ies at redshift 0.5 would be close enough for individual supernovae to be observed in large numbers. Contrarily, supernovae in normal galaxies at redshift 3 or more would be too faint to be observed. A comparison of pictures obtained at different times will tell whether short-lived supernovae are seen or not, and therefore immediately give important information about the nature of the objects seen.

This NTT picture has given us a tantalizing, first glimpse of what can be done with the new and improved observational means which are now at our disposal. It has given us a unique look into regions of the Universe, so remote in space and time that they have never before been explored.

This is the type of work that will be at the frontline of optical observational cosmology during the coming years.

HST – the First Year

R. FOSBURY, ST-ECF

At the end of April, the Hubble Space Telescope completed its first year in orbit. With a projected lifetime, however, of some fifteen years, the observational programme of the spacecraft is just beginning. After the announcement in June 1990 of the spherical aberration in the primary mirror, the first assessment by astronomers tended to relegate the observatory to the role of a "large IUE with some UV imaging".

Now that the science verification phase of the commissioning process is nearing completion and the Guaranteed Time and General Observer programmes have started, it is a good time to assess what we have learned so far and try to paint a somewhat more realistic picture of the current capabilities of the instruments as they will be until the optical correctors are installed late in 1993 (current estimate).

In our eagerness to examine and assess the first real observations with the cameras and the spectrographs, it is perhaps too easy to overlook the tremendous complexity of the spacecraft and the ground operation and so to underestimate the achievement that the by now regular observing schedule represents. In the early months of the year, many of the pointing and target acquisition problems were overcome and by April, when revised pointing control software was installed in the on-board computers, the rate of successful completion of planned observations had become encouragingly high.

An engineering assessment of the spacecraft reveals both good news and some cause for concern. The new NiH2 batteries, specified at a late stage in the project, are performing well and the solar arrays are exceeding expectations in their power output. This means that the extra power can be used to minimize the thermal cycling of the scientific instruments and so help to extend their lifetime. Also, the thermal behaviour of the spacecraft as a whole is excellent and imposes no additional operational restrictions on the observing programmes. Communications with the ground, both direct and via the TDRS system, are no problem with a bit-error-rate some thousand times better than the minimum specification. The data management is also operating well, although a failed memory unit (one of six, four of which are currently used) caused the HST to enter a deep sleep – "hardware sunpoint safemode" state – recently. A five-day recovery process was completed just in time to intercept the observing schedule for some GHRS observations of the flare star AD Leo coordinated with a variety of ground- and space-based observatories.

After an equivocal start, the pointing performance has been improved to a level where most target acquisitions are successful. The spacecraft motions induced by the solar arrays during terminator transitions mean that the "jitter" does not meet specifications although large parts of the orbit are extremely quiet (~ 5 milliarcseconds rms). Noisy periods, which would degrade certain observations, can be rendered benign

