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SPACE TELESCOPE SCIENCE INSTITUTE

Newsletter

Highlights of this Issue:

The Initial Mass Function at Low Stellar Masses: The Case of the R136 Cluster

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with Marco Sirianni (JHU), Claus Leitherer (STScI), Guido DeMarchi (ESO), and Mark Clampin (STScI)

The quest for a *universal* Initial Mass Function (IMF) has been a long standing problem in stellar astrophysics (Scalo, 1998). With the advent of *HST* and the improved sophistication of ground-based instrumentation, it has been possible to expand to nearby galaxies studies that were in the past feasible only in our own Milky Way, and at the same time reach the new domain of the faintest and least massive stars even before they approach the main sequence. The studies of the IMF have expanded in scope but have also triggered new questions and added new uncertainties.

Let's consider the case of the IMF in star clusters, where the distance effects are removed and the star formation history is simpler: at intermediate masses (10 to 100 $M_{\odot}$), there is good agreement that the Salpeter IMF is ubiquitous. At lower masses (1 to 10 $M_{\odot}$), the situation is very different. Even in the LMC itself, deep photometry of clusters has produced wildly discrepant results, ranging from the very steep IMFs found by Mateo ($\Gamma \cong -2$) to the much shallower slopes ($\Gamma \cong 0$) derived by Elson et al. (1989), Hunter et al. (1995, 1996), and Sirianni et al. (1998).

30 Doradus in the LMC is the closest extragalactic HII region. It ideally offers a true laboratory for stellar population studies because of its rich star formation history and well-determined distance. It is close enough that the individual stars can be individually resolved, and its stellar content can be studied in detail. R136 is the dense core of 30 Doradus (Figure 1). Its central object was once believed to be a supermassive object of ~2000 $M_{\odot}$. In the 1980s, interferometric techniques and finally *HST* settled the controversy by resolving the individual components into a rich cluster of stars. R136 was used to show the superb resolution capabilities restored by the first refurbishment mission in the first WFPC2 Early Release Observations.

The increased sensitivity of WFPC2 showed in those first images a completely different view of the cluster, unraveling a myriad of fainter stars down to the mass limit of our own Sun. Finally it was possible to study the lower end of the IMF, to understand how low mass stars form in clusters, and maybe extrapolate the conclusions to more distant starbursts. Hunter et al. (1995, 1996) had an accepted proposal to do exactly this, but R136 was observed many more times in those first few months by other observers, almost always with the same configuration. Browsing through the archive, we studied the collection of available data, and we decided to take advantage of this opportunity: we merged all the observations together and constructed the deepest images of the cluster ever obtained. We succeeded in extending by one magnitude the work already published by Hunter et al. (1995, 1996) and to study the R136 IMF down to 1 $M_{\odot}$.

Down to ~3 $M_{\odot}$, our determination is in good agreement with that of Hunter et al. The shape of the IMF at

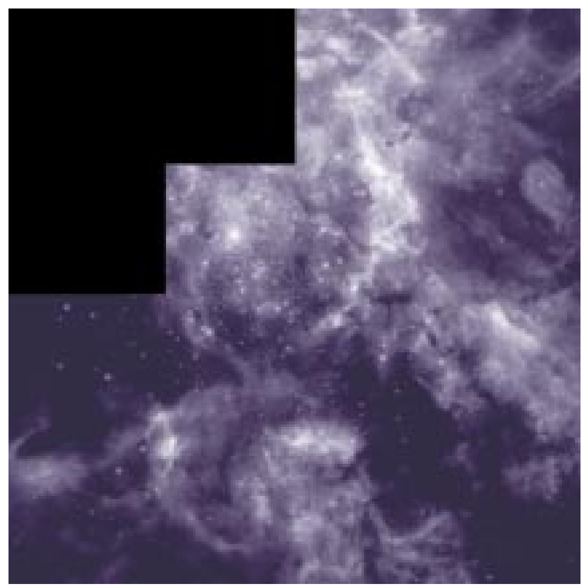

Figure 1: Three color image of the 30 Doradus nebula as seen by WFPC2, courtesy of R. Barba. The R136 cluster is visible at the center of the Planetary Camera.

masses larger than ~3 $M_{\odot}$ is compatible with a slope of $\Gamma \cong -1.2$, extending up to ~6 $M_{\odot}$ in our study, and all the way to ~15 $M_{\odot}$ in theirs. The agreement with the canonical IMF of Salpeter (1955) is preserved in this mass interval. Our determination of the IMF is also consistent with the work of

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Director's Perspective

Steven Beckwith

First Impressions. Last Friday, September 11, the Institute was humming as proposals started pouring in over the internet, first a trickle, then a steady flow, until more than 1,000 proposals had passed the electronic gates. Bets were laid as to the number we would receive. Anxious scientists wondered if the release of the Starr report on the same day would bring the net down. A few wanted a director's decision on what to do if it did, which I put off in the hope that the US backbone could simultaneously support science and scandal without hurting science (it can). On Saturday afternoon, I found an overworked scientist asleep on the couch in my office, the couch being a target of opportunity through an open door. Though exhausting, the process was smooth, not chaotic, and by Saturday evening the main work was largely finished. On Monday, I was presented with a few decisions artfully made in my absence needing my signature to retain the full force of authority. I signed. It has been quite a while since I witnessed the dedication to duty that STScI staff put out last week, my second week on the job.

