ST-ECF NEWSLETTER

December 2009

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Hubble Science Conference

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Space Telescope
European Coordinating Facility

HUBBLE UPDATE

ERO IMAGES AND INFORMATION ABOUT THE NEW INSTRUMENTS

Jeremy Walsh

Following the release of the Hubble Space Telescope by the Shuttle Atlantis on 19 May at the end of the very successful Servicing Mission 4 (SM4), the Servicing Mission Orbital Verification (SMOV) phase began at once. SMOV is a very complex set of nested activities as instruments are turned on, checked out, tuned and gradually brought to their full science operation capability. On account of the risk of outgassed material being deposited on reflecting or transmitting optics, first light could not occur for several weeks after the release and for the ultraviolet instruments, such as the Cosmic Origins Spectrograph (COS), not for more than a month. The early checks showed that the new instruments were fully functioning and the only instrument repair that had not been successful was the fix for the Advanced Camera for Surveys (ACS) High Resolution Channel (HRC).

Even before the Wide Field Camera 3 (WFC3) was fully tested, Target of Opportunity images of the unexpected collision of a small body with Jupiter were made on 24 July 2009 with the UVIS channel (Figure 1). The checkout of the instruments proceeded extremely well, with ACS achieving, or even exceeding its old performance, allowing for two and a half years of detector exposure to ionising radiation causing charge-transfer efficiency (CTE) degradation. The Space Telescope Imaging Spectrograph (STIS), whose power supply failed in 2004, also showed the expected level of CTE loss for the CCD detector, and apart from increased dark current, shows excellent performance. The STIS near-UV MAMA detector, however, displays a much higher level of phosphorescent glow from the detector window, due to the presence of impurities, than was predicted and, although declining with time, will affect faint object spectroscopy.

The instrument that was the last to be re-commissioned after SM4 was NICMOS. The NICMOS Cryocooler System (NCS) proved recalcitrant to restart but eventually the high-speed Ne pump achieved a full cool-down by mid-September. However, NICMOS was affected by an independent problem, when the Science Instrument and Data Handler (SI&DH) hung. This data interface was the one whose failure delayed SM4 in September 2008 and the astronauts replaced this unit. When the SI&DH hangs, NCS and NICMOS are switched to safe mode and begin to warm up. Since there is a danger that if the NCS is restarted quickly ice may condense in the cryocooler, with the possible result of catastrophic damage, it must be completely warmed-up before a cooling cycle can begin. The cryocooler takes about one month to cool NICMOS to its operating temperature of 80K, and, since the SI&DH has hung twice more, NICMOS has not reached operating temperature again since September. The cause of the SI&DH problem is not yet diagnosed (it can be cured by a power cycling of the electronics) but the effect on the other instruments amounts only to an interruption of operations.

The two new instruments, COS and WFC3, have fulfilled all expectations and in the case of WFC3 have shown an increased throughput in comparison with the ground tests. Rather than reflecting anything unexpected, it serves to emphasise that it is very difficult to perform absolute calibrations on the ground. The two infrared grisms in WFC3, which are supported by the ST-ECF and whose in-orbit calibration is described in Kuntschner et al. in this Newsletter (page 4), also show the same throughput increase. The orbital verification of COS has shown excellent performance with, for example, the far-UV dark count about three times lower than the pre-launch predictions and sensitivities close to the expected values. For both of these instruments extensive calibration activities will continue throughout Cycle 17.

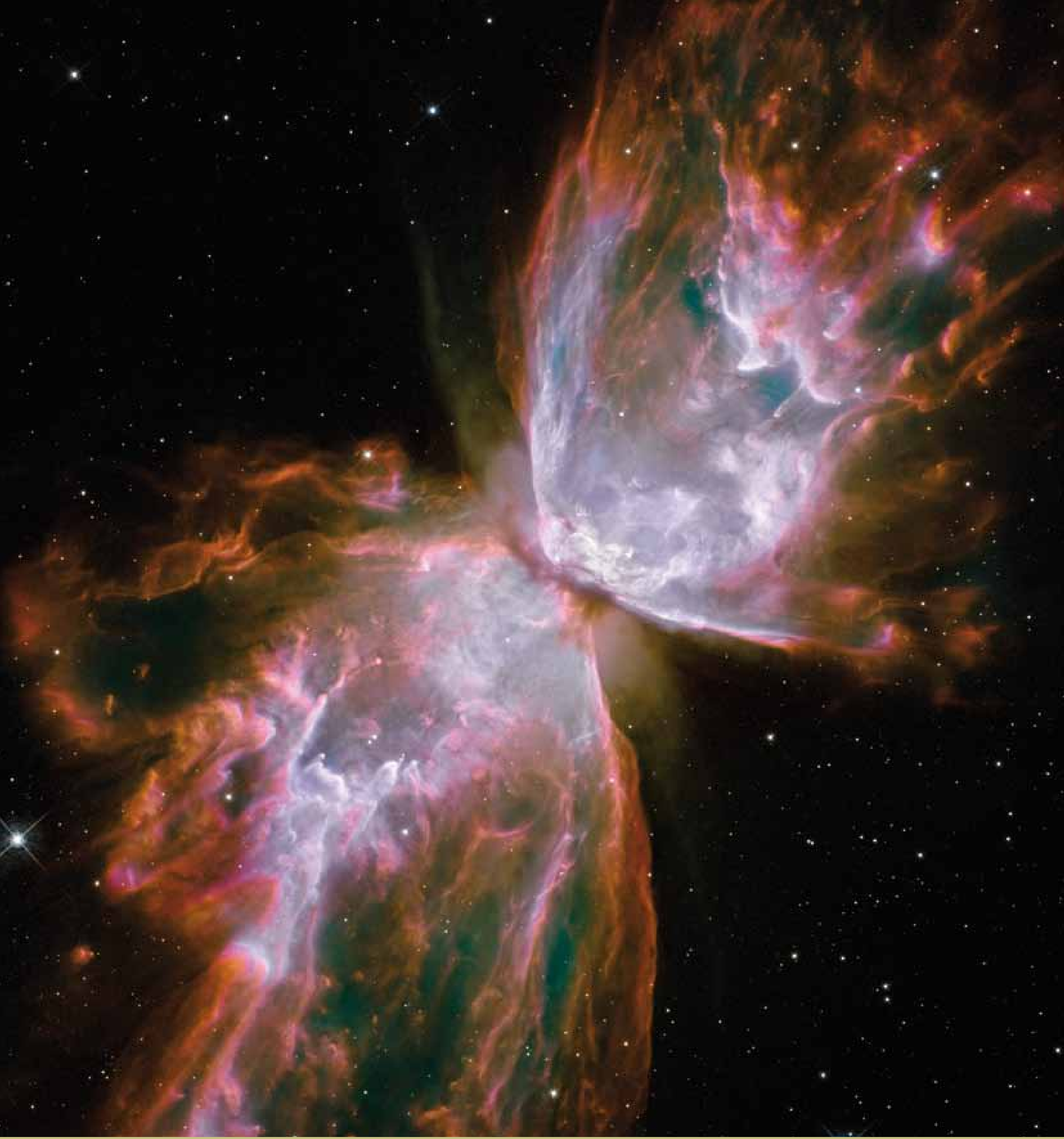
Credit: NASA, ESA, Michael Wong (Space Telescope Science Institute, Baltimore, MD), H. B. Hammel (Space Science Institute, Boulder, CO) and the Jupiter Impact Team

Fig. 1: *This Hubble picture, taken on 23 July, is the first full-disc, natural-colour image of Jupiter made with Hubble's new camera, the Wide Field Camera 3 (WFC3). It is the sharpest visible-light picture of Jupiter since the New Horizons spacecraft flew by that planet in 2007. Each pixel in this high-resolution image spans about 119 kilometres in Jupiter's atmosphere. Jupiter was more than 600 million kilometres from Earth when the images were taken.*

On 9 September 2009 images and spectra from the new and refurbished instruments were made public at a press conference held by NASA. Since then an increasing fraction of the time has been devoted to General Observer (GO) observations and, for COS, Guaranteed Time Observations (GTO) to the COS instrument team and, for WFC3, Early Release Science planned by the WFC3 Science Oversight Committee (SOC). Already new results have started appearing, most newsworthy being the detections of high redshift ($z > 7$) galaxy candidates from WFC3 deep imaging by several competing groups (see page 14).