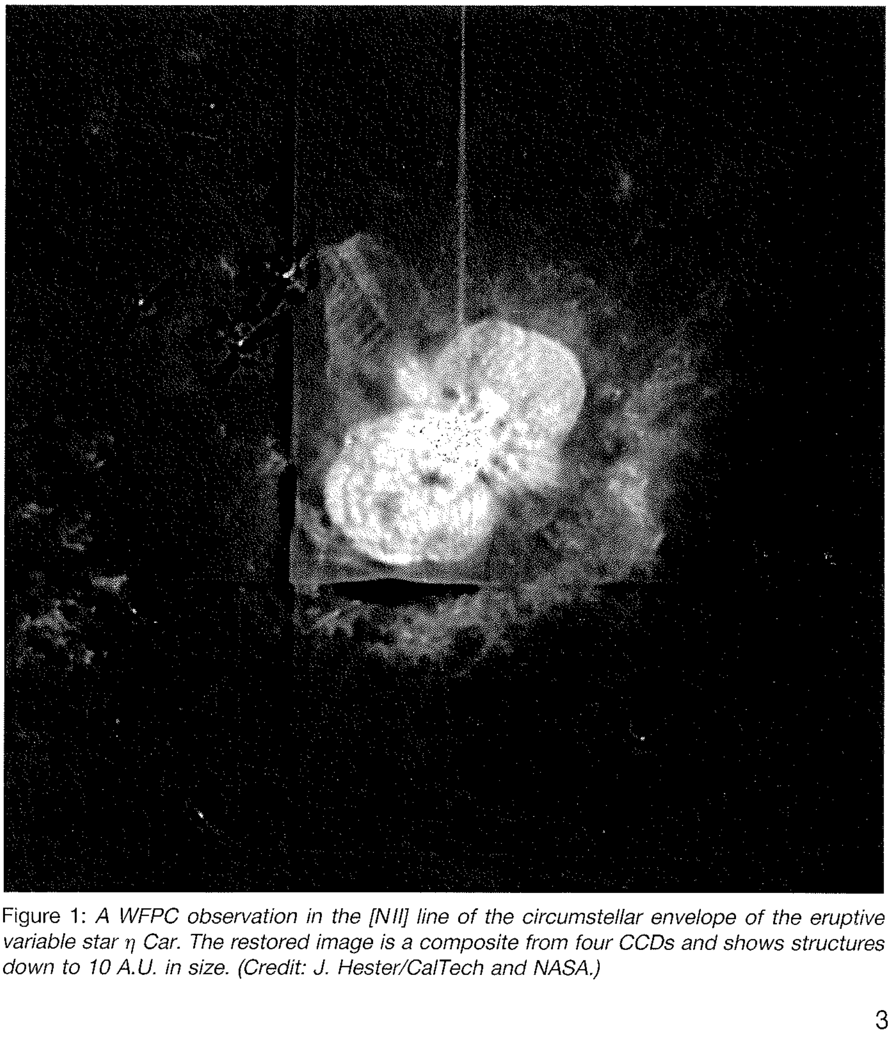

Figure 1: *A WFPC observation in the [NII] line of the circumstellar envelope of the eruptive variable star η Car. The restored image is a composite from four CCDs and shows structures down to 10 A.U. in size. (Credit: J. Hester/CalTech and NASA.)*

