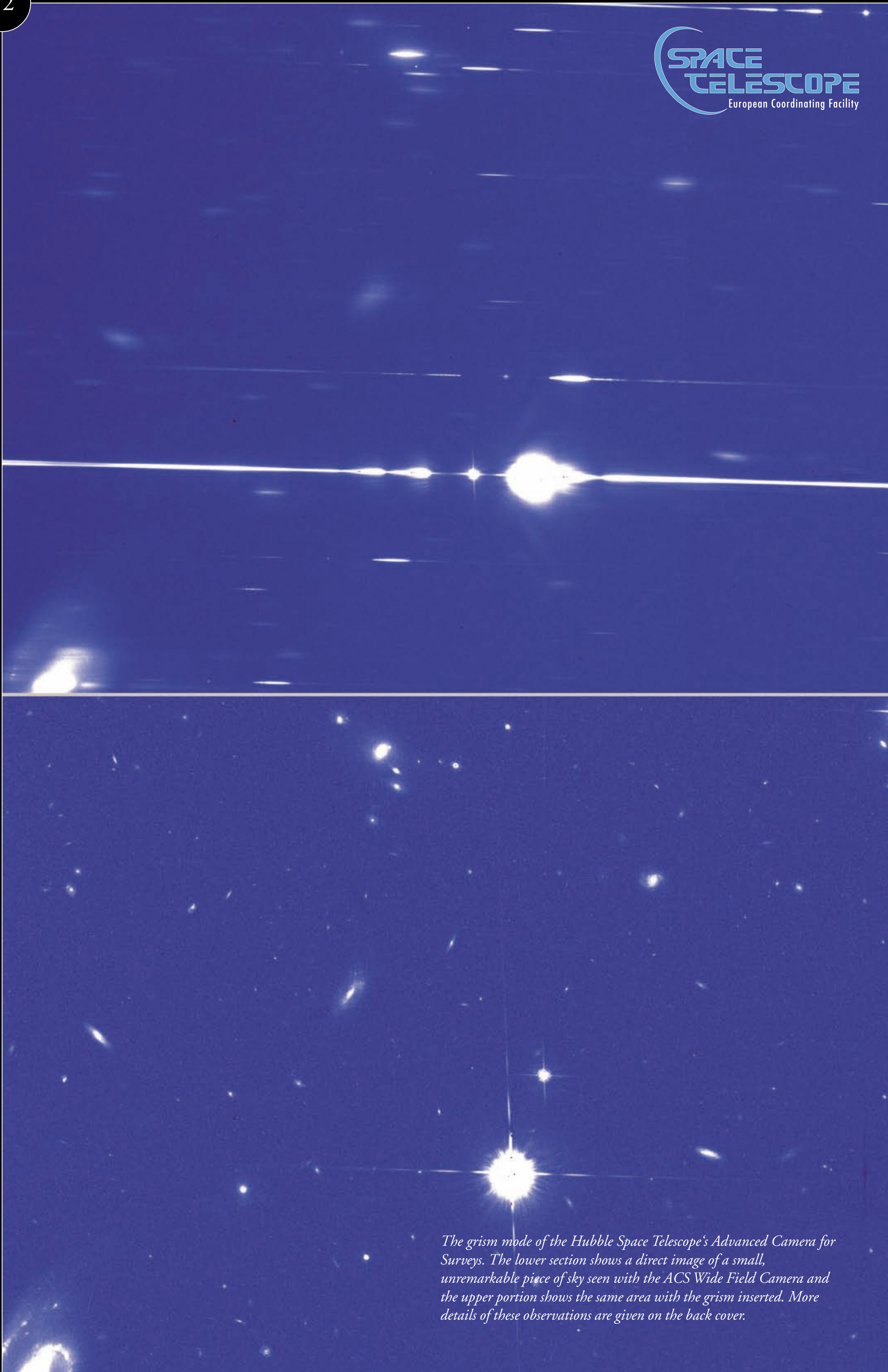
November 2002

ST-ECF Newsletter



James Rhoads and the APPLES team

The grism mode of the Hubble Space Telescope's Advanced Camera for Surveys. The lower section shows a direct image of a small, unremarkable piece of sky seen with the ACS Wide Field Camera and the upper portion shows the same area with the grism inserted. More details of these observations are given on the back cover.

HST News and Status

Jeremy Walsh

Hubble has been performing almost faultlessly since the last servicing mission, SM3B in February 2002. Orbital verification has proceeded very smoothly and is now formally complete.

The infrared camera and spectrometer, NICMOS, now cooled by the newly installed NCS Cryocooler, has reached a detector temperature of about 77K, at which level the quantum efficiency is actually higher than during its former solid nitrogen operation whilst the dark current is only slightly worse. At the J and H bands NICMOS is now more sensitive than previously and all the modes have been recommissioned. An article in this Newsletter by Wolfram Freudling describes the recommissioning of the NICMOS grism mode.

The new Advanced Camera for Surveys (ACS) has been producing much high quality science since its recent installation. The quantum efficiency of its Wide Field Channel (WFC) CCD detectors in the red (5000-8000Å) is above the pre-flight predictions. The Great Observatories Origins Deep Survey (GOODS) has been collecting public ACS imaging data in the Chandra Deep Field South region and a series of data releases has already begun. The sensitivity of the ACS slitless mode in a space environment that is free from a high variable atmospheric background has surprised some when used with the grism for spectrometry of point sources. Both the wavelength calibration and flat fielding of this mode, supported by the ST-ECF, are described in this Newsletter. Even though the WFC grism spectral resolution is low (about 100 for two pixels), this mode can be used to determine the redshift of supernovae Type Ia in the redshift range 1–1.5 directly, making it particularly interesting for cosmological studies of the expansion properties of the Universe.

The remaining instruments – WFPC2, STIS and FGS – continue to perform well. Improvements in the calibration of all instruments, including WFPC2, which celebrates ten years in orbit next year, were discussed at the recent HST Calibration Workshop. One major problem that has emerged and afflicts all the instruments with CCD detectors (viz. ACS, WFPC2 and STIS) is charge transfer inefficiency that progressively degrades in the harsh in-orbit radiation field.

The Cycle 12 Call for Proposals for observing time on Hubble has been released with a deadline of January 24th 2003. The observatory now has the most comprehensive and powerful set of instrumentation in its history.

NGST News

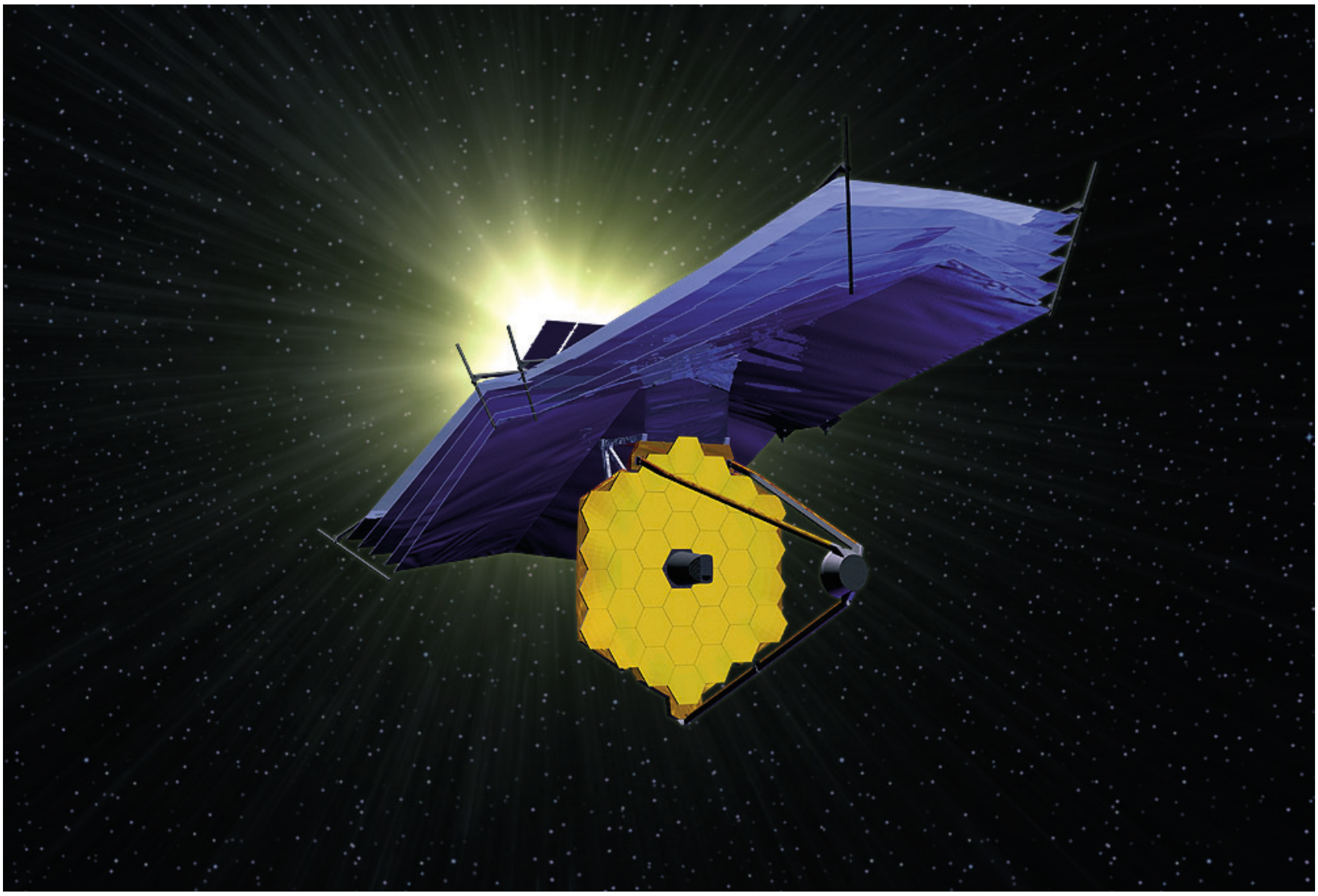
Robert Fosbury, Gillian Wright (ATC) & Peter Jakobsen (ESTEC)

On September 10th 2002, NASA announced that TRW (TRW Space & Electronics; Ball Aerospace & Technologies Corp.; Eastman Kodak Company) would be the prime contractor for the design and fabrication of the NGST deployable primary mirror and spacecraft. Under the terms of an M$824.8 contract, TRW will also be responsible for integrating the science instrument module into the structure and for performing the ground and on-orbit testing of the observatory. The contract was placed on the basis of a launch in June 2010. Just before this Newsletter went to press TRW released public papers describing the observatory architecture and its expected performance. The design includes a hexagonally-segmented primary mirror of 7m edge-to-edge diameter with an area corresponding to a 6.1m aperture. Further illustrations from these papers are shown opposite.

Following high-level reviews of and by the NGST project at the Goddard Space Flight Center, it was decided by NASA that ESA would not, after all, provide the spacecraft bus as part of its contribution. Consequently, ESA is now engaged in the process of selecting an alternative contribution. A number of options were discussed at the November 2002 meeting of the ESA Science Programme Committee and it is anticipated that a final decision on the suite of instrument and non-instrument contributions will be made by ESA in February 2003.

The two competitive definition phase studies of the near-infrared spectrograph, NIRSpec are continuing within the consortia led by Astrium GmbH and Alcatel Space. The final presentations of both studies will be given at ESTEC in mid-February 2003.

The mid-infrared instrument (MIRI) project has made considerable progress over the summer. The MIRI consortium successfully completed a Phase-A study sponsored by ESA and there was a parallel European industrial study of a solid H_2 cryostat to cool the MIRI optics and detectors to about 7K. A final presentation took place at ESTEC in September with the European and US (JPL) teams present. The technical feasibility of MIRI on the observatory has been conclusively demonstrated by these studies. The MIRI design resulting from phase-A has the following capabilities: 5-27µm imaging with a selection of 12 filters, R~100 spectroscopy from 5-10µm, coronography at 5, 10 and 15 µm and R~3000 integral field spectroscopy with a



TRW/BALL/KODAK

Fig. 1: An Artist's concept of the James Webb Space Telescope (JWST). In the centre of the drawing the 7 m diameter primary mirror composed of 36 semi-rigid hexagonal segments is seen. The deployable, multi-layer sun-shield maintains the telescope at very stable cryogenic conditions.

