ST-ECF

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NEWSLETTER 48

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CLOSURE OF THE ST-ECF

Robert Fosbury

Following decisions made by both ESA and ESO during the last few years, the ST-ECF closed and ceased operations on 31 December 2010. Established as a joint venture between these two organisations in 1984, the ST-ECF has worked in close collaboration with the STScI in Baltimore to support European users of Hubble and to provide significant contributions to the operation of the observatory and its instruments. The history of the activities of the group in Garching is captured in the 48 issues of the *ST-ECF Newsletter*[1], of which this will be the final edition.

Information resulting from the group's instrument science activities has been transferred to STScI and is available from their website. Of topical interest, this includes all the work concerned with slitless spectroscopy obtained with NICMOS, ACS and WFC3.

The Hubble outreach activities, started in response to a request from NASA more than a decade ago and delivered through www.spacetelescope.org, will continue at a substantial, but somewhat more modest, level with the continued involvement of the ESO education and Public Outreach Department (ePOD) and a financial contribution from ESA.

Until very recently, it was intended to keep the European Hubble Data Archive at ESO, where it was originally the model for the development of the ESO Science Archive Facility. The intention now, however, is to create a European access point for Hubble data at ESAC in Spain. ESO will cooperate as far as possible in achieving this transfer in a way that avoids an interruption in public availability in Europe.

Most of the recent ST-ECF archive features were developed in close collaboration with the Canadian Astronomy Data Centre (CADC) and are available there[2].

All Hubble data remains accessible at both the STScI and CADC through their respective archive interfaces.

More detailed information about the fate of the ST-ECF website is given by Jeremy Walsh on page 12 of this issue.

Arrangements for the travel of European scientists to the USA on ESA Hubble business — previously dealt with by the ST-ECF — will now be handled by ESA's Hubble Mission Manager at STScI.

The European engagement with the Hubble project and its outstanding record of scientific productivity was recently marked by a conference, exhibition and art installation in the city of Venice, hosted by the Istituto Veneto di Scienze Lettere ed Arti and organised in conjunction with STScI. This is described in the following article in this issue, with a sister article appearing in the next *STScI Newsletter.*

LINKS

[1] *http://www.spacetelescope.org/about/further_information/newsletters/*

[2] *http://cadcwww.dao.nrc.ca/hst/new/*

Fig. 1: *An evening view along the Grand Canal showing the conference venue, the Palazzo Franchetti, on the left.*

HUBBLE IN VENICE

Robert Fosbury, Antonella Nota & Mario Livio

Following the completion of the spectacularly successful fifth servicing mission (SM4) in May 2009 and with the prospect of Hubble's 20th orbital birthday in April 2010, the ST-ECF and STScI decided to organise the third Science with the Hubble Space Telescope conference at a European venue. The first of these meetings was held in Sardinia in the summer of 1992 while Hubble was operating under the shadow of spherical aberration. The second, held in Paris in December 1995 was able to showcase the performance of the repaired observatory.

After such a long gap, a conference in 2010 offered the opportunity for a comprehensive retrospective narrative of the telescope's 20 years of epoch-making scientific observations coupled with promise of, and early achievements from, the new and repaired set of instruments available after SM4. The scientific results of this meeting, held in October, are summarised in a sister article in the *STScI Newsletter*. The presentations themselves are available online[1].

Following early discussions with members of the Istituto Veneto di Scienze Lettere ed Arti (IVSLA), the decision was made to hold the conference in their spectacular Palazzo Franchetti fronting the Grand Canal next to the Ponte dell'Accademia. Venice seemed particularly appropriate since, 401 years earlier, Galileo Galilei had demonstrated his telescope to the assembled city senators. The location turned out to be an irresistible attraction for potential participants and precipitated several collateral events.

Hubble's images have deservedly become public icons for science and art. Few people, however, have had the chance to see any of the hardware associated with the orbiting space telescope since most of it is still in orbit! We saw the opportunity for collecting and exhibiting some of the best of Hubble's images and combining them with some of the surprisingly beautiful tools that were developed for the astronauts to use while servicing the telescope from the Shuttle. Some of the tools used during SM4 for the repair of STIS and ACS are particularly innovative. We were also able to get a large section of the second of the ESA-supplied solar array panels — in orbit from 1993 to 2002 — which show some of the physical effects of almost a decade in space. Having John Grunsfeld explain to us the design and use of the tools was a magical experience. We also shamelessly exploited John's presence in Venice by getting him to give a public lecture, The Story of Hubble — translated into Italian — in the nearby Chiesa di S. Vidal.

Creating a public exhibition was made possible by the generous offer from IVSLA of the use of their beautiful home, the Palazzo Loredan, as an exquisite setting for contrasting their venerable old scientific library with the state-of-the-art in observational astronomy. Tom Griffin from NASA, Salim Ansari from ESA and Lars Lindberg Christensen from ESO, together with their colleagues, helped us make it all happen by solving a string of almost intractable problems associated with transporting bulky and valuable exhibits from the US and northern Europe and deploying them in an ancient building in the centre of a city served by canals rather than roads. None of this would have been possible, however, without the tireless dedication of Elena Dalla Bontà from the University of Padua, the chair of the LOC, who masterminded the local arrangements and contacts, Bonnie Eisenhamer from STScI who held many of the exhibition arrangements together and Britt Sjöberg of the ST-ECF who made sure that the bills were paid! The exhibition was open for slightly more than a month — from mid-September to mid-October — and attracted over 12 000 visitors, with many school parties amongst them. A brochure describing the exhibit was distributed to around 10 000 of the visitors. A PDF version of this is available online[2].

It has to be admitted that Venice is known for its artistic as well as its scientific associations. Not to be outdone, we worked with the German artist Tim Otto Roth[3] to create an installation entitled *From the Distant Past* that, for the duration of the exhibition, projected Hubble spectra and images of over a thousand faint astronomical objects onto the facade and lawn of the Palazzo Franchetti. The spectra came from a recently published collection of 47 000 produced by the ST-ECF from grism observations with the ACS and were written onto the wall of the palazzo using a powerful green laser. Many of the sources in this collection are at high redshift, giving us the idea for the title. Seen as a piece of visual art, this was very impressive — especially given the extremely prominent location on the Grand Canal, next to a bridge that provided an ideal viewing location. For those viewers who wanted to understand what it was all about, there was an explanation posted in the Loredan exhibition. It was a powerful idea and we believe that it created a strong impact for many of the viewers.

For the conference participants there were other delights in addition to the exhibition and the art. The conference dinner in the Tintoretto-encrusted Scuola Grande di San Rocco was accompanied by a concert given by the Interpreti Veneziani on the upper floor of the same remarkable building.

And the weather was perfect!

