hydrides may in fact play a key role for our understanding of interstellar chemistry. Of special interest for astrophysics are transitions of atoms and atomic ions since they allow abundance determinations. Furthermore, fine structure lines of atoms and ions as C° and C^{+} provide part of the cooling for interstellar clouds. The λ 610 μm line of C° should be of special interest for the physics of dense interstellar clouds and may be observable with a ground-based telescope. However, only heterodyne radiometers will provide sufficient sensitivity for sub-millimetre spectroscopy. As mentioned before, intensive development work on this type of radiometer is in progress in several laboratories in Europe and USA:

There are other, more speculative, objects to be observed in the sub-millimetre range, such as the redshifted dust radiation from giant elliptical galaxies in their formation stage. The cosmological implications of such observations are obvious. We may also envisage a galactic survey for both the quasithermal emission from cool dust and for some higher rotational (and therefore optically thin) transitions of the CO molecule. (But of course such a survey would be carried out not with the VLT but with small telescopes.) This should lead to a much more realistic picture of the distribution of interstellar gas than the present one which is based on the observation of the opaque $J = 1 \rightarrow 0$ transition of ^{12}CO.

European Astronomers Discuss the Use of the Space Telescope (continued)

With the publication of the Proceedings of the ESA/ESO Workshop on "Astronomical Uses of the Space Telescope", held in Geneva on February 12–14, 1979, it is now possible to better judge the interest of the European astronomical community in the Space Telescope. The Proceedings of course only represent the "official" part of the meeting. There were also lively discussions among the 186 participants and it is impossible to write them all down!

The Space Telescope

The workshop was opened by three speakers—Longair, O'Dell and Macchetto—presenting a general introduction of the technical as well as the political aspects of the ST.

In his contribution "The Space Telescope and its capabilites", Longair compared ST with ground-based telescopes, stressing the improvements in angular resolu-