The deadline for proposals for Cycle 18 is 26 February 2010 and before that the results of the Multi-Cycle Treasury (MCT) time allocation will be announced. A total of 39 MCT proposals were submitted, requesting 26 800 orbits, and the specially convened TAC will meet to judge the proposals in early January 2010. The number of available orbits for Cycle 18 GO proposals will then depend on how many MCT proposals are allocated for Cycle 18.

Credit: NASA, ESA and the Hubble SM4 ERO Team



BUTTERFLY EMERGES FROM STELLAR DEMISE IN PLANETARY NEBULA NGC 6302

[heic0910]

The Wide Field Camera 3 (WFC3), a new camera aboard the NASA/ESA Hubble Space Telescope, snapped this image of the planetary nebula, catalogued as NGC 6302, but more popularly called the Bug Nebula or the Butterfly Nebula. WFC3 was installed by NASA astronauts in May 2009, during the Servicing Mission to upgrade and repair the 19-year-old Hubble.

NGC 6302 lies within our Milky Way galaxy, roughly 3800 light-years away in the constellation of Scorpius. The glowing gas is the star's outer layers, expelled over about 2200 years. The "butterfly" stretches for more than two light-years, which is about half the distance from the Sun to the nearest star, Proxima Centauri.

CALIBRATING THE WFC3 GRISMS

Harald Kuntschner, Martin Kümmel, Jeremy Walsh & Howard Bushouse (STScI)

The newly installed Wide Field Camera 3 (WFC3) on the Hubble Space Telescope is fitted with three grisms for slitless spectroscopy that cover the near-UV and near-IR wavelength ranges. During Servicing Mission Orbital Verification (SMOV) and early Cycle 17 calibration activities, the ST-ECF led the verification process for the IR grisms to ensure that they were working correctly and established the in-orbit calibrations. First results from these calibrations show excellent performance of the IR grisms. Additionally, we have released new versions of the integrated, semi-automatic data-reduction package aXe for Cycle 17 users and the slitless spectroscopy simulation package aXeSIM for Cycle 18 preparation.

INTRODUCTION

The Wide Field Camera 3 (WFC3) provides spectroscopic capabilities via three grisms. In the UVIS channel there is one grism, G280, for the near-UV to visible range (200–400 nm). The near-infrared (NIR) channel has two grisms, G102 and G141, for the shorter (800–1150 nm) and longer NIR wavelengths (1100–1700 nm), respectively. Table 1 summarises the capabilities of the three WFC3 grisms in first-order mode. Through a Memorandum of Understanding (MoU) the ST-ECF is responsible for the calibration of the WFC3 grisms, the provision of reference files, the provision of data-reduction software and user support. The WFC3 grisms were tested in three thermal vacuum ground calibration campaigns (TV1–TV3) and preliminary calibration files for trace, wavelength and throughput were derived. During the recent Servicing Mission Orbital Verification (SMOV) programme, which took place from June to September 2009, throughput and wavelength calibration proposals were carried out for the two IR grisms. Further calibrations, including the UVIS grism, will be carried out in the Cycle 17 calibration programme.

Tab. 1: *WFC3 UVIS and IR grism parameters*

Grism	Channel	Wavelength range (nm)	Resolving power	Dispersion (nm/pixel)
G280	UVIS	200–400	~70 @ 300 nm	1.4
G102	IR	800–1150	~210 @ 1000 nm	2.45
G141	IR	1100–1700	~130 @ 1400 nm	4.65

Slitless spectroscopy has some special features and properties, which require a dedicated extraction package. A slitless dataset usually consists of a dispersed image and a corresponding direct image taken at the same position in order to derive the wavelength zeropoint. Because the spectral resolving power is often low, there are typically multiple spectral orders for the same object visible in a single dispersed image. The absence of slits makes contamination, which is the mutual overlap of spectra from different sources, a ubiquitous phenomenon in both the spatial direction and the dispersion direction, even across different spectral orders and over distances of many hundreds of pixels.

The aim of the SMOV and Cycle 17 calibration programmes is to provide field-dependent trace, wavelength and throughput calibrations, which together with our software package aXe can be used to extract the spectra of the many hundreds of sources in deep grism exposures.

SMOV OBSERVATIONS AND CALIBRATIONS

The SMOV calibrations for the IR grisms (Program 11552; PI: Bushouse) comprise observations of the Hubble primary flux standard star GD153, and the compact planetary nebula HB12 (= PN G111.8-02.8) as a wavelength calibrator, at several positions over the field-of-view (hereafter FoV) of WFC3. Furthermore, we made use of the Cycle 17 calibration programme 11937 (PI: Bushouse), that comprises observations of another planetary nebula Vy2-2 (= PN G045.4-02.7) over nine different field positions.

As is typical for slitless spectroscopy, the first order spectrum is often not the only one visible on the dispersed image. Depending on detector size and dispersion, additional spectral orders are often recorded. An example of a G102 grism observation of the flux standard star GD153 with a F098M direct image (circled) superimposed to illustrate the relative positions is shown in Figure 1 (top panel). Spectral orders 0, +1, and +2 can be seen on the image. The image shows the full extent of the detector in the x-axis (1014 pixels) and about 200 pixels in the y-axis. For the lower dispersion G141 grism (see Figure 1; bottom panel) orders 0, +1, +2, and +3 can be seen. Depending on the source location, even negative orders or higher positive orders can appear on the dispersed images.

The IR grisms show excellent in-orbit performance. They provide peak total throughputs, including all Hubble optics and the detectors, of 42% and 48% for the G102 and G141 grisms respectively. As shown in Figure 2, the two IR grisms together deliver >10% total throughput over the wavelength range 800 to 1700 nm. As compared to the ground calibration estimates, the in-orbit performance exceeds the expectations by up to 10%.

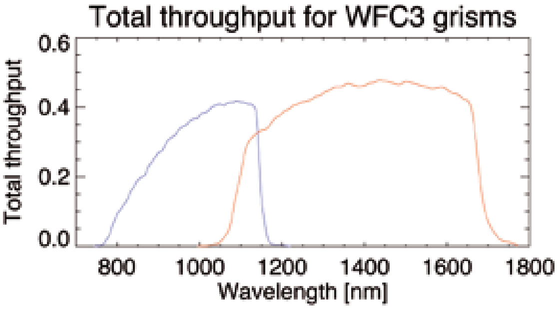


Fig. 2: *Total throughput, including detectors and Hubble optics, for G102 (blue) and G141 (red) grisms in the IR channel of WFC3.*

Slitless spectroscopy of the planetary nebula Vy2-2 was used to establish a field-dependent calibration of the trace and dispersion solutions for the IR grisms. Consistent with the ground calibration results, the in-orbit dispersion solution for the first order varies smoothly across the FoV ranging from 2.36 to 2.51 nm/pixel for the G102 grism. For the G141 grism the first order dispersion varies from 4.50 to 4.77 nm/pixel across the FoV. A more detailed analysis of the IR grism calibrations is provided in two WFC3 Instrument Science Reports (Kuntschner et al., 2009a; 2009b).