LINKS

[1] *http://www.stecf.org/conferences/HST3/programme.php*

[2] *http://www.stecf.org/conferences/HST3/exhibition/*

[3] *http://www.imachination.net/*

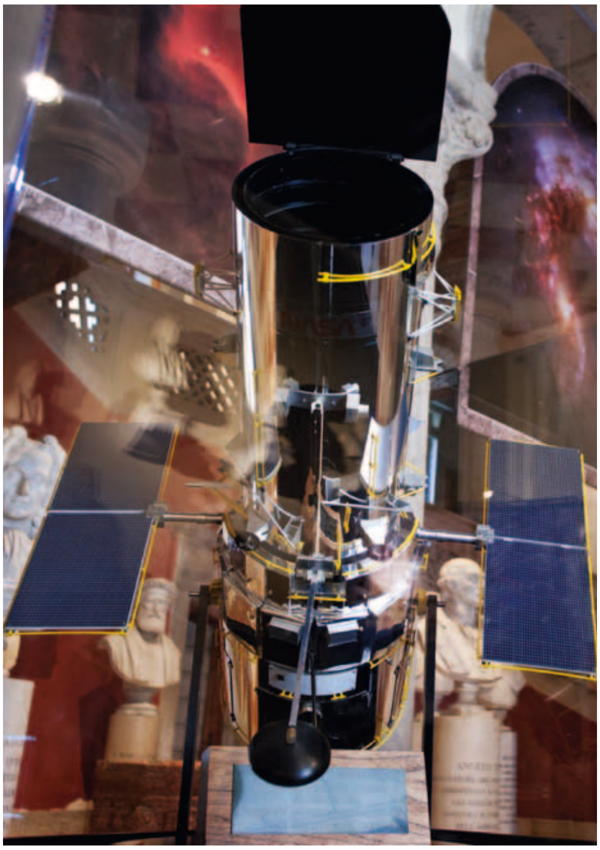

Fig. 2: *The entrance hall to the exhibition in the Palazzo Loredan showing the Hubble model and some mounted images — all set in the midst of busts from Venetian history.*

Fig. 3: *The installation* From the Distant Past *by Tim Otto Roth, projected on the side of the Palazzo Franchetti.*

Fig. 4: *The first room of the exhibition with some Hubble images mounted on easels. One of the light boxes, showing an image of Jupiter, is seen in the next room.*

Fig. 5: *John Mather being interviewed about JWST by Olivier Usher.*

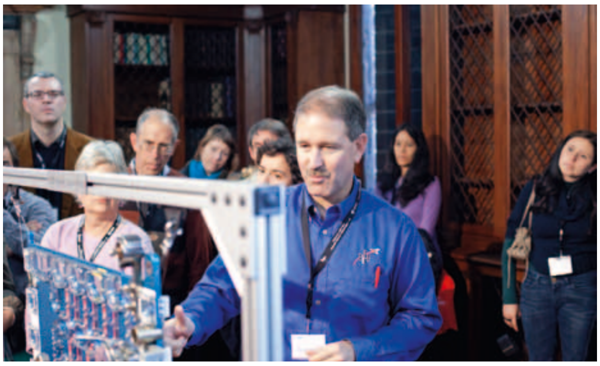

Fig. 6: *John Grunsfeld explaining the operation of the STIS capture plate, used during the STIS repair in SM4 to capture the many small screws that had to be removed.*

Fig. 7: *John Grunsfeld giving a public lecture on The Story of Hubble in the Chiesa di S. Vidal.*

Fig. 8: *A gaggle of Hubble historical figures herded into a corner of the Franchetti garden during the conference. From left to right: John MacKenty, Jeff Linsky, Holland Ford, Piero Benvenuti, Rudi Albrecht, Ted Gull, Blair Savage, Dave Leckrone, Helmut Jenkner, Garth Illingworth, Bob Kirschner, Mario Livio, Bob O'Dell, Frank Cepollina, Bob Fosbury, Dave Koo, Sally Heap, John Danziger, Ken Carpenter, Duccio Macchetto, Malcolm Longair and Mike Disney.*

THE HUBBLE LEGACY ARCHIVE ACS GRISM DATA RELEASE

Piero Rosati, Martin Kümmel, Harald Kuntschner, Marco Lombardi, Jonas Haase, Richard Hook, Kim Nilsson, Felix Stoehr, Jeremy Walsh, Alberto Micol & Robert Fosbury

The ST-ECF ACS grism team has now completed the public release of 47 919 slitless spectra of 32 149 unique sources, obtained with the G800L grism mode of the Wide Field Channel of Hubble's Advanced Camera for Surveys (ACS/WFC). These were extracted from 153 Hubble associations distributed across the two Galactic caps. Each dataset contains science-ready one- and two-dimensional spectra, as well as multiband image cut-outs of corresponding sources. Released spectra were validated using an automated classification algorithm, trained on the visual inspection of thousands of spectra, which rejected 35% of the original 73 581 spectra. This final release (2 July 2010) completes the ST-ECF tasks aimed at enhancing the content of the Hubble Legacy Archive with highly processed data products that facilitate the scientific exploitation of the Hubble data.

INTRODUCTION

As part of the Hubble Legacy Archive (HLA) project to create well-calibrated science data and make them accessible via user-friendly archives, the ST-ECF has exploited its expertise in slitless spectroscopy to uniformly extract spectra from widely used Hubble slitless spectroscopy modes and to distribute the high level products through the HLA archive. In the first part of this project, about 2500 spectra from the NICMOS G141 grism, covering the wavelength range 1.10–1.95 μm, were extracted and made publicly available (Freudling et al., 2008). In the second part of the project, summarised here, and fully described in Kümmel et al. (2011), the data-processing pipeline was further enhanced to extract a much larger sample of slitless spectra from archival observations with ACS/WFC and the G800L grism. This resulted in a twenty-fold increase in the number of released spectra and ancillary imaging information. The ACS G800L grism provides a wavelength range of 0.55–1.0 μm, with a dispersion of 40 Å/pixel and a resolution of FWHM $\sim$ 100 Å for point-like sources. A first sampler of 1235 ACS slitless spectra extracted from two NICMOS parallel pointings in the Chandra Deep Field South (CDFS) area was released in May 2009 (Kümmel et al., 2009b) and is now superseded by the final release. The fully automated processing of 153 ACS fields (Figure 1), consisting of direct and dispersed images selected in the Hubble archive as suitable for automated processing, required further software enhancements and the development of a new automated quality control process to classify over 70 000 spectra. The release is currently available online[1] and will be accessible at the Multimission Archive at STScI (MAST) in the future[2].

