$\lambda$ = 1730 and 5010 Å in the *f*/96 mode) are shown in Fig. 4. The central object (Fig. 4a) is SN1987A itself and the bright objects on either side are relatively bright companion stars. The faint structures or halos surrounding these brighter stars are not real but result from the spherical aberration. The second image (Fig. 4b), taken using the light of twice ionised oxygen thanks to a narrow filter centred on a wavelength corresponding to the wavelength of the [O III] oxygen emission line doublet at 4959 and 5007 Å, unveils a beautiful circumstellar luminescent structure surrounding SN1987A. This structure is most probably a ring and not a shell as the quantity of light emitted is low and the model agrees with other observations.

The existence of the ring had been gleaned previously from both ground-based and space observations in the ultraviolet. However, the FOC images have provided a much clearer view of its structure. The angular separation between the ring and SN1987A is estimated to be about 0.8 arcsec from the major axis — corresponding to 0.75 light years at the distance of the Large Magellanic Cloud. Being too large to have originated from material ejected by the supernova explosion, astronomers speculate that the ring (circular but seen at an angle of about $\approx$ 1.5°) must have existed prior to the explosion as a ring of gas ejected and shaped by the "stellar winds" from the progenitor supergiant star some 10 000 years prior to the supernova explosion. The ring material was then ionised and heated by the intense flash of ionising radiation emanating from the supernova. This radiation reached the ring within the year following the explosion and it is still glowing today, many years later. The presence of the ring thus provides astronomers with an important clues as to the nature and history of the progenitor star that exploded as the SN1987A supernova.

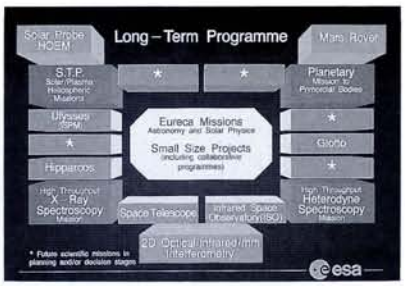
**Future Developments**

It is clear that the Hubble Space Telescope is not as powerful as it should have been because of a flaw. Nevertheless, the telescope is still extremely useful. Observations considered impossible from the ground are now acquired routinely.

Numerous studies have been made of a variety of possible remedies to the hardware problem. The most reasonable means for restoring the performance of the Faint Object Camera — and indeed those of the two other instruments — is widely recognised to consist in building and installing a device called COSTAR (Corrective Optics Space Telescope Axial Replacement) which would deploy corrective optics in front of each instrument's aperture. COSTAR is now fully funded and is scheduled to be mounted during the first maintenance mission with the Space Shuttle in early 1994.

## ESA's Scientific Programme

Dr. R.M. Bonnet, Director of the Scientific Programme of the European Space Agency (ESA), outlines the Agency's activities in the disciplines covered by the Programme, namely: exploration of the solar system, astronomy and fundamental physics.




*ESA's Horizon 2000 long-term scientific programme for solar physics, astronomy and fundamental physics: major Cornerstone missions (boxed) having predefined objectives are augmented by competitive, Medium-Size Missions offering flexibility, and existing missions. There are also small projects as well as missions launched on the European Retrievable Carrier (EURECA).*

**Missions**

The current missions are:

— the cometary probe *Giotto*, which, having flown by the nucleus of Comet Halley in 1985 has been redirected on to a trajectory leading to an encounter with Comet Grigg-Skjellerup in mid-1992;

— the *International Ultraviolet Explorer* (IUE), launched in 1978 and operated jointly with the US National Aeronautics and Space Administration (NASA) and the UK Science and Engineering Research Council since 1978 as an observatory facility;

— the astronomy satellite *Hipparcos*, launched in 1989, which will determine the positions, proper motions and parallaxes of 120 000 stars with an accuracy of 0.002 arcsec;

— the *Hubble Space Telescope*, launched in 1990, a joint project with NASA in which ESA has a 15% share (see page 206);

— *Ulysses*, launched in 1990, a probe to explore the heliosphere at high latitudes, including the space over the poles of the Sun. This mission is also an ESA/NASA collaboration (see page 203).

The next mission to be launched will be the *Infrared Space Observatory* (ISO). This cryogenically cooled 60-cm telescope will be operated as an observatory facility starting in 1993. It covers the spectral domain from a few μm to 200 μm and represents the only telescope of its class to fly in space until the early part of the next century.

**Horizon 2000 Long-Term Plan**

The centerpiece of ESA's long-term Horizon 2000 science programme, embarked upon in 1985, is a set of four *Cornerstone* missions, *i.e.*, major missions with scientific aims which were determined at the outset of the programme and which cover the interests of a broad segment of the European space research community as follows:

— solar system disciplines: *Solar-Terrestial Science Programme* (the first Cornerstone — see page 213) and the return of a sample from a comet nucleus or an asteroid *(Rosetta)*;

— astronomy: high-throughput X-ray *(XMM)* and sub-mm astronomy *(FIRST)*.

The Cornerstones are augmented by a number of *Medium-Size Missions*, each selected competitively and — after four years of studies and evaluation — leads to the selection of a new project. The first Medium-Size Mission is *Huygens*, a probe to be launched in 1995 on NASA's Cassini spacecraft and to be released upon arrival at Saturn for a descent through the atmosphere of the moon Titan.

Four candidate projects for the *Second Medium-Size Mission* (M2) are presently being studied, prior to final selection in early 1993 and launch around about the year 2000. Two are astronomy missions, namely: an International Gamma-Ray Laboratory (INTEGRAL) and a mission to examine the asteroseismology and microvariability of stars (PRIMA); one is a solar system mission involving a set of meterological and seismograhic stations on Mars (MARSNET); the fourth is a Satellite Test of the Equivalence Principle (STEP) — a fundamental physics mission (see page 216).

**ACKNOWLEDGEMENTS**

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**FURTHER READING**

See *Astrophysical J. Lett.* **369** No. 2 Pt. 2 (1991) L21-L75 and **377** No. 1 Pt.2 (1991) L1-L29 for detailed results and for interpretations of the scientific observations discussed in this article.