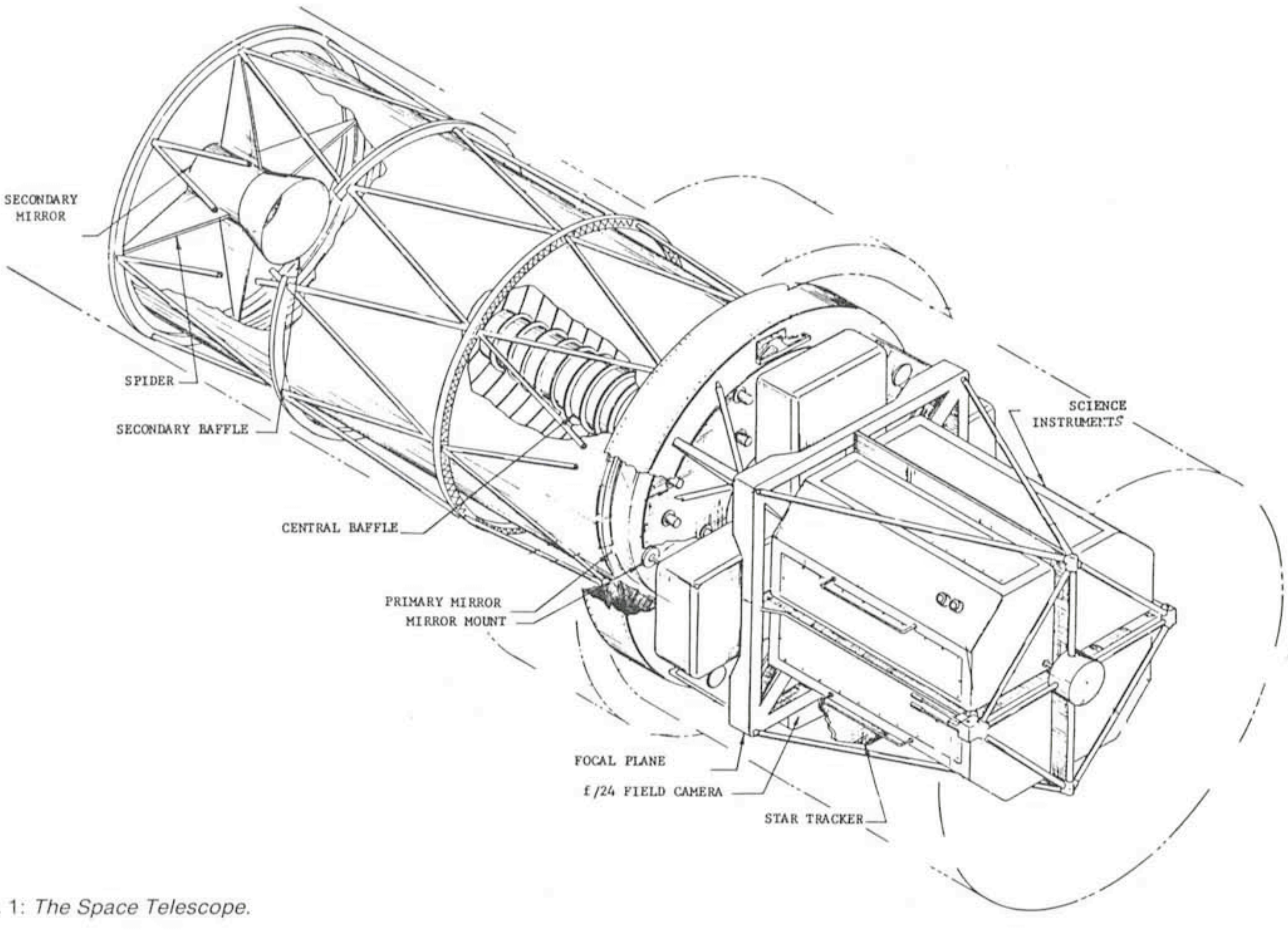

Fig. 1: *The Space Telescope.*

Space Telescope Parameters

Specification and performance goals of the NASA Space Telescope

Telescope aperture	2.4 m
System focal ratio	f/24
Optical design	Ritchey-Chretien Cassegrain
Central obscuration	14 % aperture area
Field of view for science	18 arcmin diameter
Spectral range	120 nm – 1 mm
Optical performance: system wavefront error	λ/13.5 r.m.s. at 632.8 nm
Radius of 70 % encircled energy from a point source at 633 nm	0.1 arcsec
Faint object sensitivity subject to viewing in directions greater than i) 50° from Sun ii) 70° from Earth's limb iii) 15° from Moon	Point objects having m_v = 27 or brighter; extended sources to a limit of 23 magnitudes (arsec)$^{-2}$ in visual wave-band. Both in 10 hours of integration.
Pointing stability	0.007 arcsec on a target having m_v = 13 in the range 400–800 nm
Minimum reflectivity	85 % at 632.8 nm 70 % at 120 nm

Satellite orbit

Circular Earth orbit serviceable by the Space Shuttle

Altitude	about 500 km
Inclination	28.8°

The Wide-Field/Planetary Camera

The Camera can operate with two different focal ratios, f/12.9 or f/30. The former gives a field of view 2.67 × 2.67 (arcmin)^2 and is referred to as the Wide-Field Camera; the latter gives a field of view of 68.7 × 68.7 (arcsec)^2 and is called the Planetary Camera.

	Wide-Field Camera	*Planetary Camera*
Picture format	1600 × 1600 pixels	1600 × 1600 pixels
Angular field of view	2.67 × 2.67 (arcmin)^2	68.7 × 68.7 (arcsec)^2
Pixel size	0.1 arcsec	0.043 arcsec
Dynamic range (per pixel, single exposure)	> 15,000	> 15,000
Maximum S/N (per pixel, single exposure)	450	450
Photometric precision	Better than 1 %	Better than 1 %
Photometric accuracy	Better than 2 %	Better than 2 %
Overall dynamic range for stars (m_v)	+ 3 to + 29	+ 1 to + 29

Faint-Object Camera

This table shows the proposed instrumental parameters which will be achieved by the Faint-Object Camera operating in the f/96 mode.