DATA PROCESSING, QUALITY CONTROL AND RELEASE

A flow diagram of the entire data and quality control processing pipeline is shown in Figure 2 (Kümmel et al., 2011). As a preparatory step, ACS G800L grism pointings in the archive were first grouped into data associations, satisfying pre-defined rules on sky position, roll angle, availability of the same guide stars and direct images. This led to the selection of 153 fields suitable for further processing with the PHLAG pipeline (Kümmel et al., 2008), which delivers MultiDrizzled image combination, object detection with SExtractor on associated direct images, spectral extraction on the dispersed combined images with the aXe package (Kümmel et al., 2009a), and metadata generation. Data products were subjected to a rigorous quality control process before the final sample was ingested into the Hubble Legacy Archive. Several independent methods were used to verify, refine and quantify the accuracy of astrometric positions, wavelength and flux

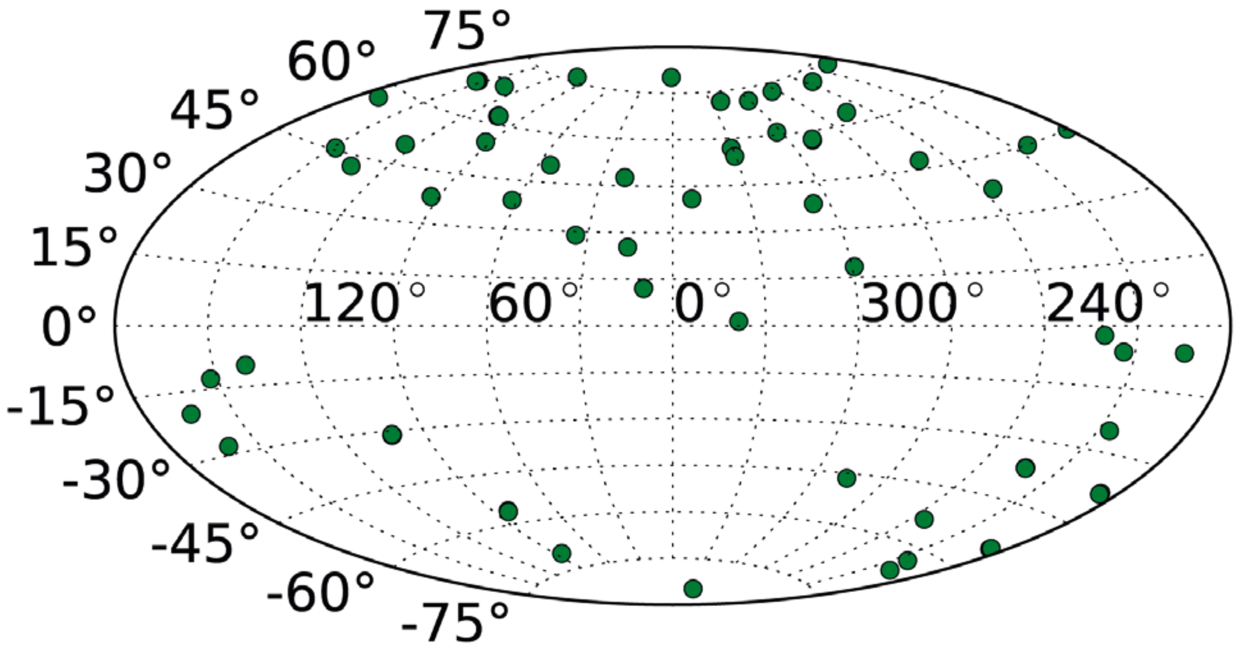

Fig. 1: *Distribution in Galactic coordinates of the 153 associations included in the HLA/ACS spectra release (several fields are too close to be discerned separately in the plot).*

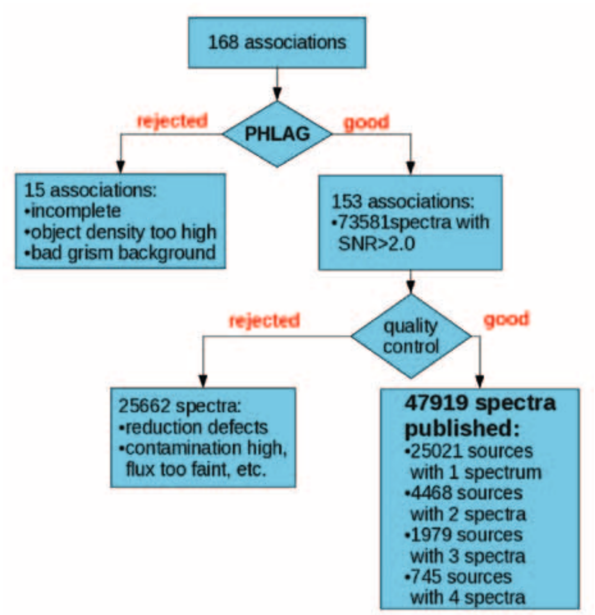

Fig. 2: *Flow diagram of the data processing and quality control, leading to the released sample of HLA/ACS spectra and associated number of unique sources.*

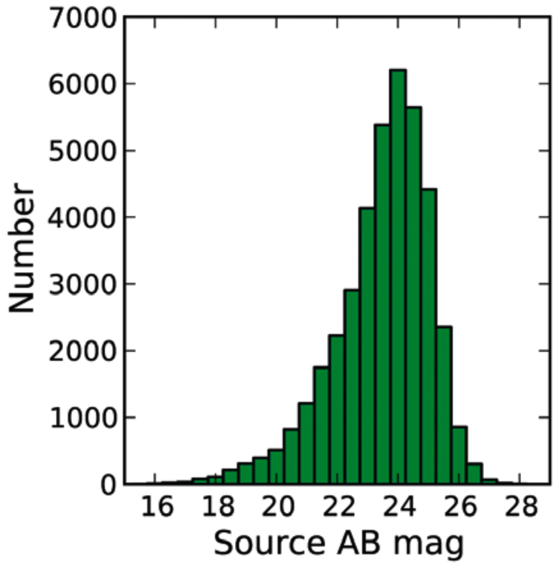

Fig. 3: *Magnitude distribution of the 32 149 individual sources associated to the HLA/ACS spectra. AB F775W magnitudes are used for most of the objects.*

calibrations (see Kümmel et al., 2011) of the extracted spectra. A significant effort was devoted to developing an efficient classification scheme for all extracted spectra, building on the experience with the visual inspection of the sample release, where ~ 40% of the spectra were discarded, primarily because of significant contamination from nearby sources.

Since visual inspection of the full sample of 73 581 spectra was no longer an option, we have explored ways of making an automatic classification. The application of machine-learning techniques to this problem is described in the article on page 9 of this *Newsletter.*

This process results in a very clean and homogeneously classified training sample, a key to high automatic classification success rates. Interestingly, numerous tests established that classification quality achieved by the algorithm is comparable to what a single scientist can achieve by visual inspection. At the end of an iterative process of automated classification and visual feedback to the learning algorithm on subsamples of "good" and "bad spectra", the final number of 47 919 spectra (65% of the original set) was reached, corresponding to 32 149 independent sources with typical (median) magnitude of i_{AB} = 23.7 (Figure 3), reaching i_{AB} = 26.5 for the faintest objects. Note that, when training the selection of spectra to be published, we adopted the general principle that, although contaminated to some level, many spectra can still provide useful information on the nature and redshift of the source. In many cases where the extraction region is not optimal, a simple re-extraction of the one-dimensional spectrum from the two-dimensional slitless cut-out can produce a better result (a simple IDL script is provided in the release pages for such a customised extraction).

All data products can be retrieved via the ST-ECF HLA archive interface or the STScI HLA portal, which, for each target, return a cut-out of the direct (undispersed) image in all available filters, a two-dimensional spectrum (position versus wavelength) and a flux-calibrated one-dimensional integrated spectrum of the target. All products are in VO-compatible FITS files with related metadata in FITS keywords. A visual summary of all data products is given in a preview page for each target, also available from the archive (in PNG format, see Figure 4). For each association, co-added direct and G800L FITS images of the entire field are also available for download at the release website.