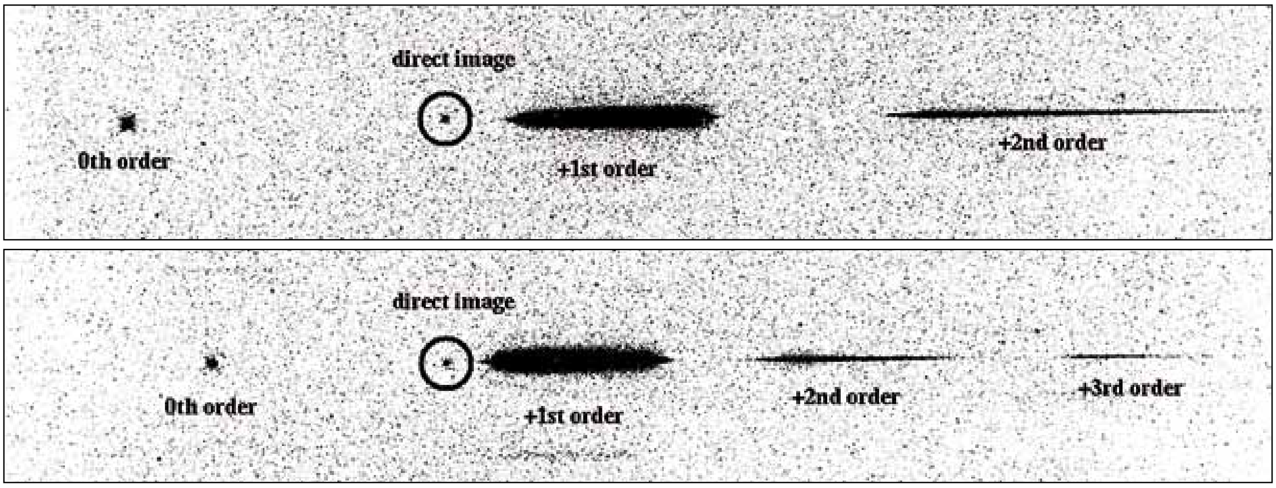


Fig. 1: *WFC3 IR grism observations of the flux standard star GD153 for the G102 (top) and G141 (bottom) configurations. To illustrate the relative positions, a direct image (shown circled) in the F098M (top) and the F140W (bottom) filter is superimposed on the grism image.*

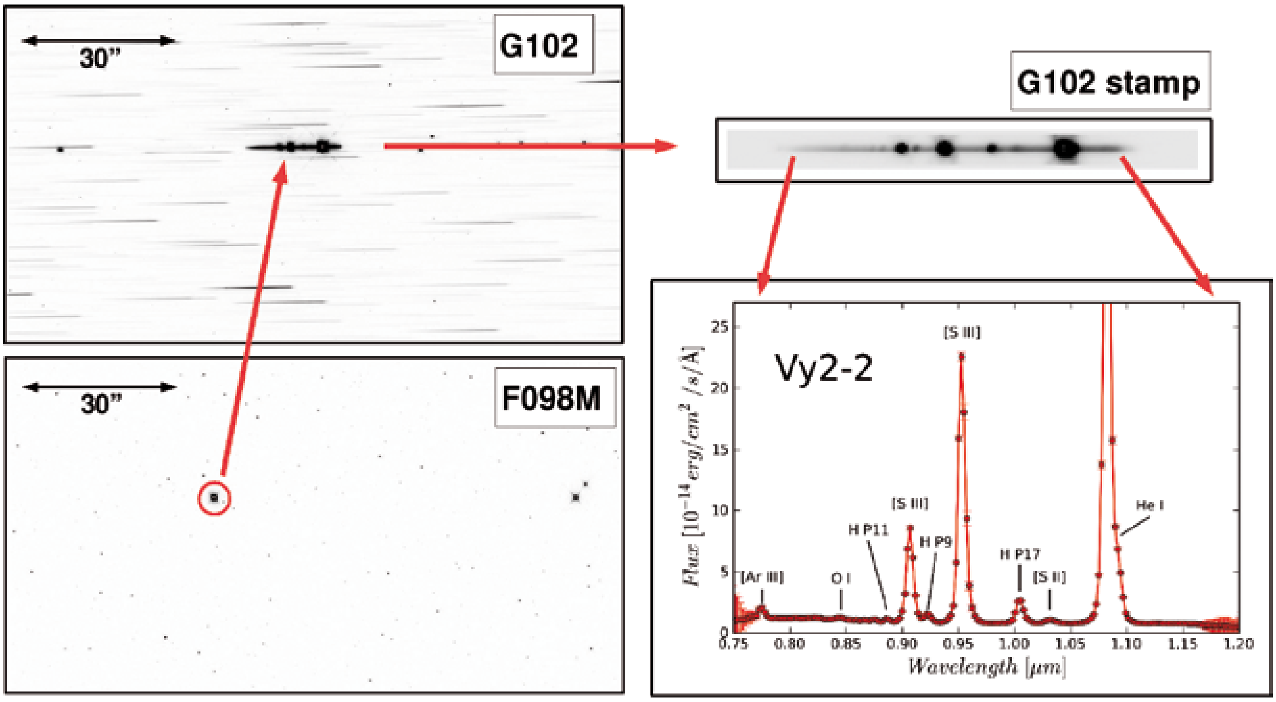


Fig. 3: *Example of G102 observations of the planetary nebula Vy2-2 and the source spectrum extraction with aXe. The left panels show an example of a G102 dispersed image (top) together with its associated direct image in the F098M filter (bottom). The right panels show the combined, aXedrizzled stamp image from the entire dataset (top) and the extracted one-dimensional spectrum (bottom) with the identification of prominent emission lines.*

DATA REDUCTION WITH AXE AND SIMULATIONS

In order to facilitate extraction of the source spectra from the WFC3 grism modes, we offer the software package aXe (Kümmel et al., 2009). Originally, aXe was developed to handle large-format spectroscopic slitless images from the Advanced Camera for Surveys (ACS) on Hubble. However, it has been also used for data from other instruments, e.g., to extract NICMOS G141 grism spectra for the Hubble Legacy Archive (HLA) project (Freudling et al., 2008). aXe is a PyRAF/IRAF package which consists of several tasks and forms part of the STScI STSDAS package (in the sub-package analysis.slitless.axe).

The starting point for the software is a catalogue of source positions in the accompanying direct image typically obtained with SExtractor (Bertin & Arnouts, 1996). The aXe tasks perform specific processing steps, such as the preparation of grism images and the extraction of first order two-dimensional ("stamp" image) and one-dimensional spectra, resampled to a linear wavelength scale and calibrated to an absolute flux scale. An example can be seen in Figure 3. The mutual overlap of spectra from different sources and spectral orders ("contamination") is tracked so that each output stamp image and one-dimensional spectrum carries the quantitative information on the contamination from neighbouring objects. Furthermore, aXe calculates statistical error estimates for each spectrum by propagating the initial noise (Poisson and read-out noise) through the entire extraction process.