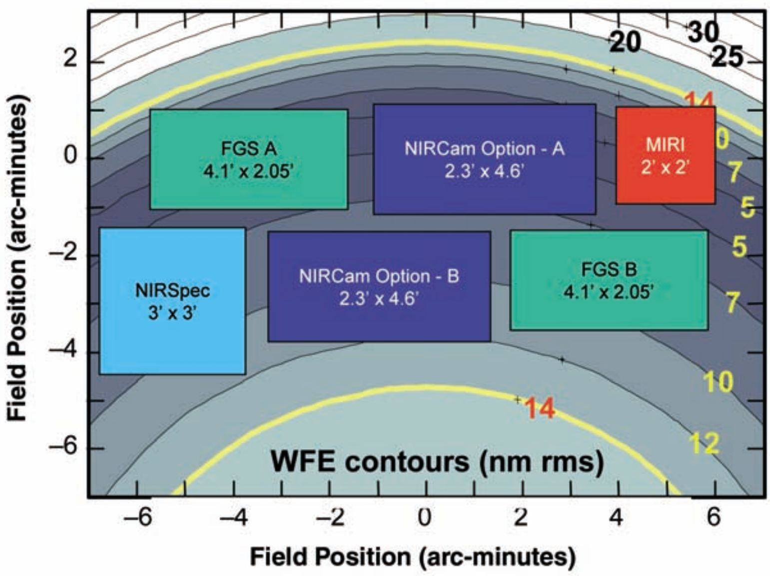


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Fig 2: Example of the instrument focal plane, populated by the science instruments and the fine guiding sensor. The design residual wavefront error (WFE) is shown in the background.

3-7 arcsec field of view. The MIRI team are currently working on adapting the instrument to the real telescope and science instrument module and completing the consortium formation. There is a web page with some general information about MIRI and MIRI science at: http://ircamera.as.arizona.edu/MIRI/

NASA have decided to rename the NGST as the JWST. This is recognition of the Agency's second administrator, James E. Webb, who led the Apollo missions in the 1960's and was responsible for starting a vigorous science programme.

Wavelength Calibration of the Wide Field Channel Grism of ACS

Anna Pasquali, Norbert Pirzkal & Jeremy Walsh

The Advanced Camera for Surveys (ACS) was installed in HST during Servicing Mission 3B in March 2002. All three of the instrument's cameras have extensive imaging facilities and are also equipped for slitless spectroscopy. The Wide Field Channel (WFC), with a field of 3'.4 x 3'.4 and spatial sampling of 0".05/pixel has a grism mode working from optical wavelengths to 1 micron; the High Resolution Channel (HRC; field of 26" x 29" with a pixel size of 0".025 x 0".028) provides both a prism for spectroscopy in the range near UV to optical and a grism for visible-to-1 micron slitless spectroscopy. Finally the Solar Blind Channel (SBC; field of 31" x 35" and a pixel size of 0".030 x 0".034) has a UV prism.

Slitless spectroscopy only works well if there is good contrast against the background sky. Here the ACS grism mode on HST is particularly effective, especially when using the WFC grism in the far red and for small or point-like objects. From the ground the sky background in this wavelength range is brightened dramatically by a forest of constantly changing atmospheric OH spectral features that strongly limit what can be achieved, particularly at low resolution on faint objects. ACS, on the other hand, delivers a stable, diffraction-limited point-spread function with a high total throughput that is dispersed onto the dark background seen from orbit. As a result the ACS grisms are highly competitive and are already delivering impressive new science, such as the spectra of high redshift supernovae. The wide field also means that the grism mode may be effectively used for surveys where it is especially sensitive to emission line objects. Such a survey, known as APPLES (PI: James Rhoads, STScI with the authors of this article as CoIs), and conducted as a Hubble parallel programme, has already started. The cover image of this Newsletter shows a typical APPLES dataset consisting of a direct i-band image (lower) and grism exposure (upper) of a blank field.

The ST-ECF is responsible for the support of the spectroscopic modes of ACS in addition to its strong scientific involvement. This support work is mainly focussed on the provision of wavelength and flux calibrations and the aXe software for the spectra extraction. aXe has been described in earlier Newsletter articles and here we concentrate on describing how the wavelength calibration is performed and showing the results.

The Observations

The very first calibrations of the grism element in ACS were carried out during the Servicing Mission Orbital Verification (SMOV) at the end of April and beginning of May 2002. The calibration strategy has been extensively described in the 2002 January issue of the ST-ECF Newsletter. Here we will just highlight the key points. The high spatial resolution of the WFC and the HRC mean that grism spectroscopy with no slit can be accurately calibrated using a point-like source:

- whose brightness is high enough to allow short exposure times;
- whose optical spectrum shows a significant number of unresolved emission lines;
- that is not associated with a circumstellar nebula that might degrade the spectral resolution;
- that is not significantly variable so emission lines can be detected at any epoch;
- that does not lie in a crowded field, thus avoiding spectral overlap;
- that is visible as long as possible to enable repeated HST visits.

Wolf-Rayet (WR) stars of the WC subtype (ie, with an optical spectrum dominated by C and He emission lines) meet all the above criteria, provided their stellar wind speed is lower than about 2000 km/s to avoid degradation of the spectral resolution.

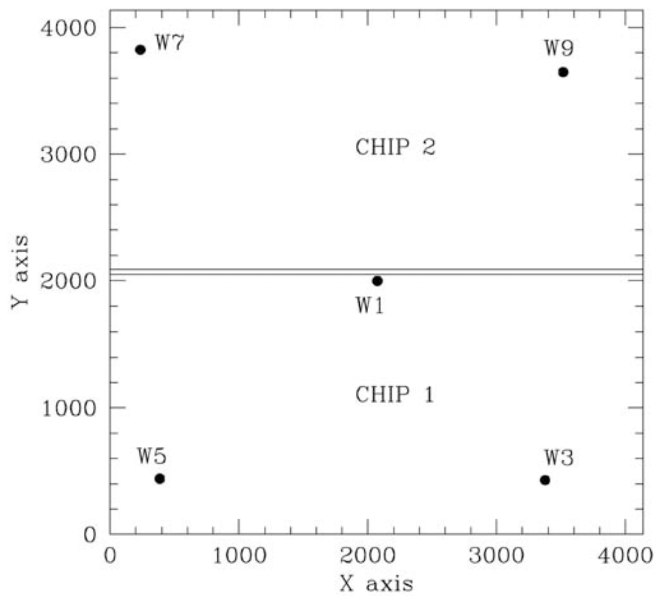

Fig 1: Map of the pointings used for WR45 in the WFC aperture.

The WFC observations were performed for the Galactic Wolf-Rayet star WR45 (V = 14.8, van der Hucht 2001) by acquiring a pair of direct and grism images at five different positions in the field of view as illustrated in Figure 1. The exposures were eventually repeated 2 to 4 times in each pointing to check the stability of the filter wheel positioning. Each direct image was taken in the F775W filter and, in some cases, also in the F625W filter, to check whether the position of the target in the direct image is independent of the selected filter. An exposure time of 1s was chosen for a S/N ratio of about 30. The grism exposure time was set to 20s in order to achieve a S/N ratio in the lines larger than 15 in all the grism orders between minus three and plus three.

The Data Extraction

The spectra were first examined to derive the tilt of the spectrum with respect to the image X axis and as a function of position in the field of view. Figure 2 shows how the tilt varies

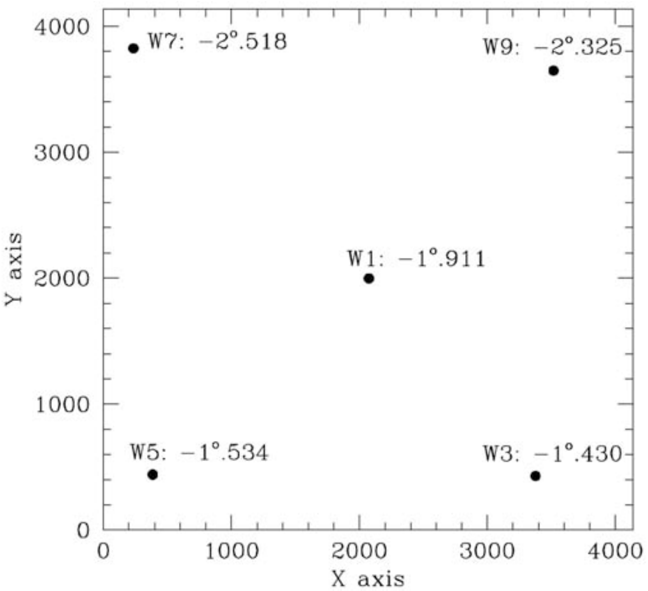

Fig 2: Map of the spectrum tilt in the WFC aperture.

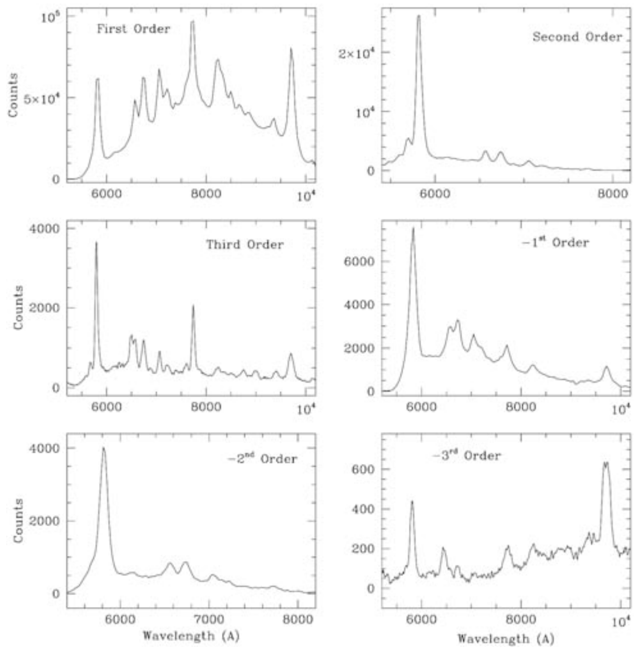

Fig 3: The extracted grism spectra acquired for WR45 at the centre of the WFC aperture (position W1). Six orders are plotted, from the negative third to the positive third.

across the chips. While its mean value across the field is -1.94 degrees, the tilt decreases by 1.1 degrees from the top left to the bottom right corner and by 0.8 degrees from the top right to the bottom left.

Shifts in the X and Y coordinates between the target position in the direct image and the position of its zeroth order in the grism image were measured for each pointing. These are the parameters that are used to identify a spectrum in the grism image once the position of the target in the direct image alone is specified. They turn out to be field-dependent as well.

A catalogue of objects was then created for each pointing, containing the coordinates of the target in the direct image and its FWHM along the X and Y axes (typically 2 pixels). The object size along the Y axis sets the width of the extraction aperture in the grism image. In addition a configuration file was written for each pointing, where the spectrum tilt, the X and Y shifts and a possible wavelength solution were specified so that spectra could be extracted in units of either pixels or Ångstroms. The raw data, the object catalogue and the configuration file were then processed with the spectra extraction code aXe (Pirzkal et al. 2001).

The Method

Wavelength solutions had been already derived from the data acquired during ground tests using a Helium/Argon arc lamp. Therefore, the spectra of WR45 were calibrated in wavelength using the ground test results and the FWHM of their emission lines was measured. The high resolution spectrum obtained for WR45 with NTT/EMMI (Pasquali et al. 2001) was convolved with this FWHM value and the emission lines in its degraded version were identified, again producing a wavelength table for cross-identification with the ACS spectra and fitted against the line peaks in pixels in the ACS extracted spectra. The POLYFIT routine in IRAF was used to fit the wavelength solutions, which rely on a set of 7 lines in the grism first, third and negative first orders, or 3 to 5 lines in the second, negative second and third orders. Fits were performed using a second order polynomial in the case of the grism first order, while a first order polynomial was adopted for the higher positive orders and negative orders of the grism.