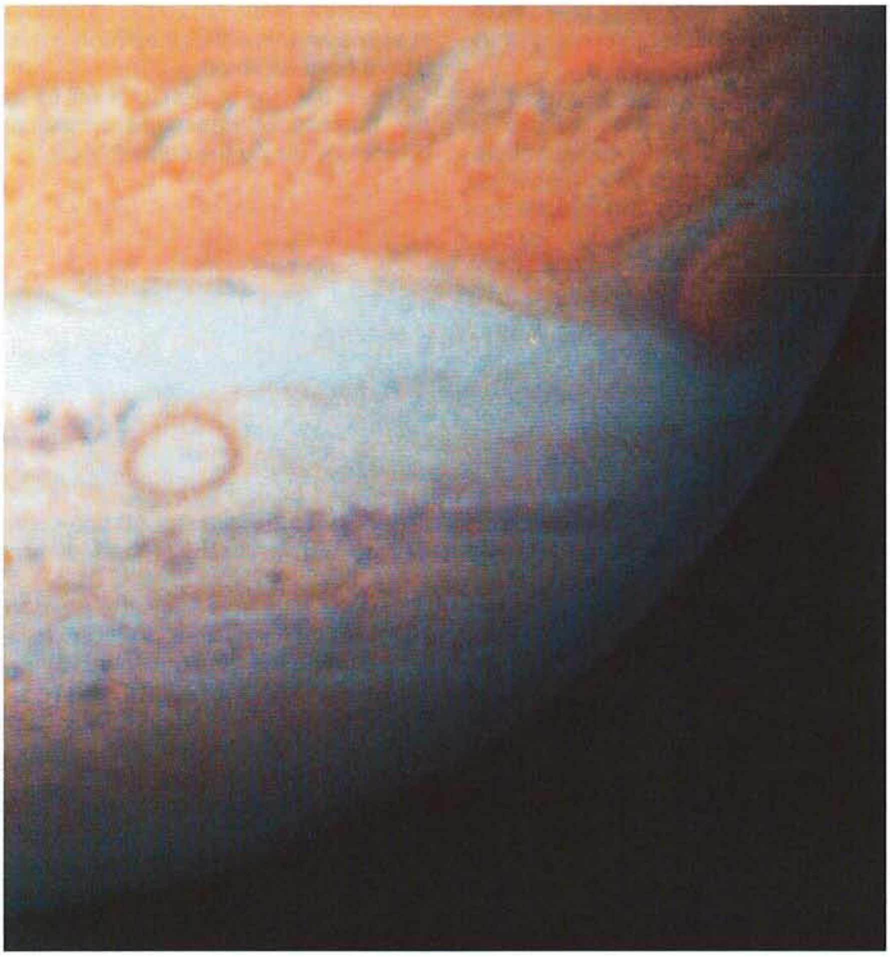

Figure 2: *The first HST WFPC observation of Jupiter. This "true colour" composite has about the same resolution as the pictures taken by Voyager five days before encounter in 1979. The banded structure at the limb is caused by the planet's rotation during the six-minute sequence of red, green and blue filter observations. (Credit: NASA.)*

by building suitable schedules. The Fine Guidance Sensors (FGS) which provide the errors to the pointing control system in one of two alternative modes – Coarse Track and Fine Lock – are affected by the spherical aberration but this is somewhat offset for the Fine Lock observations by the much lower than expected rate of spoiled acquisitions due to the unknown multiplicity of guide stars. Now that software has been provided for anticipating velocity aberration due to the orbital motion of HST, short observations under gyro control only can be made with good enough stability for some purposes and greatly reduced acquisition overhead. This will enable observers to apply for programmes of short "snapshot" mode observations which will fill unavoidable gaps in the schedule and increase the overall utilization of the observatory. One of the six gyros failed at the end of 1990. Four of the remainder are used by the control system.

The optical performance of the telescope has now been characterized with sufficient accuracy to enable the specification of corrective optics for WFPC II and for COSTAR – the scheme to replace the HSP with corrective optics for FOC, FOS and GHRS (see ST-ECF Newsletter #15, pp. 22, 23). The measurements made on the original test equipment used in the figuring of the primary mirror and in-orbit observations agree well and, incidentally, give a horrifically graphic picture of the blunder in the mirror testing which resulted in the infamous "HST point spread function". At the moment, the process of collimating the telescope remains incomplete, primarily because the two cameras and the FGS have somewhat differing requirements.

The individual scientific instruments are working well. The WFPC suffers some UV (< 3000 Å) problems due to contamination – probably from the lanoline used to lubricate the rivets in the instrument structure! The interaction of spherical aberration with the Cassegrain repeater optics in the camera produces a position-dependent PSF which complicates the processes of photometry and image restoration. The FOC is nominal. The FOS, and to a lesser extent the GHRS, suffer from magnetically induced image motion. This can, with the exception of the FOS red-side spectropolarimetry, be corrected using revised software. The FOS spectral response below 1500 Å decreases below expectation and below that of the GHRS, probably due to contamination of the surface of a grazing incidence mirror. The HSP is rather seriously affected by the combination of spherical aberration and spacecraft jitter and has not yet progressed very far through its science verification programme.

A workshop at the STScI in Baltimore in the middle of May gave the participants a mature review of the performance of the observatory and a good perspective of the early scientific results from the science verification observations and the beginning of the GTO and GO programme. Contrary to some of the earlier assessments, based more on the overall size of the PSF than on its detailed characteristics, the imaging performance of the cameras is qualitatively different from even the best ground-based telescopes. With the MTF extending almost to the diffraction limit, the resolution of sources with a limited dynamic range, e.g. planetary surfaces, is spectacular. The comparison of the (restored) 2200 Å image of the M87 jet shows it to be essentially identical with the 0.1 arcsec resolution VLA map obtained at a wavelength some one hundred thousand times longer. The WFPC emission-line image of η Car shows a wealth of structure down to 10 A.U. dimensions including a jet at right angles to the previously supposed direction of bi-polar outflow. Other circumstellar observations obtained during the first year were of the emission-line ring around Supernova 1987A and the twisted jet in R Aqr. The multi-line studies of the Orion nebula and, most recently, the Cygnus loop demonstrate the ability of the WFPC to resolve ionization structures in these nearby objects with consummate ease.