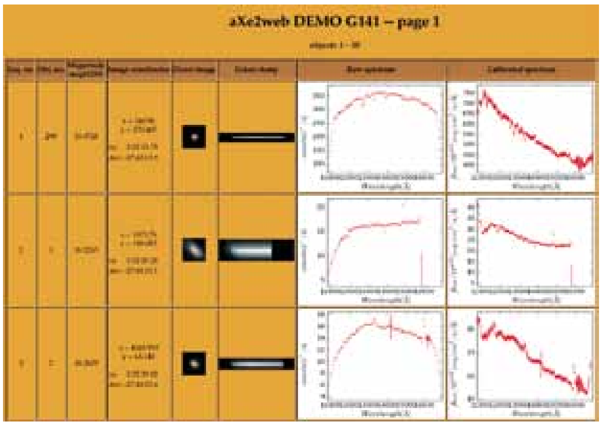
If several grism observations of the same field exist, spectra can be combined with an implementation of the drizzling code ("aXedrizzle"; see also Figure 3). The software was designed to be able to handle hundreds of spectra simultaneously.

We also provide the task axe2web, which produces web pages that show for each source in the extraction catalogue a postage stamp image from the direct image, the two-dimensional spectrum and a one-dimensional spectrum in units of detected counts and flux calibrated. An example of such a web page is given in Figure 4. These pages are a useful tool to provide a quick overview of the extracted spectra and the ability to identify potential problems in the data reduction.

Version 2.0 of the aXe software has just been released to the community as part of the STSDAS release 3.11 (November 2009). In addition, the aXe software is also offered so that it may be installed as an external PyRAF package at: www.stecf.org/software/slitless_software/axe/. The software has been extensively used and tested in the WFC3 calibration efforts in order to offer users a stable data reduction tool.

Configuration and calibration files, describing the trace, wavelength and throughput calibrations for several orders of the WFC3 IR grisms, derived from the recent in-orbit calibrations are provided at www.stecf.org/instruments/WFC3grism/ and can be directly used with the aXe software package. In-orbit calibrations for the WFC3 UVIS G280 grism will be derived in the near future.

Planning for new grism exposures can be a difficult task if, for example, one is interested in faint sources in the vicinity of brighter objects where spectral overlap (contamination) is a risk. In order to help users with this task, we provide the simulation package aXeSIM. This package needs as input a SExtractor-style catalogue of object positions, sizes and magnitudes. A single task can then produce a simulated direct image and a dispersed image for a given choice of spectral energy distribution. Figure 5 shows an example of a simulation for the F098M filter and the WFC3/IR G102 grism. Like aXe, aXeSIM is distributed as part of STSDAS (in the sub-package analysis.slitless.axesim) and as an external package at: www.stecf.org/software/slitless_software/axe/. In addition we offer the option to run aXeSIM, with somewhat reduced functionality, on our web pages via the web application aXeSIMweb at:



aXe2web DEMO G141 – page 1

__Fig. 4:__ Example of web pages produced by the task axe2web. Information on object number, brightness, position and image cutouts for the direct image, two-dimensional and one-dimensional spectra (left to right) is provided for each extracted source spectrum.

www.stecf.org/instruments/aXeSIMweb/

aXeSIMweb has been fully updated to reflect the in-orbit determinations of trace, wavelength and throughput calibrations. The main purpose of these simulations is to provide the two-dimensional distribution of the source spectra for a given input catalogue. Signal-to-noise evaluations on single sources for Cycle 18 proposals should be carried out with the Exposure Time Calculator at STScI.

www.stsci.edu/hst/wfc3/tools /etcs

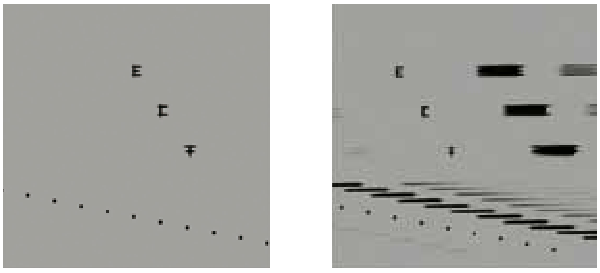


__Fig. 5:__ Simulation of a F098M image (300 s exposure) and the associated WFC3/IR G102 grism image (1000 s exposure) for a K0V template spectrum. The simulation was performed with the web implementation of the aXeSIM package. The various spectral orders ranging from -1 to +3 can be seen. The grism produces spectra for even higher or lower spectral orders, however, they are not yet implemented in the configuration files.

FUTURE ACTIVITIES

The main future tasks related to the WFC3 grisms include the derivation of in-orbit calibrations for the UVIS G280 grism, the monitoring of the stability for all grisms and the preparation for the handover of instrument grism expertise and calibrations files to STScI in 2010. On the software side we plan to implement an automatic rejection of bad pixels in the spectral drizzling routine of aXe and are preparing the software to be fully compatible with the foreseen software developments at STScI.

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Kuntschner, H., Bushouse, H., Kümmel, M. & Walsh, J. 2009, WFC3 ISR 2009-18

A NEW ARCHIVE WEB INTERFACE

Felix Stoehr, Marco Lombardi & Alberto Micol (ESO)

There are now more than one million Hubble datasets available in our archive and the number is growing daily. One of the goals of the ST-ECF is to allow scientists or amateur astronomers to find their personal needles in this huge haystack. We have developed a new web interface that makes use of latest web technologies as well as a large amount of metadata — information about the data — to make it more convenient and easy to query and browse the Hubble archive.

This new interface can be accessed through:

archive.eso.org/archive/hst/search

THE NEW WEB INTERFACE

Scientific data can be well characterised by a set of metadata values. In the Hubble Cache project, a lot of effort was devoted to improving the quality and the quantity of metadata available [1,2]. This covers the physical description of the data on the spatial, spectral and temporal axes but also includes derived metadata such as the instrument footprint on the sky or the data type (imaging, one-dimensional spectroscopy, etc). The new metadata were conceived to make scientific exploitation of the archive as effective as possible. The goal is to decrease the knowledge of the Hubble internals needed to make proper use of the archive. As an example it is now possible to query for wavelength bands directly and use values such as "U or V or B".

We also developed a generic data model, which is a super-set of the metadata required for both the Common Archive Observation Model (CAOM) [3] and the emerging observation model for the Virtual Observatory (VO) Table Access Protocol (ObsTAP). This has the advantage that, once the metadata of a collection are entered into the structure, the data are immediately available not only through the web interface, but also through VO services [4].

Since 1994 the web interface of ST-ECF has been based on WDB [5], a Perl program that allows very convenient access to database tables. From a single configuration file, the form interface is automatically generated, the database queries are executed and the output is formatted. WDB has been improved over the years to include, for example, computed database columns, VOTable output, or the possibility to upload a file containing a list of targets.

With the many query fields available thanks to the new metadata, the WDB approach was no longer practical: The generated output form appeared too large and unreadable and the control over the look and feel of the interface seemed too limited. In addition, a web VOTable viewer, originally developed by Rick White at STScI was made available by Tom McGlynn [6]. We decided to redesign the archive web interface and to introduce modern web technologies based on JavaScript, Dynamic HTML, CSS, and AJAX, which are now often referred to collectively by the term "Web 2.0".