Figure 3 shows the final extracted spectra of WR45 as observed at the centre of the WFC aperture (position W1). The spectra are background subtracted and calibrated in wavelength; their units are counts vs. Ångstroms. We have plotted six orders, from the negative third to the positive third, but excluding the zeroth.

The Effective Dispersion of the WFC/Grism Configuration

We modelled the dispersion relation of the first order of the WFC grism as a quadratic function of the offset distance measured in pixels in the X direction along the spectrum from the position of the object in the direct image. The dispersions were found to be in the range 35 - 44Å/pixel and the wavelength zero points around 4800Å. The typical uncertainties are of 0.12Å/pixel on the dispersion and 5Å on the zero point. The average RMS of the fits is 3Å.

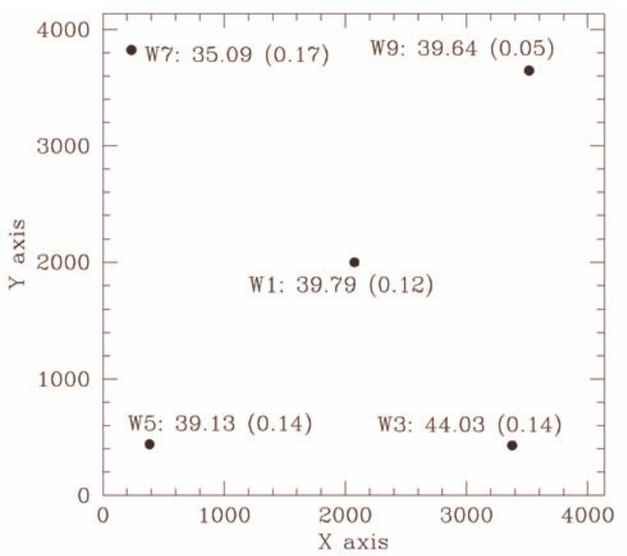

Fig 4: Map of the grism first order dispersion in the WFC aperture.

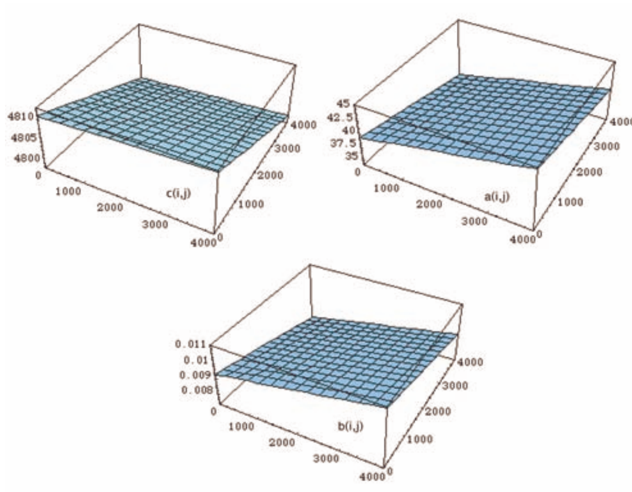

Fig 5: The parametrised field dependence of the wavelength solution for the two ACS WFC chips together. The dispersion term of the solution is shown at the upper-right, the zero-point at the upper-left and the small quadratic coefficient below.

Figure 4 visualises the field dependence of the dispersion. There is clearly a large variation along the diagonal from position W7 to W3 – it varies by 11% with respect to the value in W1 from the centre of the field to both corners. This is also the direction of the geometric distortions as measured in imaging mode. No trend can be recognised either along the diagonal from position W5 to W9, or in the second-order term of the dispersion and the zero point of the wavelength solutions.

We have also fitted a wavelength solution to the other orders and the results will be made available in the appropriate instrument science report. In these cases there was only enough data to perform a linear fit.

The Calibration Files for aXe

The field dependence of the dispersion correction as determined from pointings W1, W3, W5, W7 and W9 has to be parametrised in order to extract calibrated spectra at any position within the WFC aperture. We have therefore derived a two-dimensional fit for each of the parameters of the wavelength solution, where the parameter is a function of the (X,Y) coordinates of the target in the direct image. Given the limited number of positions acquired in the field these 2D fits have been performed, adopting first order polynomials, so that the field dependence of the wavelength solution is now represented with a plane.

An example of this procedure is shown in Figure 5, where the 2D plane of the first order dispersion is plotted for both chips of the WFC. These planes are part of the calibration database that accompanies the spectra extraction software aXe (Pirzkal et al. 2001).

The Next Step

The goal of subsequent calibration programmes is to increase the number of pointings within the field of view of the WFC, so that a finer grid of local wavelength solutions can be used to derive a more accurate parametrisation of the field dependence of the dispersion correction.

This new grid will improve the flux calibration of the grism, as the field dependence of the grism throughput will also be modelled by interpolating the local responses, derived from spectra of a spectrophotometric standard star, as a function of the (X,Y) position of the targets in the direct image.

References

- *van der Hucht, K.A., 2001, "The VIIth catalogue of galactic Wolf-Rayet stars", New AR, 45, 135*

- *Pasquali, A., Pirzkal, N., Walsh, J.R., 2001, ST-ECF ISR ACS 2001-04, "Selection of Wavelength Calibration Targets for the ACS Grism" (http://www.stecf.org/instruments/acs/pub)*

- *Pasquali, A., Pirzkal, N., Walsh, J.R., 2002, ST-ECF Newsletter, 30, 4*

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Flat Fielding of ACS WFC Grism Data

Norbert Pirzkal, Anna Pasquali & Jeremy Walsh

The effective sensitivity of the CCD detectors in the Advanced Camera for Surveys is not uniform. In the direct imaging mode a broadband flat field can easily be applied to an image to correct this effect. However this flat field is not just field dependent, but also wavelength dependent and this puts a limit on the accuracy of the flux calibration of extracted grism data. Both the position of the pixel on the detector and also the wavelength of the light falling on each pixel must be taken into account to "flat field" grism data. The effect of the wavelength dependent flat field is demonstrated by observations of a flux calibrator taken at different positions in the WFC. Wavelength dependent flat field models using ground-based narrowband and in-orbit broadband flat field exposures have been constructed and the results of applying these to WFC grism data are presented.

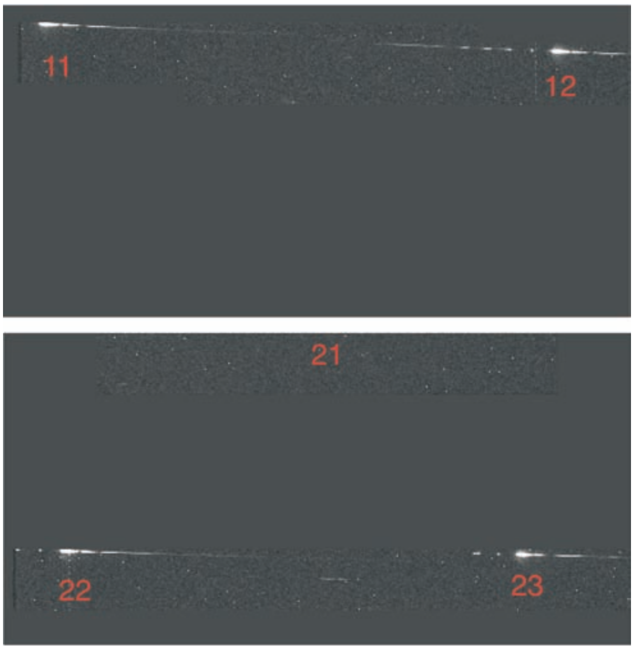


Fig 1: Mosaic of the five G800L observations of the White Dwarf GD153. Note that the first order of the dispersed spectrum is only fully available in two positions: top and bottom right.

White Dwarf Observations

The standard white dwarf GD153 was observed at five different positions on the ACS WFC detector during Servicing Mission Orbital Verification (SMOV) and the results were read out using ACS sub-arrays. Unfortunately the target position did not always end up at the centre of the aperture. This is illustrated in Figure 1, where the 5 observations of GD153 have been placed on a larger ACS image. The first orders of the spectra at positions 12 and 23 are almost fully within the apertures, while spectra at positions 11 and 22 are both too high in the sub-array and are slightly truncated at wavelengths bluer than about 7500Å. The spectrum was completely outside the aperture at position 21.

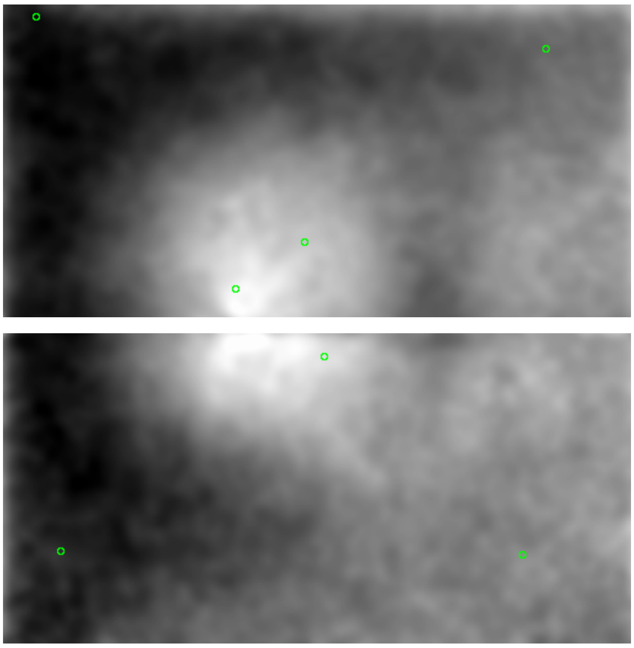


Fig 2: Narrowband flat field image showing the locations of the points where the wavelength dependence of the flat field was determined and plotted in the accompanying figures.

However, the spectra at positions 11 and 22 are truncated in nearly the same manner and can therefore still be used to check the effect of flat fielding between these two positions. For wavelengths greater than 7500Å they can be directly compared to the rest of the spectra.

Narrowband Ground Flat Variations

Narrowband flat fields were obtained using a monochromator before launch for both the HRC and the WFC. These were obtained primarily to facilitate the later modelling of the effect of fringing in the HRC and the WFC. However, these flat fields

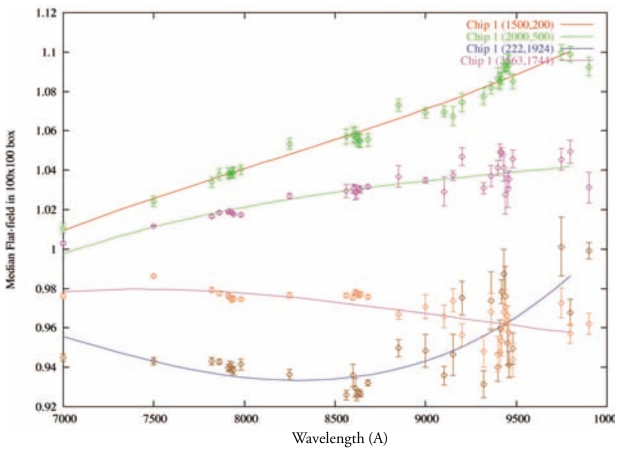


Fig 2a: Chip 1 variation of the flat fielding as a function of wavelength as measured using the pre-launch WFC narrowband flats.

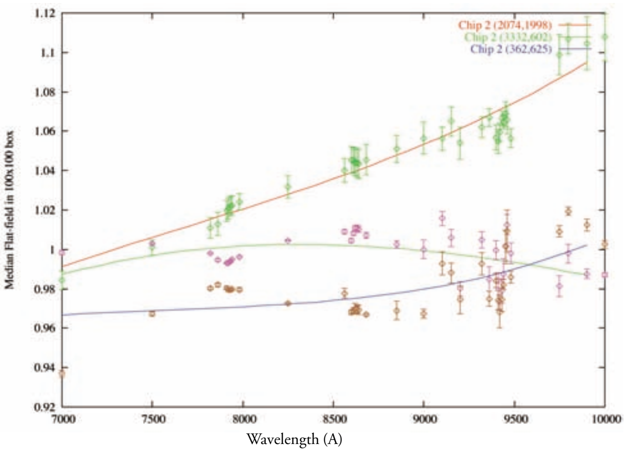


Fig 2b: Chip 2 variation of the flat fielding as a function of wavelength as measured using the pre-launch WFC narrowband flats.