SCIENTIFIC EXPLOITATION AND FUTURE PROSPECTS

The range of scientific applications of ACS slitless observations is very wide, as highlighted by a number of dedicated surveys carried out over the last five years. For example, the GRAPES and PEARS programmes have led to many publications, ranging from the search for faint Galactic stars (Pirzkal et al., 2004) to the clustering of high-*z* galaxies (Malhotra et al., 2005), or studies of emission-line galaxies (Straughn et al., 2009) and early-type galaxies (Ferreras et al., 2010). This HLA ACS grism release offers interesting science opportunities by providing science-ready data products over a ~ 700 arcmin^2 area. As a first application, Nilsson et al. (2010) have recently published a study of Lyman-break galaxies at $z \sim 1$ by modelling their SEDs with the combination of broadband photometry and slitless spectra readily available from the HLA release in the CDFS region.

Looking ahead, the grism mode on WFC3, with much increased sensitivity in the near-IR, is already showing its impressive versatility. Further into the future, a number of space-based all-sky slitless surveys have been designed over the last decade with the aim of measuring baryonic acoustic oscillations in the three-dimensional distribution of galaxies, a very robust method to constrain cosmological parameters (e.g., Wang et al. [2010] and references therein). A space-based slitless experiment in the near-infrared can take full advantage of

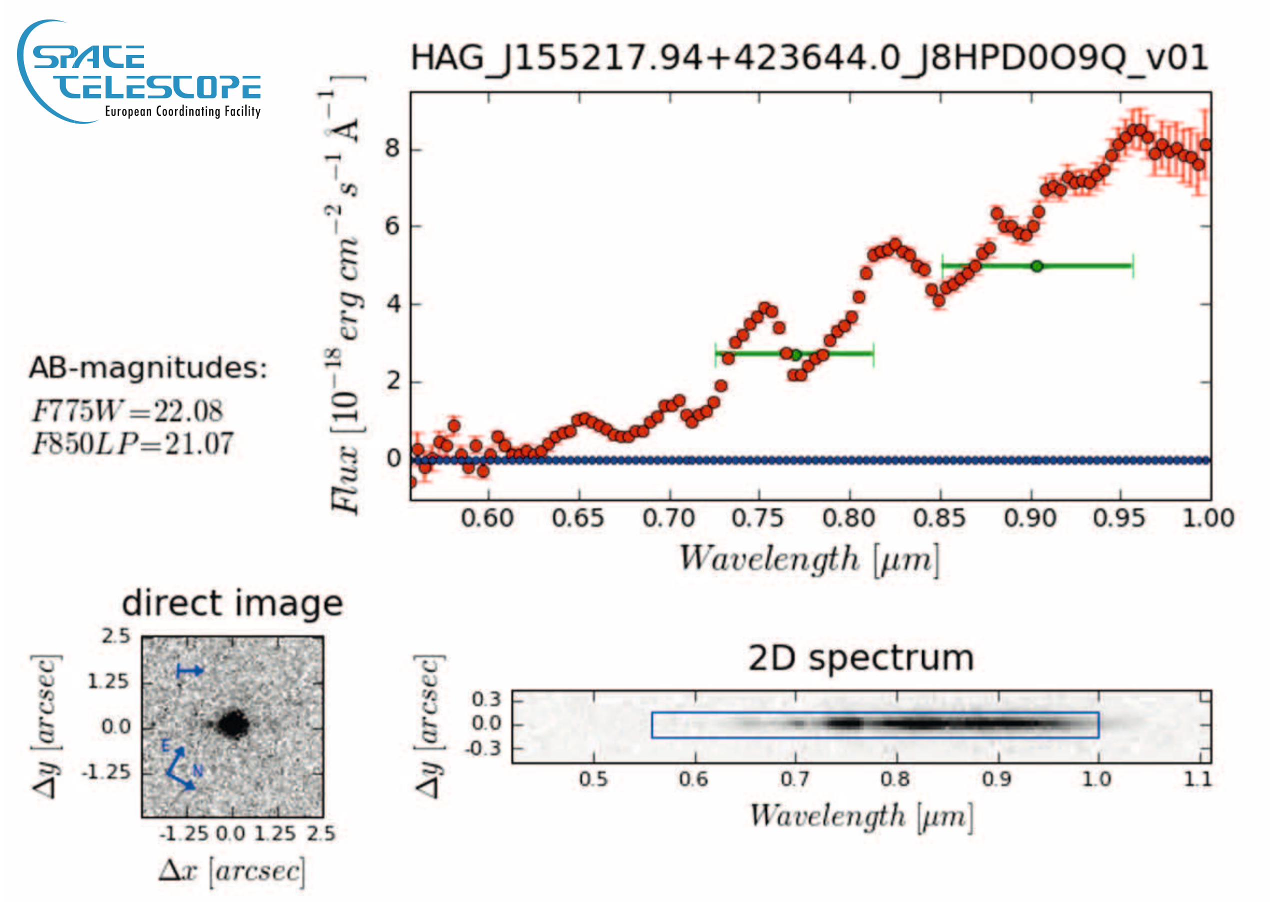

Fig. 4: *Example of an ACS grism spectrum (an M-star) as shown in the previews included in the release. Blue curves (when present) indicate the estimated contamination from nearby sources as a function of wavelength. The green data points (horizontal bars) correspond to the integrated broadband magnitudes. The blue rectangular box in the two-dimensional spectrum shows the effective extracted region where the optical extraction was performed. In the cut-out direct image (all bands combined), the pseudo-slit and the dispersion direction are indicated (blue arrow).*

the low background ($\sim$ 1000 times lower than on the ground), thus covering very wide areas with high sensitivity. Galaxy redshift surveys conducted in this way can measure a large number of redshifts ($> \sim 10^7$ emission-line galaxies) over the large volumes needed to constrain the dark energy equation of state parameter, w, to a 1% level, particularly in the redshift interval $1 < z < 2$, which is otherwise very hard to access from the ground. Such experiments are part of the Euclid ESA mission (Laureijs et al., 2009; Rosati et al., 2009), currently in the definition phase, as well as of the NASA JDEM mission concept. The accumulated experience with the slitless modes of Hubble from the aforementioned surveys, those currently underway with WFC3 in the near-IR, and the HLA dataset described here, will be key to studying the performance of these future slitless experiments.

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LINKS

[1] *http://www.stecf.org/archive/hla/acs_g800l_release.php*

[2] *http://archive.stsci.edu*

MACHINE CLASSIFICATION OF ACS GRISM SPECTRA

Felix Stoehr (ESO)

ABSTRACT

"*The good ones go into the pot and the bad ones go into your crop.*" Like Cinderella, we had the task of separating the "good" from the "bad", although in our case, instead of lentils we had to classify 73 581 ACS grism spectra produced by the PHLAG pipeline developed at the ST-ECF. This number of spectra is far too large to allow detailed visual inspection for quality control. Cinderella got help from doves to solve her problem, but we resolved to try to teach a computer how to classify spectra. For this we used a small number of carefully visually-classified spectra and then let the computer carry out the rest of the hard work for us. After the classification had finished the remaining 47 919 "good" spectra form the largest set of slitless high-level spectroscopic data products publicly released to date.