Fig. 1: *Main query page (at this stage without the one-line interface), output page and download page of the new web interface.*

THE FORM INTERFACE

While trying out different designs of the web interface a few key concepts emerged that we thought were important for us. We wanted to:

- Show to the user only information that is relevant in the actual view (e.g. query help is only available on the form screen).
- Where possible use concepts that users are already familiar with to keep the interface as intuitive as possible (e.g. query fields that can be opened, tooltips). For example the hidden tabs ("Result table", "Get data") might be familiar to users of internet shopping pages.
- Be very careful to use screen space wisely, i.e. not wasting space, reducing the amount of elements, grouping information where possible, avoiding the need for page scrolling where possible and where it is inevitable, allow for the most important information to always be seen (e.g. download

buttons) and at the same time keep the interface as simple as possible.

- Avoid having to navigate away from the page for normal use. We opted to place additional information into tooltips (e.g., help on query parameters or previews), which has the additional advantage that the information automatically disappears when it is no longer needed.
- Provide help for all key elements and give examples where they are useful.
- Show the user the full interface in one shot without forcing them to expand an advanced search box, i.e. reducing the number of necessary mouse clicks.

We have opted to show to the user by default only datasets that are science frames, that are available for immediate download and that are unique in the sense that we do not show members of an association if the association is part of the query result. The datasets obtained through the queries should therefore be particularly clean and relevant.

Nevertheless, we have also added the possibility to query for calibration, dark and bias frames, to query for data that cannot currently be downloaded, such as datasets that are still in their proprietary period and for the members of the associations by “unchecking” the corresponding check boxes.

For proprietary datasets we do not have all the necessary metadata available and therefore constraints in some query fields like the Data Type will not return any of them. A warning is issued to the user when the “Availability” checkbox is not checked.

As with the current standard interface, datasets can be downloaded either directly using the download manager or through the standard request handler if the requester desires the data to be shipped on CD, DVD, Blu-Ray or hard disks. In both cases the user can select to get calibrated, or uncalibrated data and optionally log files. For requests for associations, the members will be shipped automatically.

The backend of the archive is still WDB but this could easily be replaced if a new backend technology becomes available.

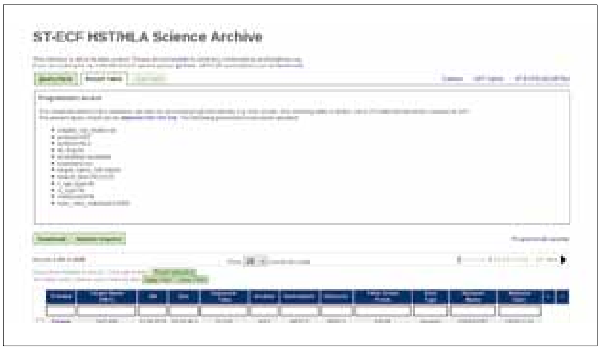

Fig. 2: *Programmatic access to all metadata and data is available.*

PROGRAMMATIC ACCESS

The archive is also accessible completely programmatically through the backend. As an example a VOTable of all the entries in the archive within 10 arcminutes of M101 can be obtained through

http://archive.eso.org/wdb/wdb/hst/hst_meta_science_votable/query?votable_out_mode=on&filt_flag=N&members=no&target_name=M101

The link “Programmatic access” on the “Result table” tab provides more information about how to formulated such queries. A good approach is to construct a query through the interface first, and then modify this query and rerun it from a script.

Similarly, all files in the archive can be obtained directly if the file_id is known via

http://archive.eso.org/archive/hst/proxy/ecfproxy?GZIPPED&file_id=

THE ONE-LINE ARCHIVE QUERY INTERFACE

In parallel with the development and improvement of the standard, form-based interface, we have also been developing a new one-line interface. This project has been driven by two simple ideas:

First, with the advent of powerful search engines on the web a large number of people are now familiar with this kind of interfaces, and appreciate their ability to perform both simple and complex queries. Examples can be found in many Google products (the standard web search engine, but also the search interface for messages in GMail or for RSS in the Google RSS reader) and on many e-commerce sites (such as Amazon). In the astronomical field, a similar product is used by the one-line NASA ADS interface.

Second, most quantities usually involved in astronomical archival searches should be easily understood by a “smart-enough” parser. For example, quantities such as Hubble instrument names, camera names, filters, optical element types (such as “filter” or “grism” or “prism”) can assume only a fixed set of single-word values. Slightly more complex values, such as principal investigator (PI) names or data type names (such as “imaging” or “2D spectroscopy”) still assume values from a fixed set of single or multi-word values. Real values, such as astronomical coordinates, search radii, exposure times, exposure dates, or observing wavelengths, usually can be easily disentangled from one another by their format (say hh:mm:ss for Right Ascension vs. ±dd:mm:ss for Declination) or from their units (30 arcsec is probably a search radius, while 2h is likely an exposure time). The only exception to this rule is represented by the target name, which clearly can have many different forms. However, since this is the only quantity that is not easily recognised, the parsing can still be done using a simple technique: everything that does not look like a known quantity must be a target name. This assumption can then be verified using the SIMBAD or NED name resolvers.

In this pragmatic approach, a query such as

ACS M42 F775W

is immediately understood to be a query for all instrument=ACS data taken with the filter=F775W around the (SIMBAD resolved) coordinates of M42. This simple example immediately highlights one of the advantages of the one-line query interface over the standard one: the user does not need to look for the right quantities and enter different values in the correct fields, but rather can mix together all values and still obtain sensible results.

In order to extend the language just described, we also introduced arithmetic operators and ranges for the numerical values. This way, one can extend the previous query by asking only for exposures longer than five minutes and taken from December 2004 to April 2005:

ACS M42 F775W >5min 2004-12-1..2005-4-30

Sometimes, one might want to explicitly specify the field to which a given value applies. This is always possible by attaching a tag to each value, and sometimes it is desirable to make clearer queries or to query seldom used quantities that could not be automatically recognised:

target="NGC 225" release_date<2008-01-01
pixel_scale=0.03..1arcsec

Note that fields such as the release_date or pixel_scale cannot be easily disentangled from similar, more common ones (in this case the observation date and the search radius), and need to be explicitly specified. Note also the optional use of quotes to group together words that have to be taken as a single value for a field.

Finally, we decided to complete our parsing language by introducing logical operators (and, or, xor, and not) and parentheses. These features mean that the new query language is very simple but also very powerful at the same time, and allows us to perform queries that could not be easily done with the standard form-based interface:

SYNTAX

Ideally, any astronomer should be able to perform simple queries with the new search engine without reading any documentation. However, in order to exploit the potential fully it might be useful to consider (at least informally) the syntax accepted by the parser.

A query is a list of words, optionally grouped together in phrases with single (') or double quotes ("). Grouped words will never be split and will never be joined to non-grouped ones; however, the parser will still try to join non-quoted words if they can be interpreted as a single value (for example a complete PI name).

As was explained above, tags and operators can prefix values. Allowed operators are the equal (=) and different (!= or <>) signs; for numerical values only, the inequality operators (>, <, =>, <=) are also accepted. Numerical tags can also use ranges, with the minimum and maximum values separated with two dots (min..max); both the minimum and the maximum values are optional (their default is zero and infinity, respectively). Note also that within ranges the unit of a numerical value does not need to be specified for both minimum and maximum: thus, 20..30min is interpreted as 20min..30min.