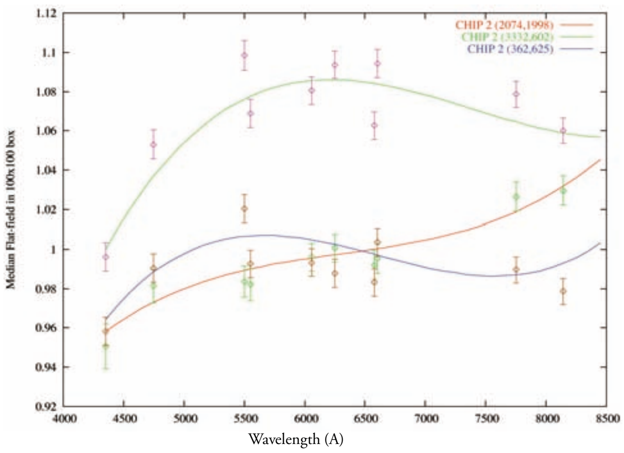


Fig 3b: Chip 2 variation of the flat fielding as a function of wavelength as measured using the latest in-orbit WFC broadband flats.

can also be used to examine the wavelength dependence of the flat fielding.

The data presented here were derived using all of the narrowband flats after they were smoothed to remove the effect of fringing, and normalised over a suitable region. Several 100 x 100 apertures were selected on chips 1 and 2 and the mean flat fielding value in each aperture was computed for each narrowband flat. The positions on the chips and the resulting measurements of the variation of the flat fielding as a function of wavelength are shown in Figure 2 and associated plots, shown in Figures 2a, 2b, 3a and 3b. The error bars indicate the standard deviations of these measurements.

Looking at these plots one expects any flat fielding correction to be both wavelength dependent and to be different on different parts of the chip. However, the variations shown appear relatively smooth and can be well fitted using low order polynomials (3rd order fits are plotted). Note that, as luck would have it, positions 12 and 23 shown in Figure 1 – where we have un-truncated spectra of our calibration white dwarf – correspond to areas on the detector that are relatively wavelength independent. Other positions however, show as much as a 10% variation of the flat fielding coefficients as a function of wavelength in the region between 7000 and 9000Å.

In-orbit Flat Field Variations

New in-orbit flat fields were recently constructed using observations of globular clusters. These flat fields are broadband flats in the sense that they were created for the filters on board the ACS/WFC. These filters have bandpasses significantly larger than those used on the ground with the monochromator. However, they offer another opportunity to study the wavelength dependence of the WFC flat fields. We have fitted a 3rd order polynomial as a function of wavelength at each pixel of the in-orbit flat fields, as discussed in the case of the narrowband ground flats above (Figures 3a and 3b). The in-orbit flats are believed to be more reliable than the ground-based narrowband flats because the latter might suffer from a variation

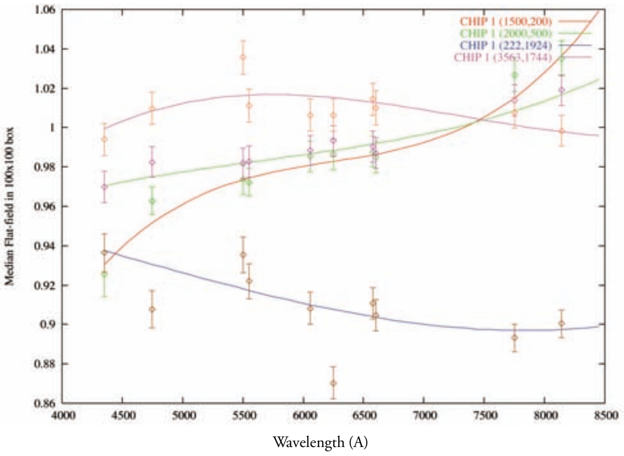


Fig 3a: Chip 1 variation of the flat fielding as a function of wavelength as measured using the latest in-orbit WFC broadband flats.

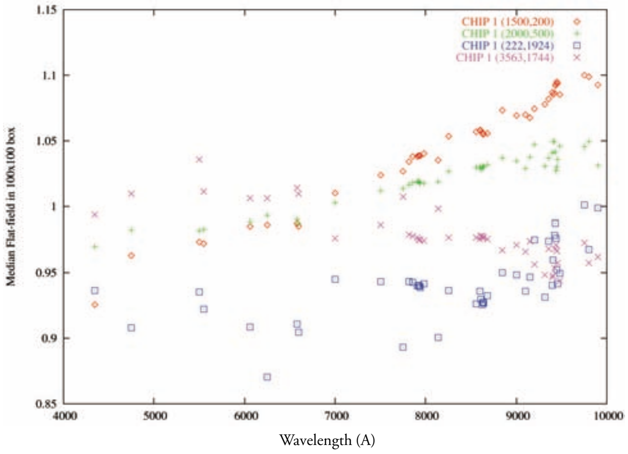


Fig 4a: Pre-launch narrowband flat field and in-orbit broadband flat field wavelength dependence for Chip 1. At most positions the two appear to be compatible.

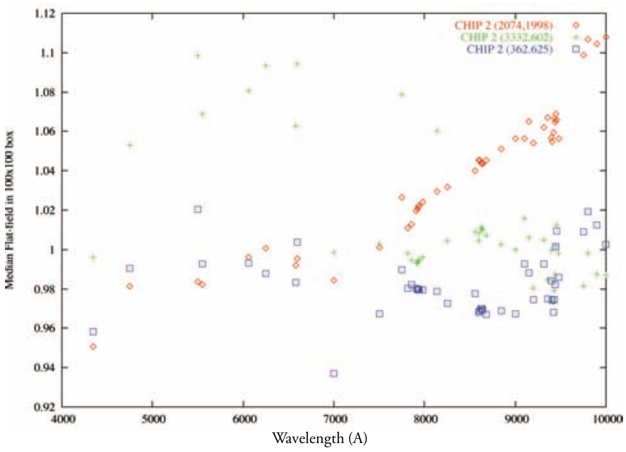


Fig 4b: Pre-launch narrowband flat field and in-orbit broadband flat field wavelength dependence for Chip 2.

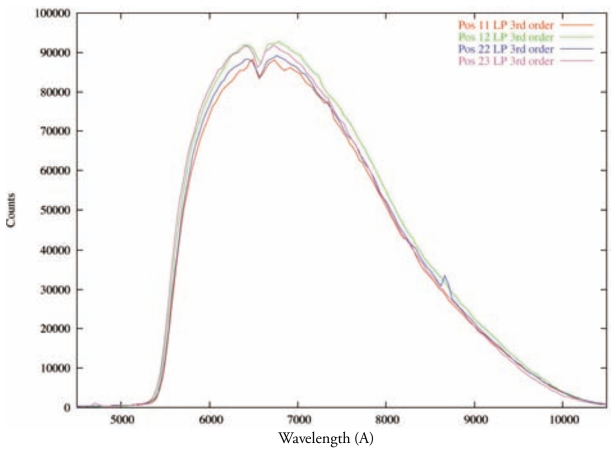


Fig 6: aXe extracted, flat fielded spectra of the white dwarf GD153 using a 3rd order polynomial model of the wavelength variation of the flat field at each pixel.

across the field of the illumination pattern. Unfortunately, the in-orbit flats do not sample the wavelength dependence of the flat field very well because only a limited number of filters are available and none reach wavelengths greater than about 9000Å. Figures 4a and 4b show the match between the ground-based and in-orbit flats for the two WFC chips at the positions in Figure 2.

aXe Extraction

aXe is the grism extraction software package developed at the ST-ECF. It was used to extract the spectra shown in Figure 1. The results are shown in Figures 5 and 6. The latest wavelength calibration at each of the five positions was applied and the white dwarf absorption features in each of the extracted spectra are well aligned. A first raw extraction was performed without applying any flat fielding and the resulting spectra are plotted in Figure 5. While the absorption feature is well aligned between all four usable spectra, there is a significant discrepancy in the flux measured at each position on the detector. Recall that the spectra at positions 11 and 22 are actually partially truncated and that while they should be consistent with one another they are expected to yield lower numbers of counts than the spectra at positions 12 and 23.

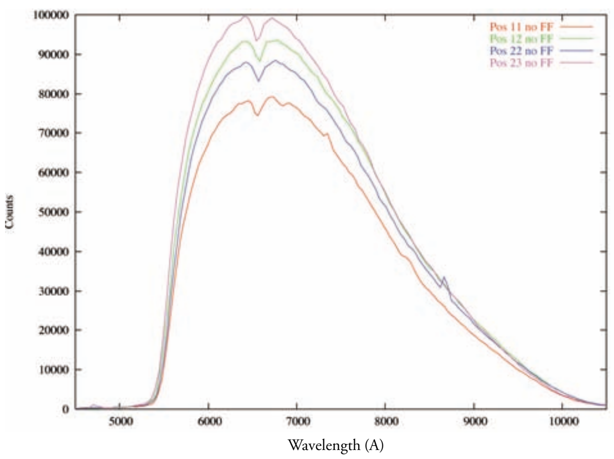


Fig 5: aXe extracted, non flat fielded spectra of the white dwarf GD153. Significant flux disagreement is evident.

A second extraction was performed using a 3rd order flat fielding model derived from the in-orbit broadband/filter flat fields (shown in Figure 3). The result of this flat fielded extraction is shown in Figure 6. Spectra at positions 11 and 22 agree well, as do the spectra at positions 12 and 23. The difference in flux between the two pairs of spectra is the result of the truncation of the spectra at positions 11 and 22 mentioned above and visible in Figure 1.

Unfortunately, the GD153 WD spectra at positions 12 and 23 do not necessarily offer a robust test of our flat field wavelength dependence model. While our flat fielding models appear to fit the wavelength variation of both the ground and in-orbit flat fields, positions 12 and 23 do not suffer much from flat fielding variation as a function of wavelength. Hence these could be equally well flat fielded using a non-wavelength dependent model of the flat field, or even by applying a broadband filter such as F814W. However, as shown in Figure 4, the narrowband ground flats and the new in-orbit flats clearly show that a much larger wavelength dependence exists at different locations on the detector and that this must be taken into account if one wishes to consistently achieve a spectral flux calibration accuracy better than 10% over the entire field of view of the ACS WFC.

Performance of NICMOS and the NICMOS Grisms after installation of the Cryocooler

Wolfram Freudling

The Near Infrared Camera and Multi-Object Spectrometer (NICMOS) was originally installed in HST during the second servicing mission and was the only Hubble instrument able to observe at wavelengths longer than about 1 micron. Unfortunately a thermal short meant that its coolant (a block of solid nitrogen) was exhausted sooner than expected and the instrument became inoperable. A special external cooling system was designed and built to restore its performance. This system circulates very cold neon gas through the instrument and brings its temperature back into the regime where it could again function.