INTRODUCTION

The extraction of fully calibrated slitless spectra from Hubble data has been one of the main contributions of the ST-ECF to the Hubble Legacy Archive. The latest phase of this project has concentrated on extracting spectra from observations with the G800L grism of the Advanced Camera for Surveys (ACS). This project and the final data release are described in more detail on page 6 of this *Newsletter*. This article describes how the very large collection of extracted spectra was classified to ensure a uniformly high quality of final products.

MACHINE LEARNING

In slitless spectroscopy a number of effects can lead to flawed spectral measurements. The contaminating light trace from one source overlaying the dispersed light of the source to be extracted is by far the most common corrupting effect. Less common effects are pixel saturation at the centres of the sources, spectra from the borders of the chips or spectra that contain pixels with insufficient cosmic ray detection and masking.

Whereas quality control of the 4825 NICMOS spectra was tedious but feasible, and the flawed ("bad") spectra could be identified by visual inspection, this is impossible to do on a reasonable time-scale for the 73 581 spectra produced by the PHLAG pipeline for ACS.

However, the pipeline does automatically compute a large number of quality parameters for each spectrum. These include:

- two estimates of the signal-to-noise ratio;
- the magnitude of the source in different bands;
- the total exposure time;
- two estimates of the contamination;
- the position of the maximum of the light with respect to the expected position;

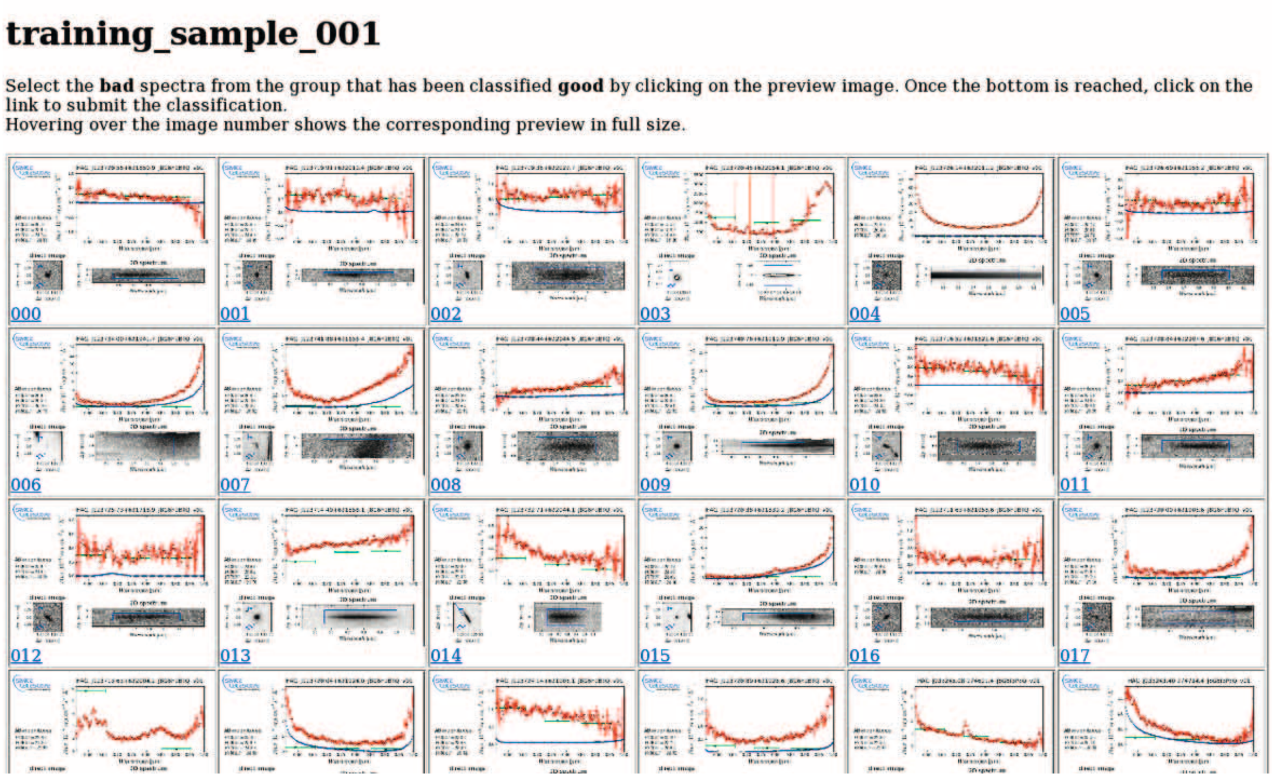

Fig. 1: *Webpage used to remove flawed spectra that were not picked up by the automatic classification.*

- the length of the spectrum in pixels;
- the source type (point or extended source); and
- the difference in the magnitudes computed from the spectrum and from the separate image(s) taken without the dispersive element.

We used the open-source machine-learning package Weka (Hall, 2009) to perform the classification of the spectra using the above parameters and a small clean training sample. This subsample of 2020 spectra was classified visually by three of us independently into "good" and "bad". All spectra that were not classified in the same way in that process (about 12% of the spectra in the sample) were looked at again by the team and consolidated classifications produced.

Although all spectra were classified, it turned out that the number of spectra that are borderline cases between "good" and "bad" was surprisingly large, of the order of perhaps 15%. Many spectra that had some kind of problem still contained a lot of scientific value, which made the decision difficult. We opted for a scheme where, when we were in doubt, the spectra were included into the "good" sample.

All the available classification algorithms of Weka were trained with two thirds of the sample and tested with the remaining third. The algorithm known as ClassificationViaRegression using weka.classifiers.trees.M5P was found to be the best performing one for the test set at hand, yielding 90.5% of correct classifications and a particularly low rate of false negatives. This classification quality is comparable with that which a single astronomer can achieve. The trained algorithm then classifies the remaining 97% of the full sample of spectra automatically.

POST-CLASSIFICATION ANALYSIS

While analysing the training sample, it turned out that there were two classes of spectra that were clearly flawed, but were classified by the algorithm as "good". One such class was composed of spectra that had their centres saturated (67 spectra). Although the flaw can be seen in the parameters we derived for each spectrum, with only about 0.1% of the spectra flawed in this way, the classification algorithms could not build up the necessary expertise when analysing the training set.

A second class of spectra had the curve of the spectrum rising at the two ends of the spectral range. The reason for this rise is that the size of the object could not be estimated well enough within the pipeline and that, as a result, the sensitivity curve used to normalise the spectrum had values that were too small at both ends (1628 spectra). The classification algorithms could not pick up these spectra as the numerical parameters we derived for each spectrum are all perfectly acceptable.

In order to remove these "catastrophic failures" from the "good" sample we have had to invent new detection algorithms. This was relatively simple given that these classes were easily identifiable. The flagged spectra were then inspected visually again, which is a quick task, given the small number.

As these data are part of the Hubble Archive Legacy project, which aims at providing fully calibrated science-ready data, a quick look at all of the spectra marked "good" was taken. This was executed in a mode where 100 previews were concatenated into a poster-like web interface for very rapid inspection (see Figure 1). This procedure took roughly as much time as the careful classification of the 2020 spectra used for training, although the sample was about 24 times larger. A further 1951 spectra (4% of the "good" sample, after the saturated centres and rising ends had been removed) were discarded through this procedure, resulting in a total 47 919 published spectra.