Values for the same or for different quantities can be joined with the logical operators (and, not, xor) or with simple spaces. In case only spaces are used, the following rule applies: values for the same tag are joined with an implicit "or"; values for different tags with an implicit "and". Hence

ACS NICMOS 5min..

is equivalent to

(instrument=ACS or instrument=NICMOS) and exptime>5min

Parentheses can be used to group tags or values. Note that parentheses can be used everywhere, even within values of a tag as in

instrument=(ACS NICMOS) exptime>5min

IMPLEMENTATION

A search engine for our newly designed language could be implemented using many different techniques. Initially we developed a Python prototype, but then we decided to switch to a completely different approach with much greater potential. We moved to a client-based engine, entirely written in JavaScript. This approach has many advantages with respect to a server-based Python engine:

We can deliver information on the entered string to the user in real time. This includes the way the parser split and interprets the current query and the possible presence of ambiguities or syntax errors, and the validity of SIMBAD or NED name resolutions. We can also have the one-line and standard form-based interfaces interact with each other. In this way, we can not only fill the one line interface when the user enter values on the form one, but also do the reverse (at least for the queries that are simple enough to be translated into a form-based search).

We can directly benefit by using the same parser to perform syntax highlighting on the search string and autocompletion, two actions that need to be performed in real-time on the client side. The query parser has been implemented using a robust, industry-standard parser generator, ANTLR [7]. The parser initially builds an abstract representation of the entered query (called Abstract Syntax Tree or AST) and then manipulates this representation to fill missing data (for example, it adds the "instrument" tag specification to the word "ACS" if no other tag has been specified). Finally, the tree is converted into a human-readable format (for syntax checks) and, eventually, to an SQL query to pass to the database.

USES

The major advantage of the new one-line interface should be a more direct interaction of the users with the Hubble archive. Ideally, this interface should speak a language much closer to the one used among astronomers, and should lead to “naturally expressed” queries. Hopefully this will not only encourage more people to use the archive, but will also inspire different uses of it. In particular, the interface does allow complicated queries that could not be performed with the standard form-based page.

OUTLOOK

In the near future we plan to extend the interface by introducing new features including autocompletion and the possibility to upload files with target names or coordinates. Comments, bug-reports or feature request to archive@eso.org would be highly appreciated.

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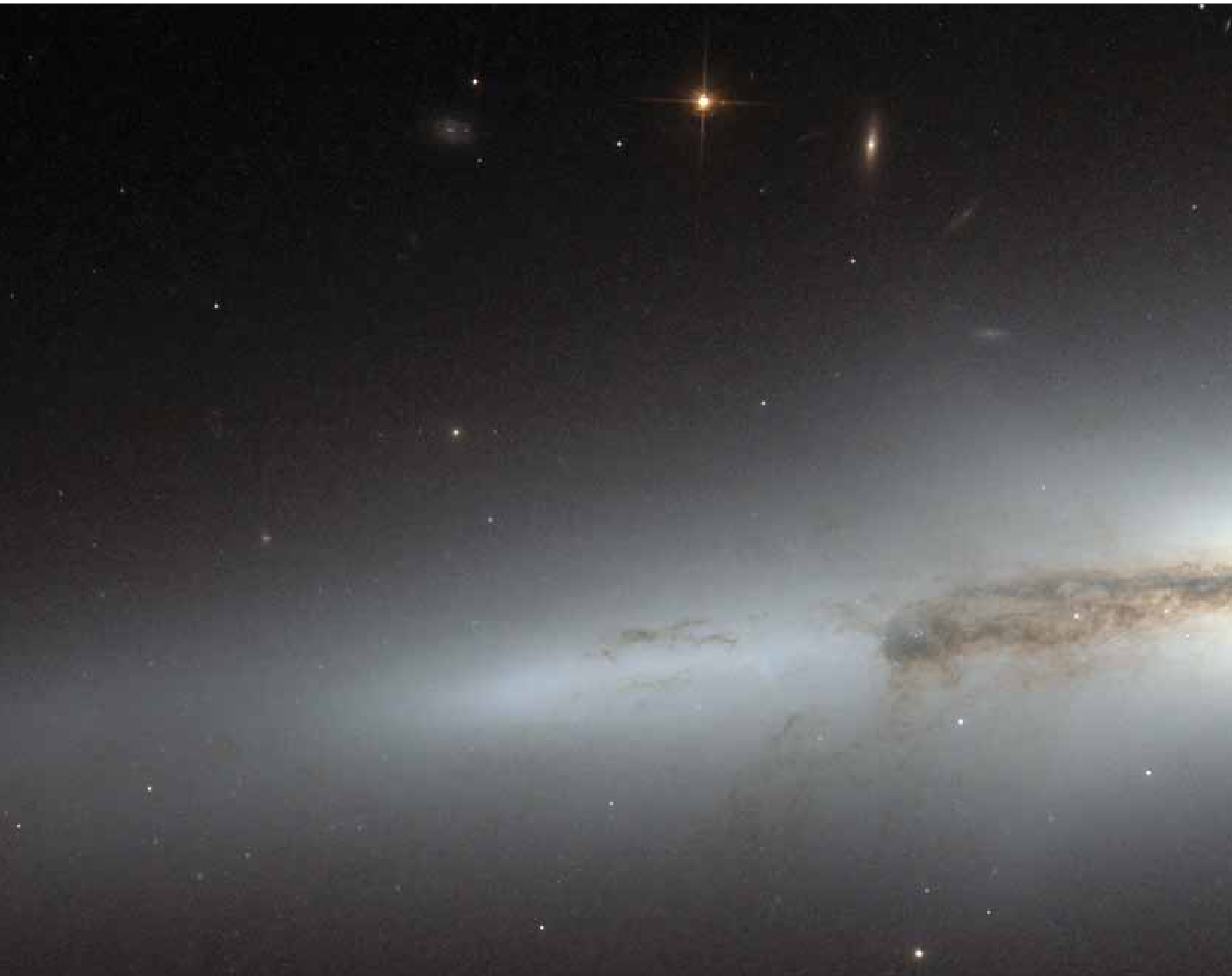


HUBBLE LOOKS AT SIDEWAYS NGC 4710

[heic0914]

Just as many people are surprised to find themselves packing on unexplained weight around the middle, astronomers find the evolution of bulges in the centres of spiral galaxies puzzling. A recent NASA/ESA Hubble Space Telescope image of NGC 4710 is part of a survey that astronomers have conducted to learn more about the formation of bulges, which are a substantial component of most spiral galaxies.

When targeting spiral galaxy bulges, astronomers often seek edge-on galaxies, as their bulges are more easily distinguishable from the disc. This exceptionally detailed edge-on view of NGC 4710 taken by the Advanced Camera for Surveys (ACS) aboard Hubble reveals the galaxy's bulge in the brightly coloured centre. The luminous, elongated white plane that runs through the bulge is the galaxy disc. The disc and bulge are surrounded by eerie-looking dust lanes.

When staring directly at the centre of the galaxy, one can detect a faint, ethereal "X"-shaped structure. Such a feature, which astronomers call a "boxy" or "peanut-shaped" bulge, is due to the vertical motions of the stars in the galaxy's bar and is only evident when the galaxy is seen edge-on. This curiously shaped puff is often observed in spiral galaxies with small bulges and open arms, but is less common in spirals with arms tightly wrapped around a more prominent bulge, such as NGC 4710.