Field of view	11 × 11 (arcsec)^2
Angular resolution	Essentially limited by the performance of the Optical-Telescope Assembly at wavelengths longer than 300 nm
Wavelength range	120 to 800 nm
Dynamic range (single observation)	m_v = 21 to 28 on point sources; 15 to 22 visual magnitudes (arcsec)$^{-2}$ for extended sources
Photometric accuracy	~ 1 % when not photon-noise limited
Focal ratio	f/96 assuming 25 μm pixels. Additional focal ratios are desirable (see text)
Number of pixels	500 × 500
Exposure time	Up to 10 hours
Calibration	Internal sources and standard stars, necessary to provide required photometric accuracy

Faint-Object Spectrograph

Spectral range	114 to 1010 nm
Spectral resolving power R = $\lambda/\Delta\lambda$	R = 10^3 first priority R = 10^2 second priority
System Absolute Efficiency	> 1 %
Radiometric precision	< 1 % of maximum scene signal
Slot sizes: fixed apertures	1.00 arcsec diameter 0.50 arcsec diameter 0.25 arcsec diameter (fail-safe position) 0.10 arcsec diameter Special purpose occulting mask Closed
Centering stability	± 0.03 arcsec
Angular resolution	0.1 arcsec
Dynamic range	10^7
Relative wavelength calibration	20 % of resolving power
Detectors	512 diode linear array Digicons
Exposure times	Minimum gate time 50 μs Minimum periodicity 10 ms No limit on maximum length of target integration

High-Resolution Spectrograph

Spectral resolving power R = $\lambda/\Delta\lambda$	2 × 10^4	1.2 × 10^5
Detector channel width:		
at 150 nm	0.0075 nm	0.0013 nm
at 230 nm	0.0115 nm	0.0019 nm
Detector step or sub-step size	variable 0.001 – 2.3 nm	variable 0.002 – 0.38 nm
Overall spectral range	105–170 nm 110–320 nm	110–170 nm 170–320 nm
Spectral range per integration		
at 150 nm	3.5 nm	0.56 nm
at 230 nm	5.9 nm	1.02 nm
Minimum and maximum integration times (seconds)	0.05 to ∞	0.05 to ∞
Field view	1.0 × 1.0 (arcsec)^2 0.30 arcsec	1.0 × 1.0 (arcsec)^2 0.30 arcsec
Dynamic range per resolution element per exposure	10^7	10^7
Photometric resolution	count-limited	count-limited

High-Speed Photometer/Polarimeter

Spectral range	115–850 nm (photometry) 210–700 nm (polarimetry)
Spectral resolution	~ 2 nm (200–300 nm) ~ 25 nm (115–350, u, b, v, y, Hβ) ~ 80 nm (UBVR) ~ 200 nm (110–350 nm) ~ 500 nm (300–800 nm)
Fields of view	0.7, 1.4, 2.8 arcsec
Temporal resolution	As fast as 16 μs
Photometric characteristics	Pulse counting over dynamic range of 10^6 with no dead-time correction over first five decades; analogue mode extends range to 10^7 and overlaps counting mode over four decades with 2 % A/D conversion accuracy.

tion, the "24-hours per day" observing time, and the wide observable waveband. He described in some detail the five scientific instruments: the Wide-Field/Planetary Camera, the Faint-Object Spectrograph, the Faint-Object Camera, the High-Resolution Spectrograph and the High-Speed Photometer/Polarimeter. Longair concluded: "It is essential to plan your Space Telescope observing programme *now* because there will not be time available for making mistakes. Everything possible should be done from ground-based observatories so that when the Space Telescope observations are made, we are all in a postition to make the optimum use of them."

O'Dell (NASA) and Macchetto (ESA) presented the status of the project and showed that ST is not a telescope under study but an instrument under construction. If everything goes well, we shall have a 2.4 m telescope in orbit in 1984. So the rest of the conference was concerned with how to make the best possible scientific use of it. For the benefit of all interested parties we have reproduced on page 19 the main parameters of the Space Telescope and its auxiliary instrumentation.

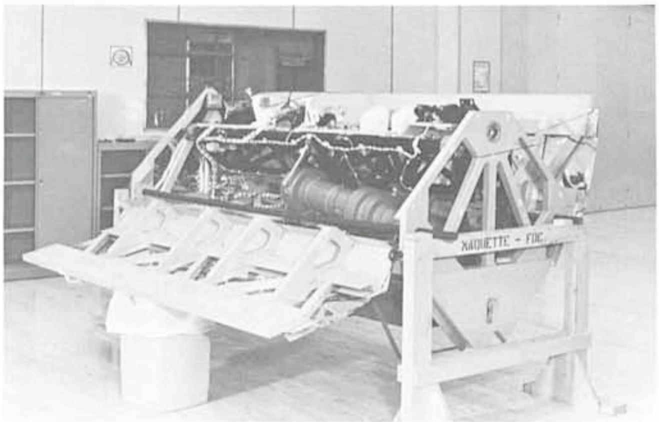

Fig. 2: *One of the main instruments onboard the Space Telescope is the Faint-Object Camera (FOC). It constitutes one of the major European contributions to the ST project and is here shown (as a full-size mock-up) at the European Space Agency (ESA).*

