secondly, to avoid dangerous imbalances, the average expenditures set entry limits for new MS, notably from eastern Europe, who must recognise the overall cost and the minimum sizes of the scientific community and of the industrial infrastructure. While expanding membership within the EC and Europe will take time, ESA is nevertheless looking at specific areas relevant to the European Community's work (see page 212).

Space Science Missions

In spite of difficulties in satisfying both national and overall community needs, the planned programme of solar system and astronomy space missions is well balanced and, if fully implemented, should ensure continuity in most fields. European activity centres on ESA's Horizon 2000 programme drawn up in 1984 and which is now financially secure following measures introduced in 1990 in the wake of launcher failures. It comprises four major Cornerstone Missions augmented by competitive, Medium-Size Missions (≈ 200 MAU) and small missions offering flexibility (see page 209). For the USA, a 1990 Advisory Panel and NASA's 1988/9 Strategic Plan recommended correcting the hiatus following the Space Shuttle Challenger disaster, which resulted in only two space science satellite missions in the 1980's, by completion of four 1 m class Great Observatories started with Hubble (page 206). Complementary support should come through reinstating medium- and small-scale Explorer-class astronomy missions (five are currently funded) that once constituted the core of NASA's space science programme until missions conceived in the mid-1970's were shelved.