UV images of the cores of globular clusters are yielding some surprising results. The core of M15 shows no light cusp and indeed has a radius of 2 arcsec; the radial light distribution does not fit equilibrium models. The core of 47 Tuc in UV light – after accounting for the filter red-leaks – shows a central concentration of blue stragglers (a phenomenon noted by Sandage in 1953), one of which falls within the X-ray source error box.

For small, isolated sources, the spectrographs are affected only by the reduced throughput of the small apertures. One of the most exciting new results came from observations of the absorption spectrum of the nearby quasar 3C273 made with both the FOS and the GHRS. In addition to lines from the Galactic halo and at the redshift of the Virgo cluster, there are nearly an order of magnitude more Lyman-α systems than expected from the behaviour of the forest above $z \sim 2$. Indeed, with a velocity resolution of 3.5 km/s, the GHRS is proving to be a superb interstellar medium machine with lines down to mÅ equivalent width being seen in the UV spectra of bright stars (ξ Per, β Pic and Capella). As an interesting aside, atmospheric OI lines can be seen and used to provide an accurate internal wavelength calibration. Studies of exotic elements in χ Lup and chromospheric features in α Tau were presented. The current sophistication in the modelling of the atmospheres and winds of hot stars was demonstrated by the successful fitting of the P Cyg profiles in Melnick 42, a 100 $M_{\odot}$ in the 30 Dor nebula.

Within the Solar System, the HST provides the opportunity to carry out extensive planetary campaigns, something not afforded by the fly-by missions. Mars can be studied for long periods with a surface resolution similar to or exceeding that obtained under exceptional circumstances from the ground only at opposition. The atmospheres of Jupiter and Saturn can be seen at a resolution similar to that of the Voyager approach sequences and, of course, the ultraviolet part of the spectrum is available for the first time.

Some of the data discussed at the workshop are already in the public domain and available from the ST-ECF archive in Garching. All of the science verification data will become public soon after the end of the SV phase later this summer.

The "Discovery" of Paranal

L. WOLTJER[1], Observatoire de Haute-Provence, France

Introduction

Early morning on April 10, 1983 an expedition consisting of Mr. Bachmann, Ms. Demierre, Dr. Muller, Mr. Schuster, Mr. Torres and myself left La Silla to explore some northern sites in Chile. The next day we visited the Paranal area for a first inspection. After subsequent discussions with the *Intendente* in Antofagasta and a visit to the areas of S. Pedro de Atacama, we returned by plane to have another look at Paranal and its surroundings. Soon thereafter, under the leadership of Dr. Ardeberg, an observing station was set up at Paranal that provided the data based on which some seven years later the decision could be taken to locate the VLT there. It may be of some interest to describe the reasons why Paranal could be considered a promising site so early on.

At the beginning of the eighties plans for the VLT were still in a preliminary stage. It was clear, however, that infrared observations would constitute an important part of the raison d'être of the VLT; the choice of 8-m unit telescopes was, in part, dictated by the wish not to be diffraction limited at 20 microns wavelength. Since infrared observations from the ground are hindered mainly by water vapour in the earth's atmosphere, a very dry site was needed. Water vapour will absorb wherever it is located, and what matters is therefore not the local humidity but the integrated amount of water vapour in the atmosphere above the site. It is usually expressed in mm of precipitable water – the amount of rain that would fall if all the water vapour rained out. Sites with less than 1 mm of H_2O are comparatively very good sites for IR observations, sites with more than 3 mm rather poor. The local humidity has only a limited relation to the integrated amount of water vapour. If it is locally very humid, the integrated

Figure 1: *The first ESO expedition to Paranal (from left to right: H.-E. Schuster, A. Muller, G. Bachmann, and the author; photograph Ms. U. Demierre).*

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[1] Professor Lodewijk Woltjer was Director General of ESO from 1975 to 1987.