Galactic Research

Different aspects of star formation and stellar evolution were the subject of interesting contributions by Appenzeller, Gahm, Staller, Hack, Buser, Rakos and Jaschek. New spectroscopic data obtained with IUE, a 45 cm space telescope—rather primitive when compared with the ST—were used to demonstrate the great potential of ST. The unique possibility offered by ST to obtain extremely deep pictures of star fields in different colours from the UV to the IR will be used to investigate the space distribution, luminosity function and chemical gradients of stars inside and around our galaxy.

The H II regions, interesting because of their relation with the star formation problem, opened the topics of interstellar matter. Galactic as well as extragalactic H II regions, planetary nebulae and supernova remnants were discussed by Courtès, N. Vidal, Elsässer, Perinotto, D'Odorico and Danziger. Making use of the advantage of the monochromatic character of the emission of these objects there was general consent that high-resolution pictures, obtained with narrow interference filters, centred on lines and on the continuum, will show new structures that could revolutionize our ideas concerning the interstellar matter. The main limitations will be in the angular sizes of the ST fields of view, which are indeed very small when compared with the extension of H II regions or supernova remnants.

Globular clusters are traditionally objects of transition between galactic and extragalactic astronomy, and during the ST Workshop they continued to play this role. The great advantage of the use of ST in globular cluster research was strongly expressed by Castellani. He concluded: "It looks clear to me that ST could be devoted to such a problematic for a very long time without exhausting this subject. I, of course, cannot ask for a GCST (Globular Cluster Space Telescope) though I am personally convinced that such an instrument would be among the most busy and useful instruments to be launched in space!". This idea was immediately accepted by Aurière, Renzini and Wyller who presented observing programmes for the ST for globular clusters. Following these speakers, Weiss discussed the use of globular clusters as distance indicator for galaxies.

Extragalactic Research

Westerlund pointed out that "many of the research programmes that one may foresee for the Magellanic Clouds with the aid of the ST are of a similar nature to those that may be planned for objects in the Galaxy". Studies of field stars, star associations, interstellar matter will make significant contributions to the solution of the riddles of the Magellanic Clouds. With ST it will be feasible to extend similar programmes to other galaxies in the Local Group and to the Virgo Cluster. Pagel presented a review paper on the chemical evolution of galaxies and van der Kruit described the advantage of ST in the study of dynamics of galaxies. In this field of astronomy one of the problems is the velocity dispersion in elliptical galaxies. Crane described the potential of the Faint-Object Camera in the spectrographic mode with respect to dynamics of the nuclear regions in elliptical galaxies.

If normal galaxies will be primary targets of ST, then the so-called "active" galaxies, including quasi-stellar and BL Lacertae objects, are the extragalactic objects from which we hope to obtain the most surprising results. Since long one of the dreams of extragalactic astronomers is to observe NGC 4157, 3C273 or OJ 287 with high spatial resolution over a wide spectral range. ST will for the first time allow us to look into the inner part of active nuclei of galaxies close to "the source".

These subjects for ST research were discussed extensively by Ulrich, Penston, Disney and Heidmann.

Tarenghi, N. Vidal and Fong dealt with distant galaxies and clusters of galaxies and the puzzling problem of galaxy evolution. The workshop ended with a review by Tammann on "Cosmology with the Space Telescope". In the beginning, ST was considered "the tool" to solve all cosmological problems. However, after a lucid analysis of the limits of ST, Tammann concluded: "ST will be helpful for the determination of H_0, it will be very important for the mapping of the expansion field, and it offers a unique chance to determine q_0 from supernovae and to verify the Doppler nature of cosmological redshifts."

The general impression after this workshop is that ST will be a heavily oversubscribed telescope and that the European astronomical community will try hard to obtain more time than the 15 % share they are guaranteed in the ESA-NASA agreement.

M. Tarenghi