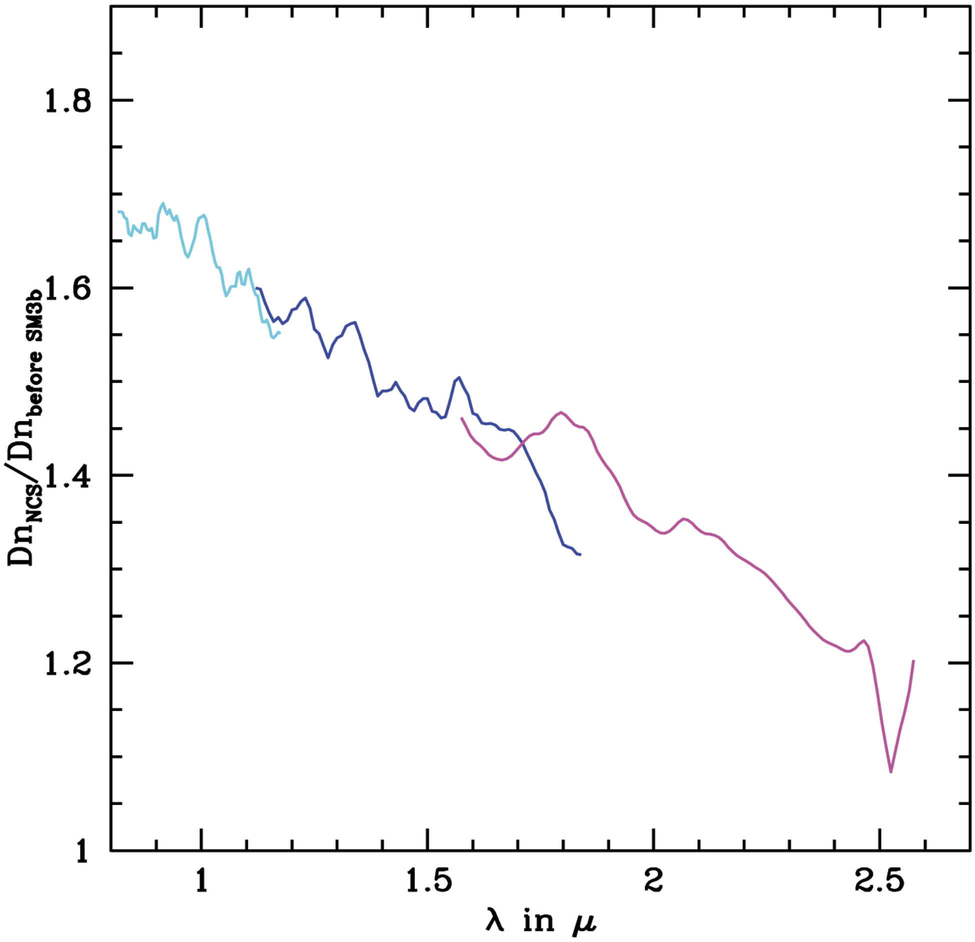


Fig 1: The relative sensitivity of NICMOS with the cryocooler.

Since the successful installation of this so-called NICMOS Cryocooler (NCS) during the last servicing mission the NICMOS detectors have been cooled to a stable temperature of about 77K. This compares to a temperature of 63K when NICMOS was cooled by a cryogen before the installation of the cryocooler. The higher operating temperature has an impact on the performance of NICMOS. The linear dark current is about 50 to 70% higher, leading to more noise in the images. This is partially offset by the higher quantum efficiency (QE) of the detectors. The gain in QE as a function of wavelength is demonstrated in Figure 1. It compares the total count rate per flux in cycle 7 (when the instrument was cooled by the original cryogen) and 11 (when the new cryocooler was in use) as a function of wavelength for NICMOS camera 3. The data have been measured with the 3 NICMOS grisms.

Not only is the average QE higher, but also the variation of the QE is smaller, ie, the flat fields are "flatter". This in turn leads to better calibrated images. Another change in the performance of NICMOS is caused by the change in focus positions. The foci of the higher resolution cameras NIC1 and NIC2 moved slightly closer together. Therefore, imaging that uses both cameras simultaneously is now better in focus. In addition, the camera with the largest field of view, NIC3, can now be better focused, although its optimal focus position is still out of reach of the focusing mechanism. However, the loss of flux within the centre pixel of the PSF is now close to negligible.

ST-ECF continues to support the NICMOS grism mode. New calibration data for flux and wavelength calibration are available. The intra-pixel response function imposes a wavelike pattern on the raw extracted spectra. The amplitude of this effect has changed due to the shift of the NIC3 focus position. New models of this effect have been derived. The combination of more calibration data, better support in the control software for obtaining pairs of undispersed and grism images, flatter flat fields and the shifted focus position of NIC3 significantly improves the spectrophotometric accuracy achievable with the NICMOS grisms.

The NICMOS specific IDL spectrum extraction software package NICMOSlook is available at http://www.stecf.org/nicmoslook/. The latest version 2.12.0 includes the new NCS flat fielding and calibration data and supports automatic selection of the best calibration data for a given observation.

Communicating Science: A Case Study – The Hubble Space Telescope

Lars Lindberg Christensen

The NASA/ESA Hubble Space Telescope is one of the most successful scientific projects of all time, both in terms of its scientific output and in terms of its public appeal. The scientific success needs no explanation for readers of this Newsletter. In this article we discuss the reasons why Hubble is also such a highly effective and successful means of science communication and describe the workings of the Hubble science communication office in Europe. We also present a short introduction to the practical experience of communicating science that stems from this work.

Introduction

Astronomy plays a special role in the field of natural science communication. It covers a very broad area of research with instant photogenic appeal and a scale and scope that go far beyond our daily lives to stimulate the imagination. As one of the greatest adventures in the history of mankind, space travel continues to hold the interest of the general public. Many of the phenomena we observe in the near and distant Universe have the necessary 'Wow!' factor beloved of Hollywood. Space is an all action, violent arena (admittedly on rather large scales in terms of time and space), hosting many exotic phenomena that are counter-intuitive, spectacular, mystifying, intriguing, dazzling, fascinating.... The list of adjectives is almost endless. There is a large element of discovery in astronomy as the field is extremely fast moving, delivering new results on a daily basis.

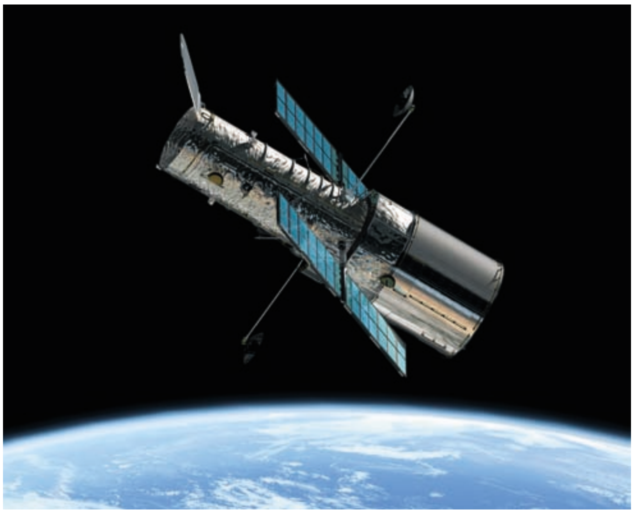
On top of all this, astronomy touches on some of the largest philosophical questions of the human race. Where do we come from? Where will we end? How did life arise? Is there life elsewhere in the Universe?

The Hubble Space Telescope is one of the most well-known and high profile of all scientific projects. The main reason for this is naturally the excellent scientific results coming from the telescope, but a very dedicated and meticulously planned strategy for the communication of its results to the general public has also been a key factor in the success of the project. Before looking in detail at science communication related to Hubble we will look briefly at the subject in a wider arena.

Science communication in general

Science communication is a multi-faceted field and is known by many names: outreach, PR, or scientific marketing. Sometimes education is defined as being part of this, sometimes not. Science communication is a bridge between the scientific community and the wider world, providing examples of scientific success stories to society at large and supporting the educational use of scientific products. One of its main tasks is to publicise the presence of the natural sciences in all aspects of society and our daily lives. In our opinion, increased public scientific awareness is in the interest of scientific organisations, scientists, decision-makers and society at large.

Science communication addresses many different and obvious target groups:



ESA

Fig. 1: Artist's impression of the Hubble Space Telescope.

* The general public
* Pupils, students
* Decision makers
* Mediators: media representatives, teachers etc.

Informing experts such as scientists and others with specialised knowledge, for example, amateur astronomers, can also be very useful as they can act as mediators or may themselves have political influence.

Communicators have used a number of different methods or communication products for different occasions and/or different target groups, for example:
* Press releases
* Brochures
* Public talks
* CD-roms
* Web texts, images and animations
* Educational material and courses
* Television videos
* Exhibitions
* Press conferences

Typical Production Workflow

To illustrate just how science communication works the production phases for a typical product, for example, a press release, a brochure or a CD-rom will be described. The production can be perceived as a chain with a number of links (numbered 1-9 below).

1. Market research

Researching the market where the products are to be 'sold' is vital. It is necessary to understand both the marketing environment and the habits and motivations of the target groups. Communication is a highly result driven field and our customers – the 'consumers' – decide when, where, how and why our products will be 'purchased'.

2. Planning
Based on an understanding of the marketing environment, a feasibility analysis will clarify the details of the production, for example, the right choice of medium. The optimisation of limited resources such as time and money is a key concept.

3. Written communication
Although the different phases of the physical production are often carried out in parallel, the text remains the backbone. Multiple layers of text, such as a summary, main text and supporting fact sheets are recommended and make it possible to aim material at several target groups at once. However it is not always possible to make 'layers' depending on whether the product is multi-stringed (for example, an exhibition) or single-stringed (a video script). Different consumers need material with differing levels of detail and terminology, but there is always a balance between being too broad ('messy' and over-generalising) and too narrow (addressing too few). As an example, a well-written press release should be accessible and readable for the inexperienced journalist as well as look exciting enough to entice the battle-hardened 'seen-it-all before' expert journalist. In communicating science there is always a built-in conflict between scientific correctness and the simplification necessary to obtain the public interest ('sexiness'). This is where a good science communicator will excel through good judgement and a broad overview of the field.

4. Visual Communication
Images, illustrations and design are often key factors in the success. The effort here can hardly be overemphasised. It is necessary to have an elegant, simple and appealing packaging design for the product. The ability to brand a science project calls for consistent design and thoughts about what makes the project special – finding its PR-niche.

5. Scientific/Political Validation
Scientific correctness is one of the most basic prerequisites of the field and an all-round scientific knowledge is mandatory for the expert communicator. It is necessary for the communicator to be able to interpret diverse science results from many different fields. Scientific correctness enables the successful communication department to maintain the confidence of mediators and to gain the trust of scientists who rely on a fair and expert treatment of their hard-earned scientific results. For an end-user such as the general public, quality communication will mean enlightenment and a 'fair' insight into technical areas not normally accessible to the layman. A validation of the scientific content of a product is a necessary step in the process, but needs to be handled very smoothly in order not to exceed the limited time available for the completion of a given product.

6. Technical Production
To make the final product a success it is necessary to have a relatively high degree of 'technical autonomy'. A communication department needs to be able to answer the fast-moving and dynamically changing needs of the consumers (e.g. the press). Depending on the product, advanced technology is used. Media such as video and 3D animations for TV are technology- and resource-heavy, but also have a very high impact when successful.

7. Distribution
Many means can be chosen to fight the battle to be heard and often several of them are employed in parallel: direct mailing, e-mailing distribution lists, faxing, phone etc. Mediators, including the news media, teachers and other educators are vital channels of distribution as they help to disseminate the communication products directly, thereby acting as a link connecting communicators and consumers. Communicators need amplifying outlets to reach a larger audience. To reach the widest range of different target groups there may need to be several different adaptations of the product at varying levels of complexity. The communicator can inspire *interest* and thereby raise the public *awareness* about science, but the *understanding* takes more effort and the time-consuming effort of mediators such as teachers and lecturers are extremely valuable in this process.

8. Promotion/Advertising
Interaction and links with the media are vital. The best link is direct, personal contact, but the web can also serve as an advertising banner for the products. However, the usefulness of the web should not be overestimated as it takes work on the consumer side to retrieve or 'pull' the product from the web. Expert availability (the scientist and the communicator) is important to promote the product and to serve journalists with further information and quotes.

9. Evaluation
A long-term strategic marketing plan is necessary to secure a smooth production flow for future products. Part of this is to establish some success metrics and to evaluate the product after completion. It is undeniably very difficult to quantify successful science communication: What defines a success? Is it the 'importance' of the medium? The number of readers? The type of readers? Web hits/downloaded Gigabytes? Most often it is a complex mix of all these factors. A rigorous statistical investigation of the impact is appropriate to determine the success of a given product, but due to the limited resources available for communication an intuitive/subjective understanding of the market response can also play a major role. This impact estimate can only be made if a very close contact to the target groups is maintained. A sporadic monitoring of the impact, ideally spanning a few years, will enable an intuitive understanding of which products and approaches or angles are most effective.

Science Communication in Europe

Currently we are facing a huge problem in Europe: media and public interest in science and technology is waning and the number of students pursuing science at higher educational institutions is decreasing. Investigations have shown that today articles on astronomy and space occupy only 0.1% of the leading European newspapers (Madsen, C., 2001, "The Stars in the Media", Open University).

There is a great need to improve awareness and understanding of science in Europe and a huge effort in science communication is essential to maintain and increase the level of scientific funding.