CONCLUSIONS

We used machine learning techniques in Weka for quality classification of slitless spectra. We found that this classification could be done very satisfactorily when a statistically relevant sample of carefully visually classified spectra was available and the spectra were described by a large set of relevant metadata parameters. After the removal of two classes of flawed spectra that could not be picked up by the automatic classification algorithm we skimmed through the set to remove "catastrophic failures".

The remaining sample of 47 919 "good" spectra can be accessed through the web interfaces:

- archive.eso.org/wdb/wdb/hla/product_science/form
- archive.eso.org/hst/science

or through the Virtual Observatory, e.g. :

- stecf.org/hst-vo/hla_ssa?POS=189.052,62.291&SIZE=0.1

Finally, something of the scale of the project can be grasped by studying Figure 2 — every pixel of this picture is an ACS grism spectrum.

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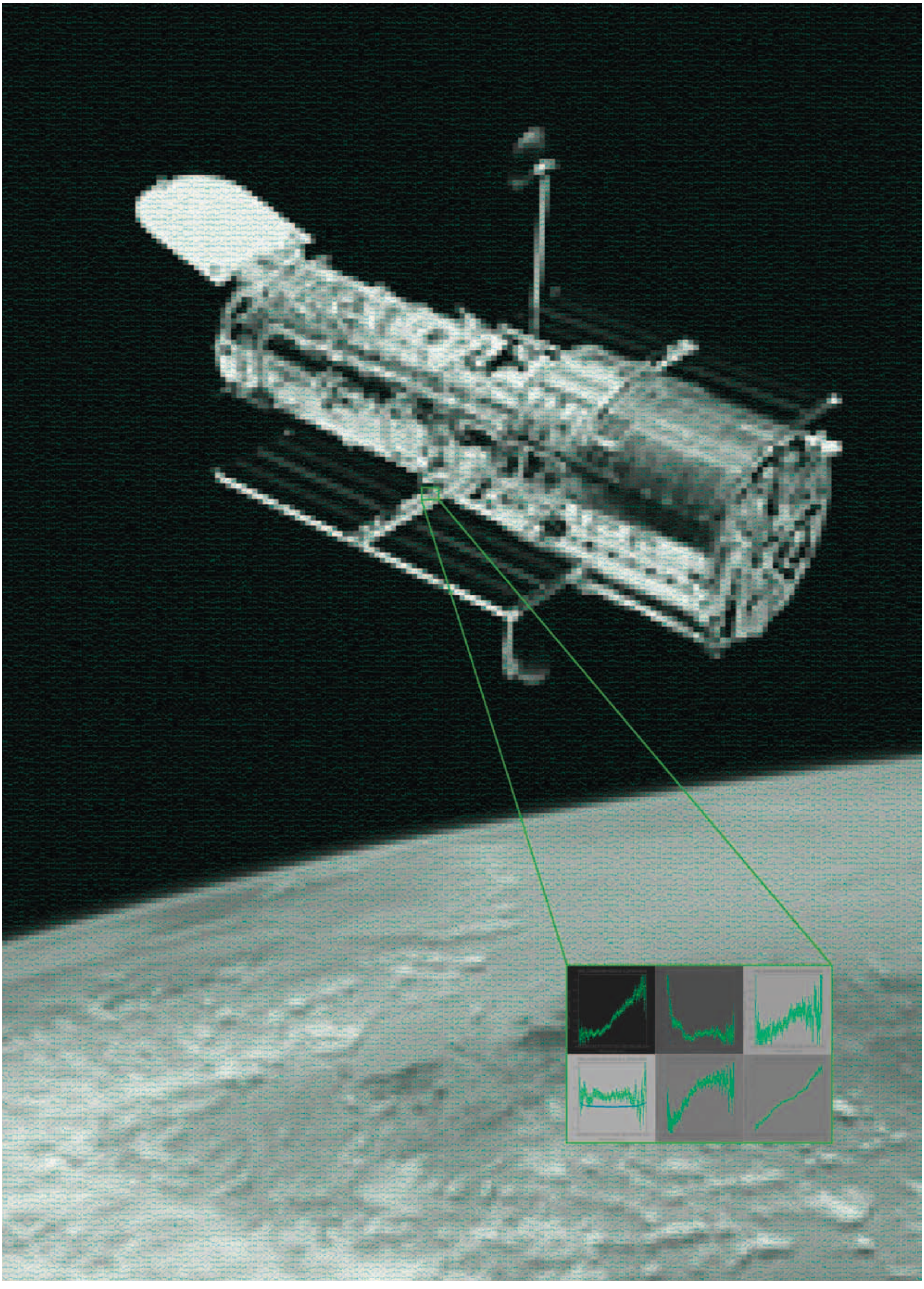

Fig. 2: *Poster for the HST3 conference in Venice in October 2010: every pixel of the background image is made out of one ACS extracted grism spectrum from the final release.*

THE ST-ECF WEB AFTER 2010

Jeremy Walsh & Martin Kümmel

A BRIEF HISTORY

Soon after the ST-ECF group formed in 1984, provision of information in electronic form became a major part of its remit to supply information to the prospective users of the Hubble Space Telescope. Even before the first call for observing proposals the Space Telescope Electronic Information System (STEIS) allowed ftp access to instrument throughput data for the optical telescope assembly (OTA) and the first generation of instruments. In early 1994, the ST-ECF was quick to establish a presence on the World Wide Web following experiments with hypertext/hypermedia tools (Adorf, 1989) and initially named it WISE, the web-based information service of the ST-ECF. The portal featured a hierarchical listing of all files available and a free-text search facility (see Adorf [1994] for details). By 1995, following the rapid development of the web, the homepage had evolved and the address started to look more familiar: http://ecf.hq.eso.org/. The home page gave access to up-to-date information on Hubble status, access to proposal submission and preparation tools, the Hubble archive and public relations images.

Like all websites the content and the scope has grown to embrace all the activities of the ST-ECF and the level of information has become richer. A neater web address was formed (www.stecf.org) — not to be confused with an EU organisation, the Scientific, Technical and Economic Committee for Fisheries. Another facelift occurred in 2006 when the look was updated and heavy reliance on development in PHP as a preprocessor was chosen for the generation of html pages (Kümmel et al., 2006). Figure 1 shows the homepage at the end of the ST-ECF's life (31 December 2010). The outreach pages were no longer included under the ST-ECF home page, as a separate website was created (www.spacetelescope.org) for access to ESA Hubble news and images, as well as much other information.

THE CURRENT SITE

Some background to the role, history and current composition of the ST-ECF is provided under the button "About ST-ECF". Access to the Phase 1 and Phase 2 tools was provided under the menu "Observing with HST" and access to the HST archive at the ST-ECF was provided under "Science Data Archive". This menu page also provided access to the ESO archive, where developments in querying the archives followed closely on the developments pioneered for the HST archive physically accessible at ESO. More recently the Hubble Legacy Archive was added, as was access to Advanced Data Products deriving from the Great Observatories Origins Deep Survey (GOODS).