NGC 4710 is a member of the giant Virgo Cluster of galaxies and lies in the northern constellation of Coma Berenices (the Hair of Queen Berenice). It is not one of the brightest members of the cluster, but can easily be seen as a dim elongated smudge on a dark night with a medium-sized amateur telescope. In the 1780s, William Herschel discovered the galaxy and noted it simply as a "faint nebula". It lies about 60 million light-years from the Earth and is an example of a lenticular or S0-type galaxy – a type that seems to have some characteristics of both spiral and elliptical galaxies.

Credit: NASA & ESA

[heic0917]

HUBBLE'S SHARPEST IMAGE OF THE ORION NEBULA WITH PROPLYD HIGHLIGHTS

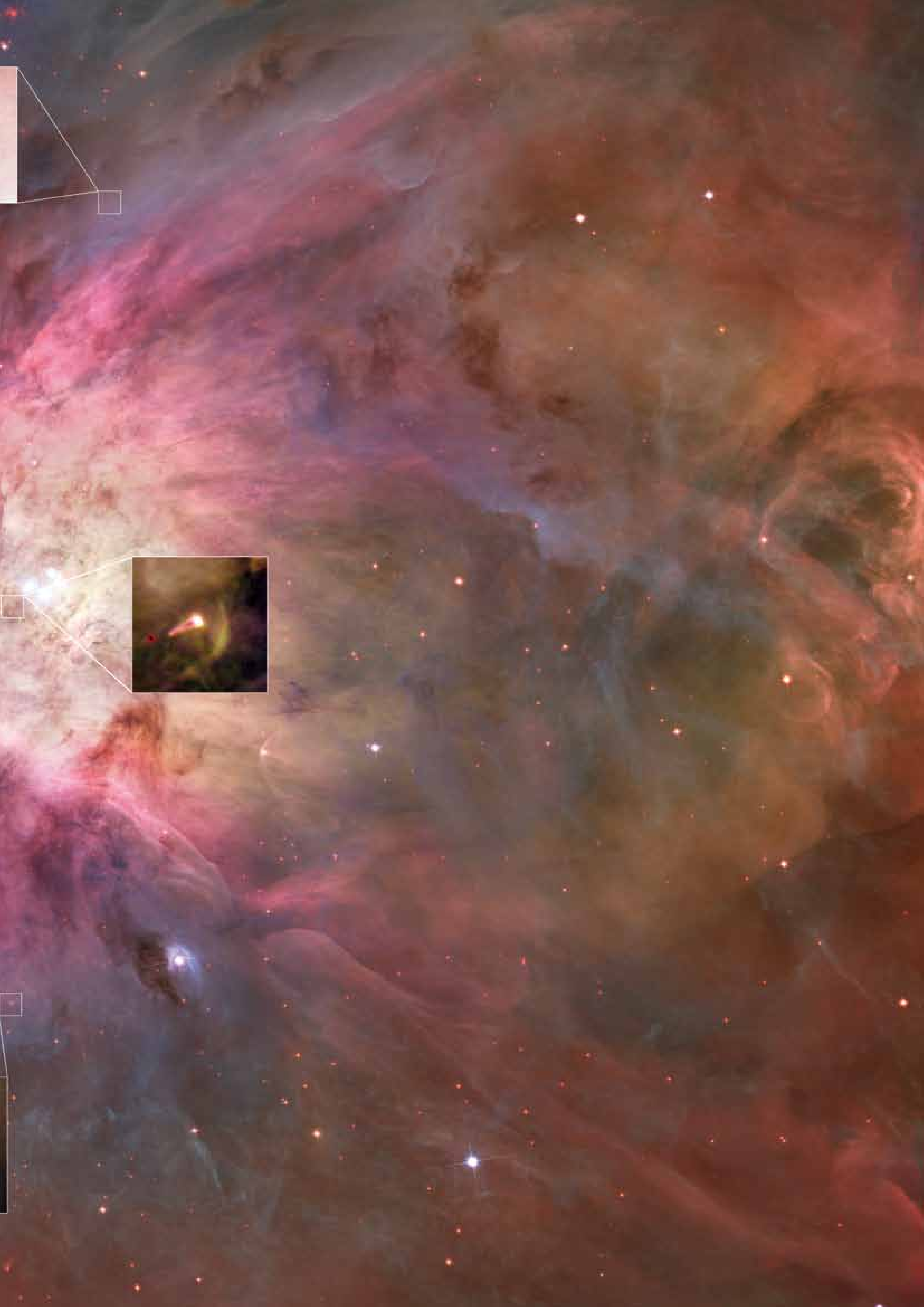
The gorgeous Orion Nebula is home to tens of what could be fledgling planetary systems. In this image, six of these modest "smudges" with big potential are highlighted. They have been selected from a collection of 30 never-before-released images of embryonic planetary systems in the Orion Nebula studied as part of the longest single Hubble Space Telescope project ever dedicated to the topic of star and planet formation.

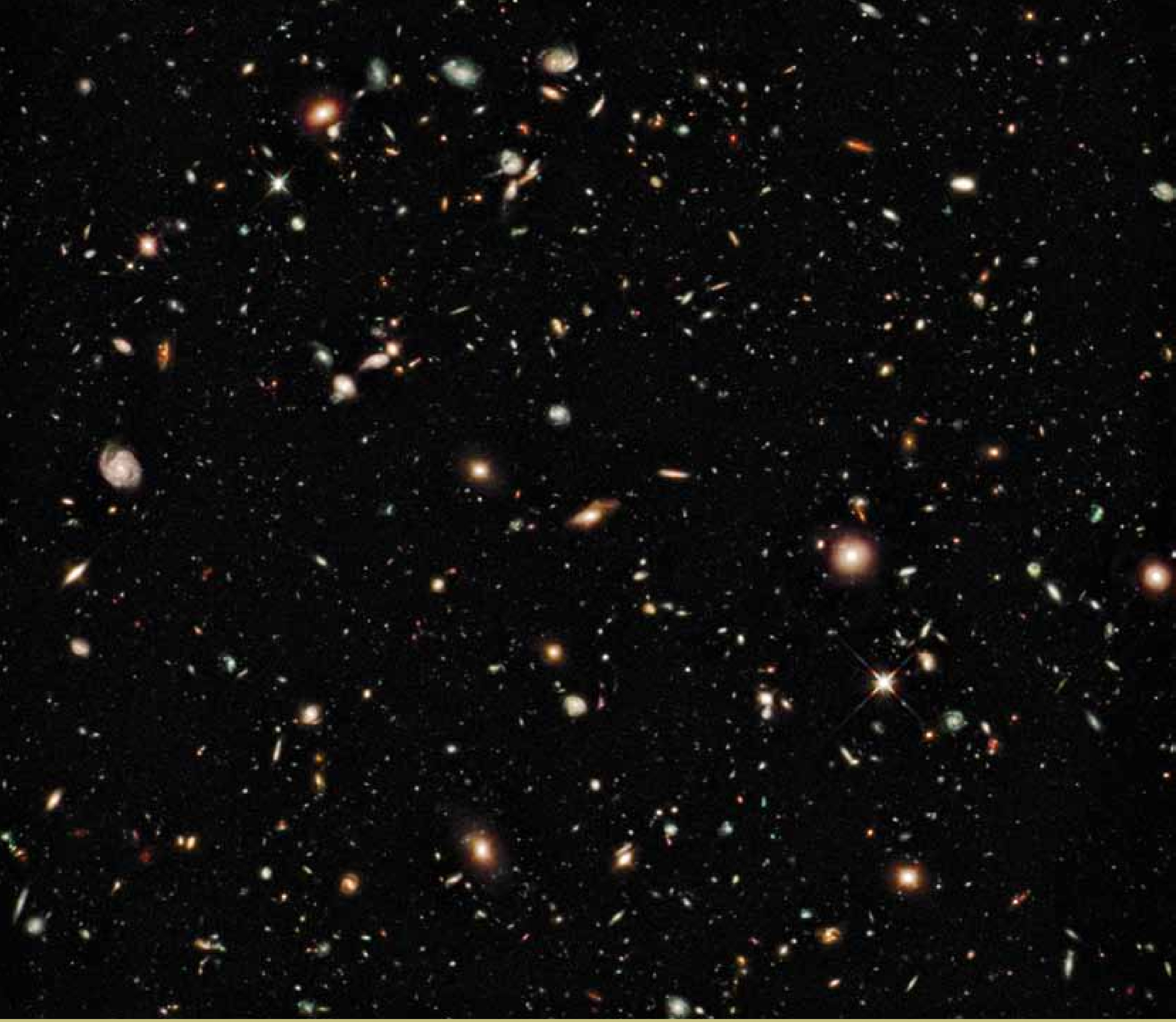
Also known as proplyds, or protoplanetary discs, these modest blobs surrounding baby stars are shedding light on the mechanism behind planet formation. Only the NASA/ESA Hubble Space Telescope, with its high resolution and sensitivity, can take such detailed pictures of circumstellar discs at optical wavelengths.