Including science communication as an integral part of every research institution is a concept that is emerging all over Europe. In the US it has long been a tradition as there is a direct feedback loop between scientific funding and the visible presentation of results. Communications-wise we are still lagging behind the US and much can be done in Europe to improve the situation.

Often the European media will favour American results and institutions, for example results from NASA. There may be several reasons for this. Perhaps part of the reason is merely habit with the journalists and editors? After all, the Americans have had many years to build up a good relationship with the media, and the media know what they are getting from the US. Perhaps the American science stories are more digestible? Or more accessible and visible? We believe all of the above apply, and the best strategy to improve the situation is to consistently produce interesting communication products of high quality in Europe.

The Language Barrier

In Europe we have a an inherent disadvantage due to the many different languages on our continent. This presents an obstacle for communicators, as it is difficult to target all of Europe with the same product. Most scientifically literate Europeans master English, but, especially in the southern part of the continent, English is less used. The end-users (often the public at large) request the various materials in their own language, and the mediators (media, teachers) also often need translated material.

The translation and editing of multiple versions of each product is a huge task. Our estimate is that it takes somewhere between 30% and 40% additional work for each new language version to be produced.

The Hubble PR Machine

The Hubble project has a smooth-running PR-machine that, especially since the mirror was 'fixed' in 1993, has helped to bring Hubble to the forefront of the public mind – as much as is possible for a scientific project.

Hubble's excellent results are naturally a firm basis on which to build good science communication, but the unique and exotic nature of the project has been just as important. In order to stand out from other scientific projects it is important to identify the best features of a given project, or its 'PR-niche'. Hubble's PR-niche is its high-resolution imaging capability and access to infrared and ultraviolet observations unavailable on the ground.

Hubble has another inherent advantage in that it is in effect a very high-quality camera. This has been a very important element in its PR-success as the media have an insatiable appetite for good images and animations to illustrate written and electronic articles. This need has increased over the years and Hubble has had huge success in delivering crisp, large-format, colourful images of space to the media.

Last, but certainly not least, there has been reasonable funding for science communication for the Hubble project. In the US the Office for Public Outreach at the Space Telescope Science Institute employs close to 40 professionals. It is a mix of highly skilled graphic designers, writers, managers, video animators, producers, technical people, media specialists and educators. In Europe we are two people working full-time at the ST-ECF on the communication of results from Hubble and produce a wide range of communication products: brochures, press releases, web pages and videos to name but a few.

Conclusions

We have outlined here a long list of experiences in the art of communicating science – a very broad and multi-disciplinary field. Some of the most important issues are:
* Astronomy is an excellent base for communicating science and can serve as an eye catcher due to its 'colourful' nature.
* Hubble occupies a unique scientific niche and has been one of the most successful scientific projects ever.
* Hubble has been a front-runner in the communications field due to a large effort and its particular advantages that include readily available high quality images.
* Science communication is a very broad field that acts as a bridge between scientists and society.
* A number of links are included in the chain of events in a communication production. If any of these links fail, the production fails.

Some of the most important issues for ensuring successful science communication are:
* Understanding the market and the target group
* Finding a PR-niche
* Branding your product
* Using professional communicators
* Optimising resources
* Using images correctly
* Having technical autonomy in the production phase
* Establishing good links with the press
* Using mediators to distribute
* Evaluating and planning ahead

To improve the level of scientific literacy in Europe communication products must be of high quality and properly funded. The scientific future of Europe depends on our ability to spark a scientific interest in the younger generation.

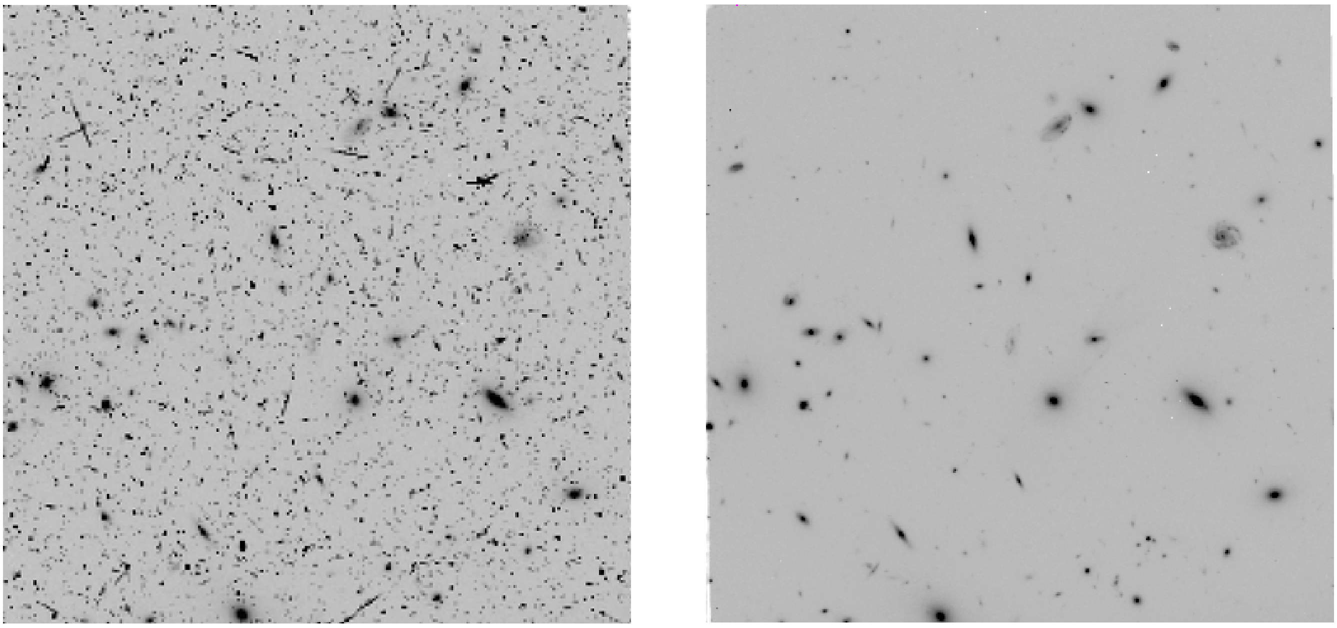
WFPC2 Associations

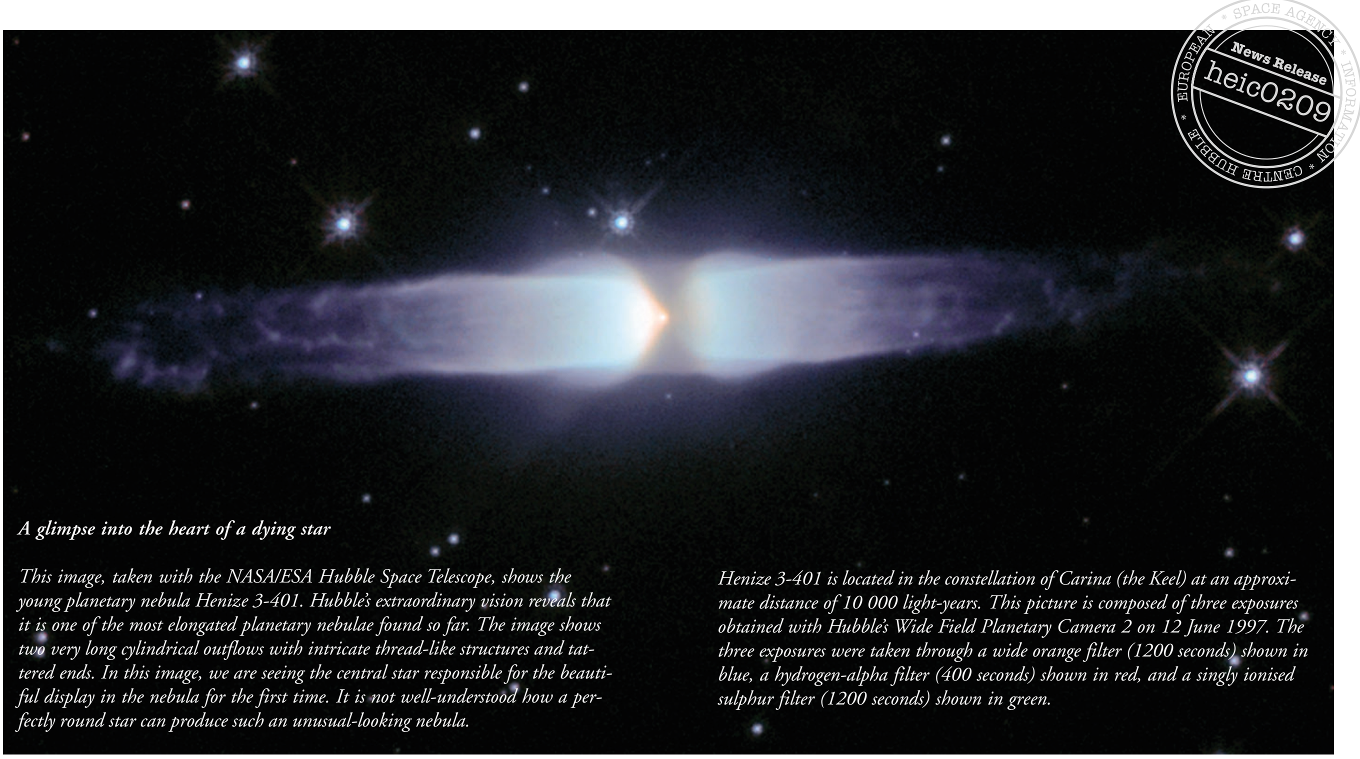
Alberto Micol

The Canadian Astronomy Data Centre (CADC), the Space Telescope European Coordination Facility (ST-ECF) and the Multimission Archive at Space Telescope (MAST) are pleased to jointly make available combined images from the Wide Field Planetary Camera 2 of the Hubble Space Telescope. These combined images are the products of the basic registration and averaging (Artificial Skepticism algorithm, Stetson 1989) of related sets of WFPC2 images, referred to as associations. They are also astrometrically calibrated if enough stars from the USNO2 catalogue lie in the field of view.

CADC: http://cadcwww.hia.nrc.ca/wfpc2/
MAST: http://archive.stsci.edu/hst/wfpc2/
ST-ECF: http://archive.eso.org/archive/hst/wfpc2_asn/3sites/

Fig. 1: A 'before and after' comparison between a raw, unreduced WFPC2 frame (left) and the B association pipeline result.





A glimpse into the heart of a dying star

This image, taken with the NASA/ESA Hubble Space Telescope, shows the young planetary nebula Henize 3-401. Hubble's extraordinary vision reveals that it is one of the most elongated planetary nebulae found so far. The image shows two very long cylindrical outflows with intricate thread-like structures and tattered ends. In this image, we are seeing the central star responsible for the beautiful display in the nebula for the first time. It is not well-understood how a perfectly round star can produce such an unusual-looking nebula.

Henize 3-401 is located in the constellation of Carina (the Keel) at an approximate distance of 10 000 light-years. This picture is composed of three exposures obtained with Hubble's Wide Field Planetary Camera 2 on 12 June 1997. The three exposures were taken through a wide orange filter (1200 seconds) shown in blue, a hydrogen-alpha filter (400 seconds) shown in red, and a singly ionised sulphur filter (1200 seconds) shown in green.

European Space Agency and Pedro Garcia-Lario (ESA ISO Data Centre)

Progress Report on the AVO Project

Markus Dolensky (ESO) on behalf of the AVO Project Team

When the Astrophysical Virtual Observatory (AVO) was first mentioned in the July 2001 issue of this Newsletter it was merely a paper concept based on experience with ASTROVIRTEL and other archive activities. Since then a geographically dispersed project team in France, Germany and the UK has started its work, guided by the advice of a dedicated Science Working Group (SWG). Here we briefly review the progress of the project.