The largest menu item is concerned with instrument science and its contents run like a history of ST-ECF instrument activities, from FOS calibration enhancement to slitless spectroscopy with WFC3. These projects often involved reduction software, along with planning and simulation tools, and these were all provided. A separate section "Software Tools" provides access to various IRAF and Python tools developed in the course of a number of projects and also includes a link to the Scisoft astronomical software bundle. The records of the extensive coordination activities between ESA and ESO (and in particular the reports of the four ESA–ESO Working Groups) are available under "Coordination Activities" and other documents (not forgetting the 48 issues of the ST-ECF *Newsletter*) are available under "ST-ECF documents". Finally conference reports and proceedings that the ST-ECF either organised, or was involved with, are available under "Conferences".

THE FUTURE

So what to do about the ST-ECF web when the ST-ECF no longer exists as an entity and a group of astronomers, software specialists, outreach people and an invaluable secretary disperse? Clearly every effort has to be made to ensure that unique information is not lost, when some day, the web pages are no longer accessible. Equally unacceptable is to have old and out-of-date information appearing on the web. It was decided therefore to have a very short (three-month) freeze period when the pages will be available, but not updated, before the ST-ECF is shut down. For material available elsewhere, there will be links only and no repeated pages. Following a well-defined schedule, plans were made, beginning in 2009, for the transfer of project expertise and information to STScI.

A series of monthly telecons, under the chair of Dorothy Fraquelli at STScI, has been underway since March 2010 to arrange the details of this transfer. The aim is that the web pages holding the "historical" ST-ECF content — viz. *Newsletters*, conference proceedings, ESO–ESA Working Group reports, etc., be available from the spacetelescope.org site for public outreach material. Some of the pages carry information that is fully provided by STScI (such as "Observing with HST") and will be removed. For the instrument science, the pages have been transferred to STScI and support will continue through the Instrument Groups, such as ACS slitless spectroscopy and WFC3 slitless spectroscopy. When the replacement pages are live at STScI, the ST-ECF pages will carry a link to the relevant STScI pages until the ST-ECF web pages are closed.

After March 2011, the ST-ECF web will no longer be live. A full copy will be kept privately for historical purposes only. No dust will gather on these runes.

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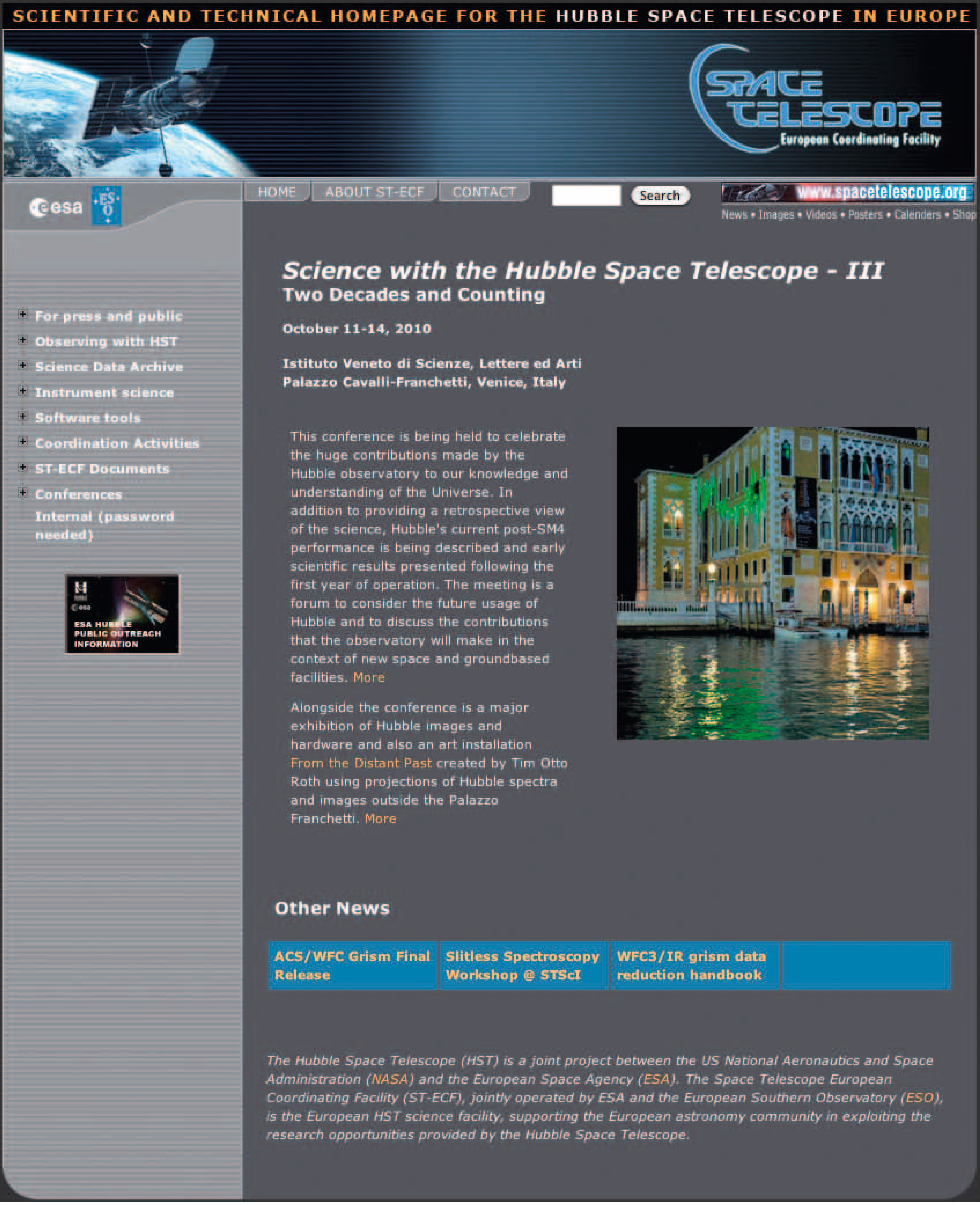


Fig. 1: *The last ST-ECF homepage as it appeared in December 2010.*

STARRY-EYED HUBBLE CELEBRATES 20 YEARS OF AWE AND DISCOVERY

heic1007

The best recognised, longest-lived and most prolific space observatory zooms past a milestone of 20 years of operation. On 24 April 1990, the Space Shuttle and crew of STS-31 were launched to deploy the NASA/ESA Hubble Space Telescope into a low-Earth orbit. What followed was one of the most remarkable sagas of the space age.