Within the awe-inspiring, gaseous folds of Orion, researchers have identified two different types of discs around young and forming stars: those that lie close to the brightest star in the cluster (Theta^{1} Orionis C) and those farther away from it. This bright star heats up the gas in the nearby discs, causing them to shine brightly. The discs that are farther away do not receive enough of the energetic radiation from the star to set the gas ablaze; thus, they can only be detected as a dark silhouette against the background of the bright nebula, as the dust that surrounds these discs absorbs background visible light.

The brighter discs are indicated by a glowing cusp in the excited material and facing the bright star, but which we see at a random orientation within the nebula, so some appear edge on, and others face on, for instance. Other interesting features enhance the look of these captivating objects, such as emerging jets of matter and shock waves. The dramatic shock waves are formed when the stellar wind from the nearby massive star collides with the gas in the nebula, sculpting boomerang shapes or arrows or even, in some cases, a space jellyfish!

Credit: NASA, ESA, M. Robberto (Space Telescope Science Institute/ESA), the Hubble Space Telescope Orion Treasury Project Team and L. Ricci (ESO)





[heic0916]

HUBBLE ULTRA DEEP FIELD: INFRARED

In 2004, Hubble created the Hubble Ultra Deep Field (HUDF), the deepest visible-light image of the Universe, and now, with its brand-new camera, Hubble is seeing even farther. This image was taken in the same region as the visible HUDF, but is taken at longer wavelengths. Hubble’s newly installed Wide Field Camera 3 (WFC3) collects light from near-infrared wavelengths and therefore looks even farther back towards the Big Bang, because the light from hot young stars in these very distant galaxies is stretched out of the ultraviolet and visible regions of the spectrum into near-infrared wavelengths by the expansion of the Universe. This new deep view also provides insights into how galaxies grew in their formative years early in the Universe's history.

A boon to astronomers worldwide, the new WFC3 data have set a multitude of teams to work, furiously searching for the most distant galaxies yet discovered. In just three months, twelve scientific papers on these new data have been submitted.

The photo was taken with the new WFC3/infrared camera on Hubble in late August 2009, during a total of four days of pointing for 173 000 seconds of total exposure time. Infrared light is invisible to the human eye and therefore does not have colours that can be perceived. The representation is "natural" in that shorter infrared wavelengths are represented as blue and the longer wavelengths as red. The faintest objects are about one billion times fainter than the dimmest visible objects seen with the naked eye.

These Hubble observations are blazing a trail for Hubble’s successor, the NASA/ESA James Webb Space Telescope (JWST), which will look even farther into the Universe than Hubble, at infrared wavelengths. The launch of JWST is planned for 2014.

Organised by ST-ECF, STScI and the Istituto Veneto di Scienze Lettere ed Arti
Sponsored by ESA and NASA

Palazzo Cavalli-Franchetti, Venice, Italy October 11–14, 2010

Science with the Hubble Space Telescope — III

The aim of the conference is to present the performance of the observatory following the successful servicing mission in May 2009 (SM4) and to provide a forum for the presentation of early scientific results arising from the first year of operation of the new and repaired instruments.

SOC:
Robert Fosbury (co-chair, ST-ECF), Antonella Nota (co-chair, STScI), Martin Barstow (U. Leicester), Francesco Bertola (U. Padova), Preston Burch (NASA, GSFC), Elena Dalla Bontà (U. Padova), Holland Ford (Johns Hopkins U.), James Green (U. Colorado), Rob Kennicutt (U. Cambridge), Bruno Leibundgut (ESO), Malcolm Longair (U. Cambridge), Mark McCaughrean (ESA, ESTEC), Robert O'Connell (U. Virginia), Neill Reid (STScI), Alvio Renzini (INAF, Padova), Giovanna Tinetti (U. College London), Eline Tolstoy (U. Groningen), Monica Tosi (INAF, Bologna), Göran Östlin (Oskar Klein Centre, Stockholm)

LOC:
Elena Dalla Bontà (Chair)

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Credits: Background image - NASA, ESA and Jesús Maíz Apellániz (Instituto de Astrofísica de Andalucía, Spain); Venice image - Michael Dawes

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SCISOFT 7.4 – NOW FOR FEDORA 11

Richard Hook & Mathias André (DCS)

Early in 2009 ESO made the decision to make the transition from the old Fedora Core 6 to Fedora 11 as the scientific Linux desktop environment. This change meant that we had to develop a new version of the Scisoft collection of astronomical software. The long gap between platforms meant that many changes were needed but had the advantage that the new version of Scisoft now runs on more of the newer Linux distributions.

In addition to the change of platform several updates have been needed and a few problems identified and fixed. Although we no longer make DVDs we update the distribution of the collections that are available through the web, as well as installing the updated version internally at ESO.

The more significant updates include:

- STSDAS/TABLES updated to 3.11
- MIDAS updated to 09SEPpl1.0
- Updates to many IRAF and Python packages

For more details, and to download the collection, please go to the Scisoft web pages (www.eso.org/scisoft).

Cover image: *After being repaired during Servicing Mission 4 in May 2009 the Advanced Camera for Surveys (ACS) on the NASA/ESA Hubble Space Telescope stared deep into the remote Universe to image the rich cluster Abell 370. Amongst the massive golden elliptical galaxies there are many gravitationally-lensed images of even more remote galaxies. In this picture the highly distorted and richly detailed image of a spiral galaxy shows up as a highly-stretched arc. These observations were taken with the ACS in its Wide Field mode on 16 July 2009. The composite image was made using filters that isolate light from green, red and infrared wavelengths. These Hubble data are part of the Hubble Servicing Mission 4 Early Release Observations. The ST-ECF provided image processing support and created the colour image shown here.*

Credit: *NASA, ESA, the Hubble SM4 ERO Team and ST-ECF*