Organisational Structure

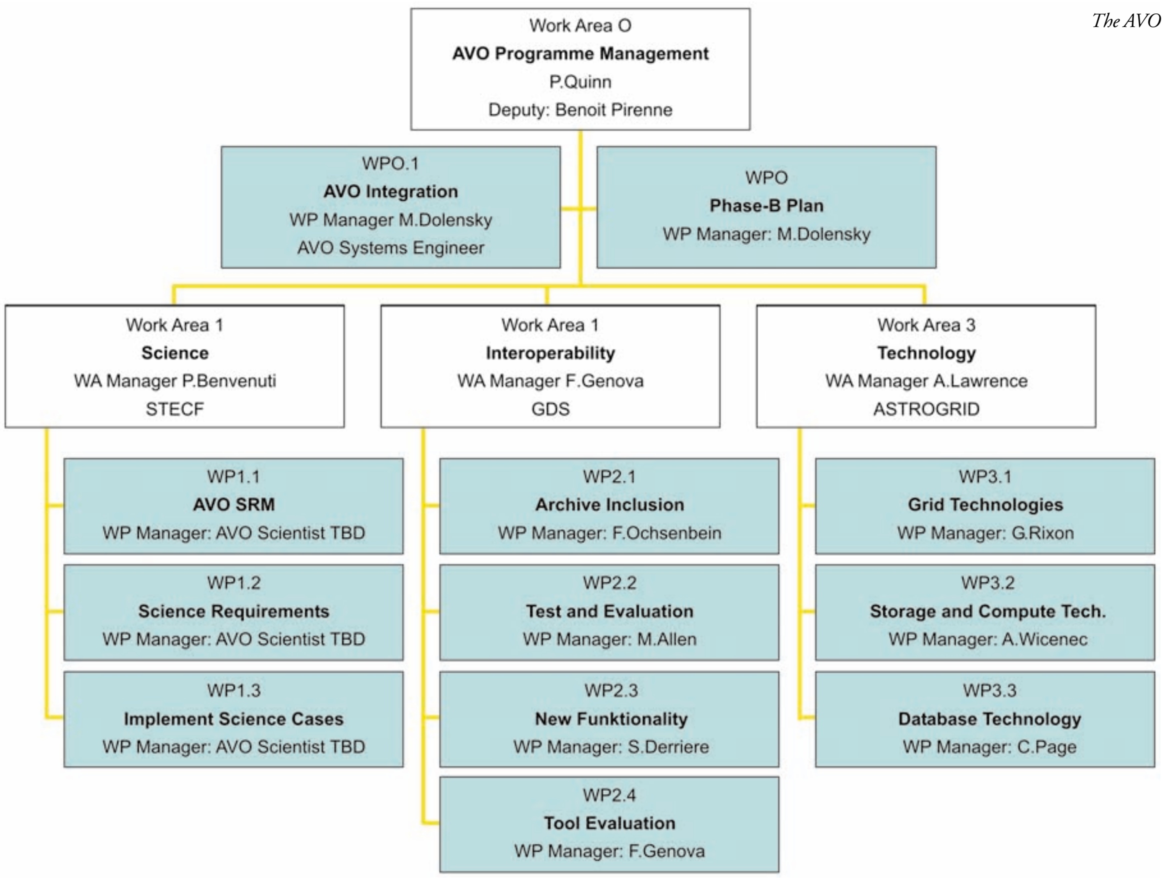
The AVO project is led by the Executive Committee comprised of representatives of the six participating organisations. An advisory body, the AVO Science Working Group, is responsible for defining science goals and requirements and for reviewing progress.

Three main working areas have been identified:
- Science
- Archive Interoperability
- GRID and Data Storage Technology

Work Area 1 – Science

The SWG nominated a subcommittee chaired by Nicholas Walton (IoA, Cambridge, UK) to select "use cases" for a first AVO software demonstrator planned for January 2003. It was decided to give priority to work on tools for finding targets for follow up spectroscopy based on the Great Observatories Origins Deep Survey (GOODS). GOODS (ESO Messenger 105, p. 40, www.eso.org/goods/) is a public, multi-wavelength survey covering two 150 arcmin^2 fields centred on the Hubble Deep Field North (HDF-N) and the Chandra Deep Field South (CDF-S).

Some of the challenges are the cross-matching of images taken in various spectral bands, ranging from the radio to the X-ray regime, the cross-identification of objects in those bands, the integration of observation logs from several space and ground-based observatories into a common scheme and the homogenisation of heterogeneous catalogues in order to visualise the Spectral Energy Distribution (SED) as well as colour-colour plots. A further challenge is the re-extraction of sources from the original images, driven by user constraints. It is clear that not all of these goals can be met fully by January 2003, but work in all these areas has started. These activities are based on initiatives in the other work areas as described below.



The AVO Organigram

Meta-Data
Meta-data can be considered as triples consisting of a name/value pair as well as a subject. This third piece is crucial, since the subject puts meta-data into a context. The context can be expressed in several ways, but is necessary to ensure that the triple is unique. One possibility is to use the URL of the XML document to satisfy this constraint. The triple { Author, Max Planck, www.abc.org/apaper.xml } unambiguously declares Max Planck as the author of the given document.

DTD vs. Schema
Document Type Definitions (DTD) and XML Schema both describe the content and structure of a class of XML documents. DTDs came first and are expressed in Extended Backus-Naur Form whereas Schema are directly written in XML. In the opinion of the author DTDs are a subset of Schema in terms of functionality and that Schema will eventually replace DTDs, at least in the XML world. Some of the additional features XML Schema offer are: Namespaces (modularity), inheritance, numerous data types, so-called facets (regular expression patterns for validation, enumeration), default values, nil values, etc. Usage scenarios for Schema suggested by the W3C Consortium are: query formulation, open and uniform data transfer between applications and databases as well as meta-data exchange.

Web vs. Semantic Web
There is a fundamental difference between the Web and the Semantic Web: when we browse the Web we experience it as a system where the human reads Web pages. The Semantic Web, however, is a system where the machine can not only read, but more importantly understand the Web pages. In historical terms, the Semantic Web is currently moving from the Stone Age to the Bronze Age.

Work Area 2 – Interoperability

A need for common standards when exchanging data across archives to build higher level services was identified early on. When ESO hosted the very successful conference “Toward an International Virtual Observatory” in June 2002 a coordinating body for such a standardisation process was formed. It is called the International Virtual Observatory Alliance (IVOA). All VO initiatives known at the time in Australia, Canada, Europe, Germany, India, Japan, Russia, UK and USA joined this alliance. The members of these national and international initiatives agreed on a mission statement and plan until 2006 (www.ivoa.net).

Two important accomplishments are worth announcing in this context: VOTable and UCDs.

VOTable

The OPTICON working group released the VOTable V1.0 specification in April 2002 (cdsweb.u-strasbg.fr/doc/VOTable/). VOTable can represent astronomical tables using the eXtensible Markup Language (XML). VOTable is not meant to be a replacement for the FITS format. It is part of a transport layer to exchange data and meta-data (see box) in a hierarchical structure. There exists a DTD as well as a Schema definition (see box) of this format and prototypes of several software libraries supporting VOTable are available. To date there are implementations in Java, perl and C.

UCD Concept

A scheme of Unified Content Descriptors (UCD, vizier.u-strasbg.fr/doc/UCD.htx) has been developed as part of an ESO-CDS data mining project. The original goal was to map database columns with a distinct set of well described parameter identifiers. Such identifiers (UCDs) were grouped in a shallow hierarchy. 1,500 UCDs were sufficient to classify some 100,000 columns from 3,000 astronomical catalogues. These UCDs cover a lot of ground in terms of defining meta-data for resource registries and some common query specifications. UCDs are widely accepted in the IVOA community as fundamental building blocks for a vocabulary in astronomy suited to automated processing. The discussion now focuses on support for unit conversion and whether the UCD tree should be refactored to improve flexibility and simplify the handling of missing items.

Work Area 3 – GRID & Infrastructure

AVO formed a strategic alliance with the British Astrogrid project. The Astrogrid project started before AVO and so it was natural to share resources in this area in order to avoid parallelism resulting in incompatible approaches. Hence AVO and Astrogrid are collaborating in the fields of database, data mining, storage and Grid technologies.

The Near Future

The first science demonstrator will be released at a workshop hosted by the Jodrell Bank Observatory on January 20/21, 2003. It will focus on the GOODS case. Software components and data from GOODS will become publicly available at the same time. Details will be announced on the new AVO project page www.euro-vo.org. A second release is planned for the IAU general assembly in August 2003. This will be complemented by a detailed recommendation of IVOA due in January 2003 concerning the items that need standardisation. It is expected that the specification of an astronomical query language based on the evolving Semantic Web technology (see box) will rank high on this list.

Scisoft for Mac OS X

Francesco Pierfederici & Norbert Pirzkal

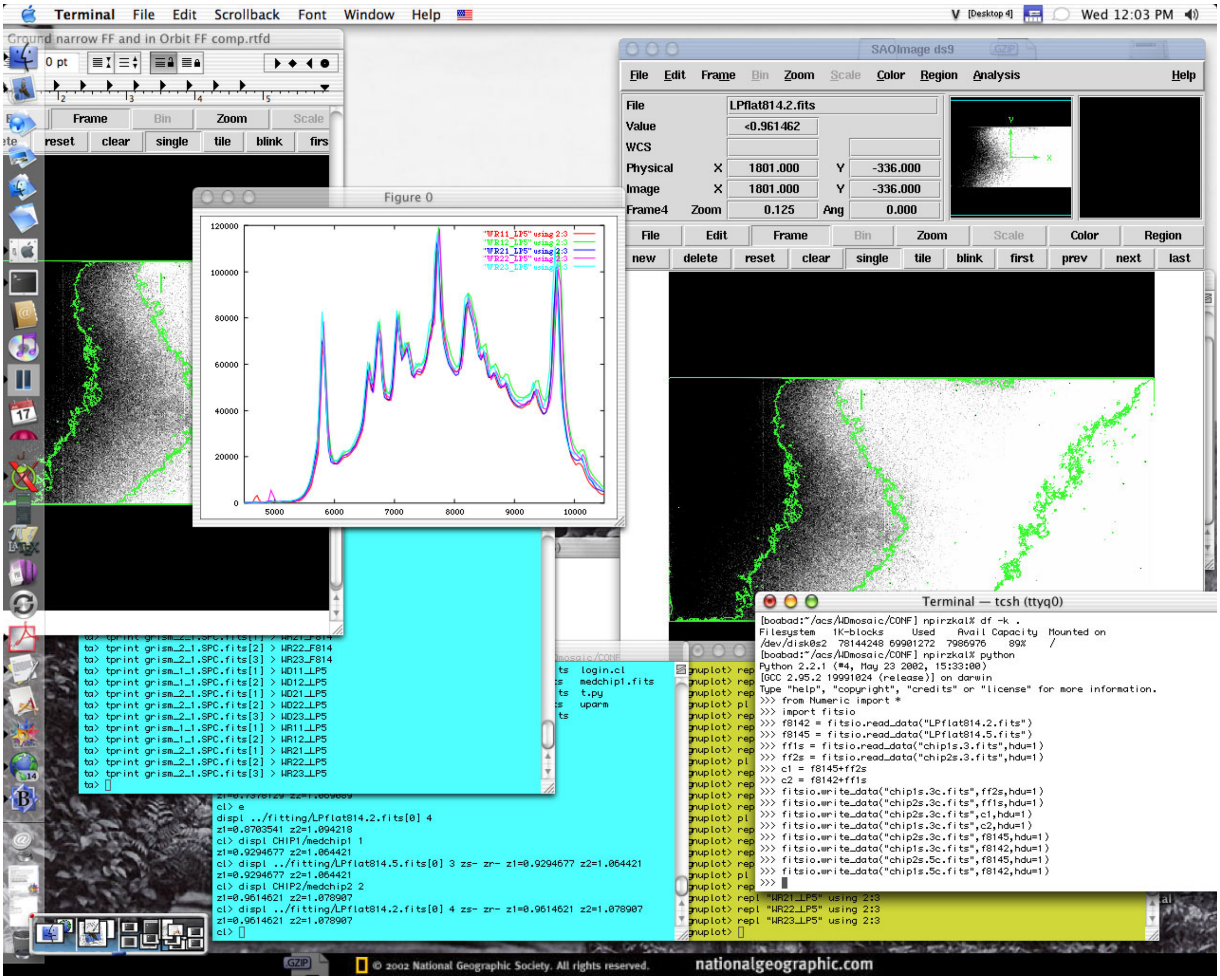


Fig 1: IRAF running under Mac OS X in conjunction with the X11-based DS9 and the Aqua version of GNUplot.