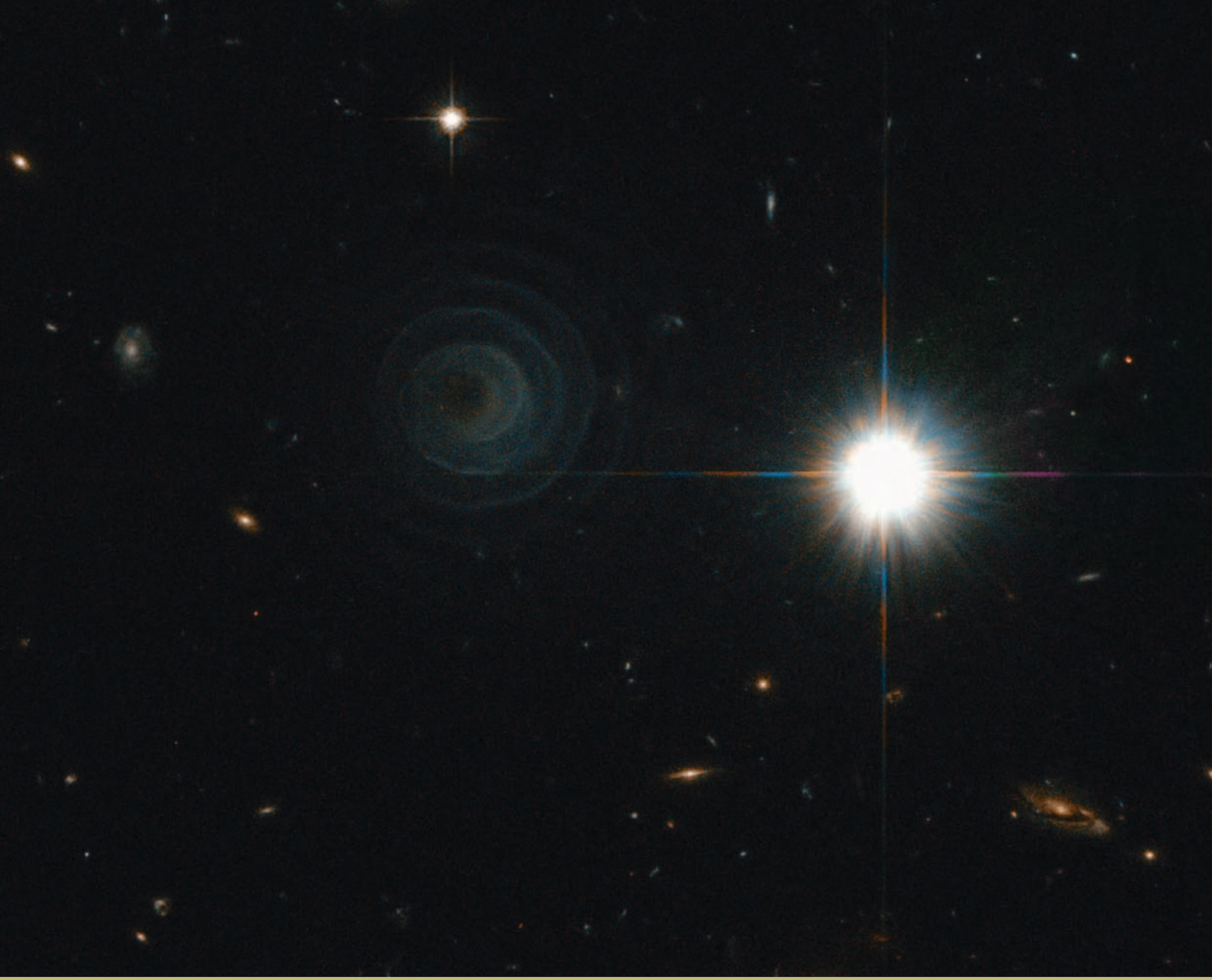
Credit: NASA, ESA, M. Livio and the Hubble 20th Anniversary Team (STScI)

HUBBLE SNAPS SHARP IMAGE OF COSMIC CONCOCTION

heic1012

A colourful star-forming region is featured in this stunning new NASA/ESA Hubble Space Telescope image of NGC 2467. Looking like a roiling cauldron of some exotic cosmic brew, huge clouds of gas and dust are sprinkled with bright blue hot young stars.

Credit: NASA, ESA and Orsola De Marco (Macquarie University)



AN EXTRAORDINARY CELESTIAL SPIRAL

This remarkable picture from the Advanced Camera for Surveys on the NASA/ESA Hubble Space Telescope shows one of the most perfect geometrical forms created in space. It captures the formation of an unusual pre-planetary nebula, known as IRAS 23166+1655, around the star LL Pegasi (also known as AFGL 3068) in the constellation of Pegasus (the Winged Horse).

The striking picture shows what appears to be a thin spiral pattern of astonishingly regularity winding around the star, which is itself hidden behind thick dust. The spiral pattern suggests a regular periodic origin for the nebula's shape. The material forming the spiral is moving outwards a speed of about 50 000 km/hour and, by combining this speed with the distance between layers, astronomers calculate that the shells are each separated by about 800 years.

The spiral is thought to arise because LL Pegasi is a binary system, with the star that is losing material and a companion star orbiting each other. The spacing between layers in the spiral is expected to directly reflect the orbital period of the binary, which is indeed estimated to be also about 800 years.

The creation and shaping of planetary nebulae is an exciting area of stellar evolution. Stars with masses from about half that of the Sun up to about eight times that of the Sun do not explode as supernovae at the ends of their lives. Instead a more regal end awaits them as their outer layers of gas are shed and drift into space, creating striking and intricate structures that to Earth-bound observers often look like dramatic watercolour paintings. IRAS 23166+1655 is just starting this process and the central star has yet to emerge from the cocoon of enveloping dust.

This picture was created from images from the Wide Field Channel of the Advanced Camera for Surveys on Hubble. Images through a yellow filter (F606W, coloured blue) were combined with images through a near-infrared filter (F804W, coloured red). The exposure times were 11 minutes and 22 minutes respectively and the field of view spans about 80 arcseconds.

Credit: ESA/NASA & R. Sahai

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DOING CARTWHEELS TO CELEBRATE THE END OF AN ERA

An image of the Cartwheel Galaxy taken with the NASA/ESA Hubble Space Telescope has been reprocessed using the latest techniques to mark the closure of the Space Telescope European Coordination Facility (ST-ECF), based near Munich in Germany, and to celebrate its achievements in supporting Hubble science in Europe over the past 26 years.

Astronomer Bob Fosbury, who is stepping down as Head of the ST-ECF, was responsible for much of the early research into the Cartwheel Galaxy along with the late Tim Hawarden — including giving the object its very apposite name — and so this image was selected as a fitting tribute. This unusual object seems to have been first noted independently by Zwicky and Ambartzumian. It was then re-discovered on wide-field images from the UK Schmidt telescope and subsequently studied in detail using the Anglo-Australian Telescope.

Lying about 500 million light-years away in the constellation of Sculptor, the cartwheel shape of this galaxy is the result of a violent galactic collision. A smaller galaxy has passed right through a large disc galaxy and produced shock waves that swept up gas and dust — much like the ripples produced when a stone is dropped into a lake — and sparked regions of intense star formation (appearing blue). The outermost ring of the galaxy, which is 1.5 times the size of our Milky Way, marks the shock wave's leading edge. This object is one of the most dramatic examples of the small class of ring galaxies.

This image was produced after Hubble data was reprocessed using the free open source software FITS Liberator 3, which was developed at the ST-ECF. Careful use of this widely used state-of-the-art tool on the original Hubble observations of the Cartwheel Galaxy has brought out more detail in the image than ever before.

Although the ST-ECF has closed, ESA's mission to bring amazing Hubble discoveries to the public will be unaffected, with Hubblecasts, press and photo releases, and Hubble Pictures of the Week continuing to be regularly posted on spacetelescope.org.