Introduction

The new UNIX-based Mac OS X operating system for the PowerPC-based Macintosh computer from Apple is the latest computer platform to attract astronomers. Using more than one operating system has become the norm in astronomy today, where UNIX machines are often used to do the work – thanks to their robustness and value as a number crunching environment – while Windows applications are often used to communicate results with others (and to read administrative emails containing MS Word attachments). This has meant either using more than one computer or running Windows under emulation under Linux. Neither of these two solutions is particularly efficient.

While being a bona fide BSD UNIX operating system, Mac OS X manages to bridge an important gap by allowing users to use standard Unix applications such as IRAF, SuperMongo, and LaTeX side by side with industry standard applications such as MS Word, MS Powerpoint, and Adobe Photoshop.

Scisoft for Mac OS X

An increasing number of astronomers are using Mac OS X as their primary operating system. This has generated a strong demand for a distribution of standard astronomical tools (eg, IRAF, MIDAS and DS9) for Mac OS X machines.

At ESO we have a widely used collection of astronomical software packages and utilities, called Scisoft (http://www.eso.org/scisoft/), previously available only for Solaris, Linux and HP-UX. It was therefore quite natural to use the Scisoft paradigm in assembling a collection of Mac OS X applications and utilities for astronomers. We decided to call it “Scisoft for Mac OS X”

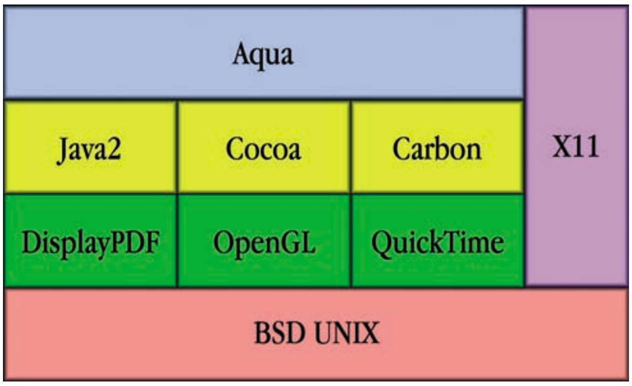


Fig 2: Mac OS X has a layered structure based on BSD Unix.. A variety of graphical display services are built on top and can work together.

and to keep the same directory structure and more or less the same software content as the official Scisoft releases.

It must be stressed that this effort, despite its name, is not officially part of the ESO Scisoft distribution and it is strictly an ST-ECF project (http://www.stecf.org/macosxscisoft/).

Most major Scisoft software packages have been successfully ported to MacOS X. While the majority of them still require X11, a couple of notable exceptions (GNUPlot and PGPlot) now have an interface to the native Aqua windowing environment. Interestingly enough, a Mac OS X native port results in increased functionality with no added disadvantages. The obvious example is the ability to produce PDF output

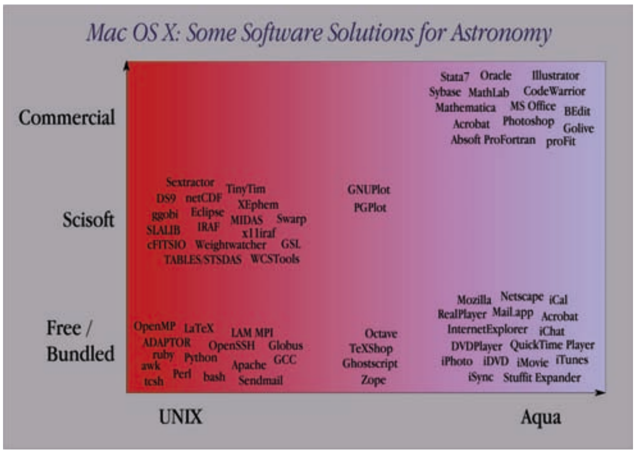


Fig 4: Thousands of applications are already available for Mac OS X including both industry standard packages such as Microsoft Office and many X11-based scientific applications which have been recently ported.

directly. The Mac version of Scisoft comes with a user friendly and hands-free installer. No special pre/post installation setup is required, other than installing X11 and sourcing a setup file. Future versions of Scisoft for Mac OS X will, resources permitting, feature more Aqua ports of astronomical packages that will not require the X11 environment.

Scisoft for Mac OS X CD requests should be directed to francesco.pierfederici@eso.org. A disc image (.dmg file) of the entire CD can be freely downloaded from the main Scisoft for Mac OS X web site (http://www.stecf.org/macosxscisoft/).

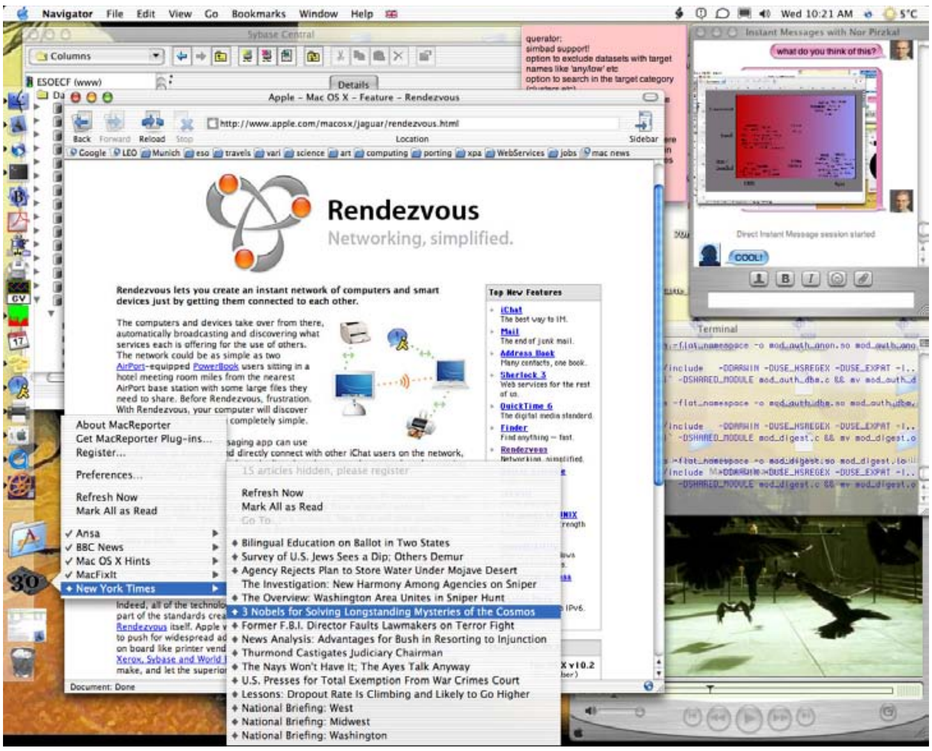


Fig 3: Mac OS X and Aqua in action.

Credit: European Space Agency & Mohammad Heydari-Malayeri (Observatoire de Paris, France)

A rose blooming in space

Resembling a delicate rose floating in space, the nebula N11A is seen in a new light in a true-colour image taken by the NASA/ ESA Hubble Space Telescope. Fierce radiation from massive stars embedded at the centre of N11A illuminates the surrounding gas with a soft fluorescent glow. N11A lies within a spectacular star-forming region in the Large Magellanic Cloud.
This nebula is particularly interesting for astronomers since it is the smallest and most compact nebula in that region and represents the most recent massive star formation event there. The excellent imaging power of Hubble has enabled astronomers to see this nebula in more detail and to study the structure of the hot gas envelope as well as the stars embedded in its centre. Shocks and strong stellar winds from the recently born, massive stars in the bright core of N11A have scooped out a cavity in the gas and dust. The fierce radiation causes the surrounding gas to fluoresce in a way similar to a neon light.
N11A is located in the constellation of Dorado (the Goldfish). This true-colour Hubble image is composed of three narrow-band filter images obtained with Hubble's Wide Field Planetary Camera 2 on 17 May 2000. The three images were obtained using a 1040 second exposure through a red filter (ionised hydrogen, H-alpha), a 1200 second exposure through a green filter (ionised oxygen), and a 1040 second exposure through a blue filter (ionised hydrogen, H-beta). N11A is about 10 arc-seconds in size, corresponding to about 8 light-years at the distance of the Large Magellanic Cloud (168,000 light-years).

HUBBLE
European Space Agency Information Centre

Image credit: ESA, ESO, Markus Kissler-Patig (ESO) & Thomas H. Puzia (University of Munich)

Young stars in old galaxies – surprising discovery with the world's leading telescopes

Combining data from the NASA/ESA Hubble Space Telescope and the ESO Very Large Telescope (VLT), a group of European and American astronomers have made a major discovery. They have identified a huge number of 'young' stellar clusters in an old elliptical galaxy. For the first time, it has been possible to identify several distinct periods of star formation in a galaxy as old as this one. Elliptical galaxies have always been considered to have undergone one early star-forming period and thereafter to be devoid of star formation. However, the combination of the best and largest telescopes in space and on the ground has now clearly shown that there is more than meets the eye.
To break the stellar 'cocktail' in elliptical galaxies down into its different constituents, a team of European and American astronomers observed massive stellar clusters in and around nearby galaxies. These "globular" clusters, so called because of their shape, exist in large numbers around all observed galaxies and form a kind of 'skeleton' within their host galaxies. These 'bones' receive an imprint for every episode of star formation they undergo. By reading the ages of the globular clusters in a galaxy, it is possible to identify the past epoch(s) of active star formation in a galaxy.
Reading the imprints and deducing the distribution of ages of the globular clusters, astronomers can reveal when many of the stars in elliptical galaxies formed. This is similar to the way a palaeontologist uses the skeletons of dinosaurs to deduce information about the era in which they lived.
The team combined images of a number of galaxies from Hubble's Wide Field and Planetary Camera 2 with infrared images obtained from the multi-mode ISAAC instrument on the 8.2-m VLT Antu telescope at the ESO Paranal Observatory (Chile). To their great surprise, they discovered that many of the globular clusters in one of these galaxies, NGC 4365, a member of the large Virgo cluster of galaxies, were only a few thousand million years old, — much younger than most of the other stars in this galaxy (roughly 12 thousand million years old).
The astronomers were able to identify three major groups of stellar clusters. There is an old population of clusters of metal-poor stars, some clusters of old but metal-rich stars and now, seen for the first time, a population of clusters with young and metal-rich stars. These results have been fully confirmed by spectroscopic observations made with another of the world's giant telescopes, the 10-metre Keck on Hawaii.

The Cover

Jeremy Walsh

The cover page shows a pair of ACS Wide Field Camera (WFC) images: the F775W direct image (below) and the slitless spectrum of the same field taken with the G800L grism (above). Only one CCD chip is shown (total field 204 x 102", although the ACS field is not rectangular as a result of the geometric distortion) and is slightly truncated in the X direction. This pair of images was taken as part of the ACS Pure Parallel Lyman Alpha Emission Survey (APPLES for short), whose PI is James Rhoads from STScI (see also STScI Newsletter Vol.19, Issue 3, cover story); three members of the ECF are Co-I's on this proposal.

The dispersed image illustrates the advantages and problems of slitless spectrometry well. The very bright star in the lower centre of the direct image produces a dispersed image covering almost the whole chip. The brightest order is the +1st, containing about 85% of the power in the spectrum; the +2 to +4 orders (to the right) merge into one another, as do the negative orders to the left of the zeroth order. The zeroth order, seen just to the left of the bright first order, is slightly dispersed and definitely should not be interpreted as an emission line. Some spatially extended structure is also visible around the first order spectrum of this bright star, arising from internal reflection. Extended objects, such as galaxies, produce a very fuzzy image, since the effective "slit" (the entire object itself) smears out the spectrum in the dispersion direction. Highest detection efficiency is achieved for point source spectra because of the small PSF of HST and ACS. Galaxies at high redshift are small, typically a few tenths of an arcsec, making the ACS and grism a powerful combination for determining their redshift and spectral character. The diagnostic power of slitless spectroscopy is shown well by the example of the compact sources in the spiral arm of the galaxy in the lower left corner. They can immediately be seen to be emission line objects, most probably HII regions. Detailed descriptions of the wavelength calibration and spectral flat fielding of the ACS grism mode are give in the articles by Anna Pasquali, Norbert Pirzkal and colleagues in this Newsletter.

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