On Tuesday, I was standing by the printer watching my viewgraphs emerge, when one of our visiting scientists walked in, an eminent professor from a far away university. He pounced on my viewgraphs. "New results about science?" he asked eagerly. "No, it's about money," I admitted, and his face fell. "Well," he said (somewhat derisively, I thought), "I guess someone has to worry about money." He turned his back to me and headed down the hall muttering to himself about science. Crestfallen that I could not engage him with my color-coordinated charts, I was comforted by the thought that my worrying about money enabled him to worry about science, and that, perhaps, is as it should be. And, frankly, the results coming from *HST* have impressed so many people from so many walks of life — and more countries than in North America alone — that I don't think we have to worry very much about money. We are giving our supporters their money's worth.

STScI is a remarkable place. It is a testament to the new reality that astronomy, like physics, is often done as a group effort. Building, launching, and operating a space satellite with the exquisite technical prowess of *HST* is a big operation, big and expensive, and it requires exceptional people. I find many exceptional people here in science, in systems engineering, in operations, in public relations, in management, in every aspect of the enterprise needed to keep Hubble healthy. At Goddard Space Flight Center, I had the privilege of meeting managers and engineers of the sort featured in the movie Apollo 13. They perform nearly impossible technical feats under enormous pressure to correct the often life-threatening problems of the mission in real time. It is gratifying and comforting to be associated with this level of talent. It's a little intimidating, too.

We are fortunate, as astronomers, that we can retain many elements of the traditional approach to science within such a superstructure. Individual scientists still work out the best way to use these facilities. They propose individually and take the credit for the resulting discoveries. They are lauded for their triumphs of pure thought, for their applications of intelligence to problems of the universe, the success of which delights their colleagues and the larger public that supports the endeavor. We have moved from constructing local observatories in bad sites using only rock (Stonehenge), to launching large, precise telescopes into orbit to penetrate the depths of space. It is impossible for me to regard this progress with anything less than awe.

As *HST* approaches the end of its first decade, it remains cutting-edge in most ways. Some of the devices — the gyros, the star trackers — are so well made that they cannot be found at equivalent levels of performance outside the *HST* program. *HST* is technically sweet. And we keep putting new instruments on every three years, an effort guaranteed to keep it young for as long as NASA wishes to service it. As a facility, it represents to me the acme of all the effort that came before it. As an institute, it is our job to keep it functioning seamlessly, minimizing the interference between creative thought and final discovery, despite the complexities involved. From my first impressions of STScI, I have no doubt that we will continue to do so.

Steven Beckwith September 17, 1998, Baltimore

R136 Cluster *from page 1*

Sagar & Richtler (1991), who have studied the intermediate mass range in five LMC clusters finding an average slope $\Gamma \cong -1.1$ in the range 2 to 12 $M_\odot$. In the 3 to 6 $M_\odot$ mass range, our results are located somewhere between the results of Mateo (1988) and Elson et al. (1989). Below the 3 $M_\odot$ limit, however, IMF determination of Hunter et al. is uncertain.

Our data, based on deeper images, clearly mark a departure from a simple power-law IMF indicating a flattening or possibly a drop below ~2 $M_\odot$ in the logarithmic plane (Figure 2). This does not mean that the number of objects is no longer increasing with decreasing mass, instead the increase proceeds at a lower pace. Although in principle crowding could be the origin of this effect, the flattening of the IMF occurs where our photometry is robust, with a completeness better than ~75%. A similar effect, i.e., a deficiency of stars in the 1 to 2 $M_\odot$ range, is also observed by Hillenbrand (1997) in the Orion Nebula Cluster, although in that case the plateau is followed first by a steep increase between 0.5 $M_\odot$ and 0.2 $M_\odot$, and then by a clear drop all the way down to the hydrogen-burning limit. Although there are several examples of a flat IMF for stars less massive than ~1 $M_\odot$ (Comeron, Rieke, & Rieke (1997) in NGC 2024 and Scalo (1998)), only in ρ Oph have Williams et al. (1995) found a flat IMF *above* 1 $M_\odot$. The question as to whether the flattening that we observe in R136 is characteristic of this cluster or a general feature still remains open: Local conditions of stellar density, age and metallicity *may* affect the low-mass IMF in clusters (Scalo 1998; Elmegreen 1998).

How is this finding related to the debate on the top-heavy IMF in M82? All these questions are far from being answered, but the discussion is getting *very* interesting.

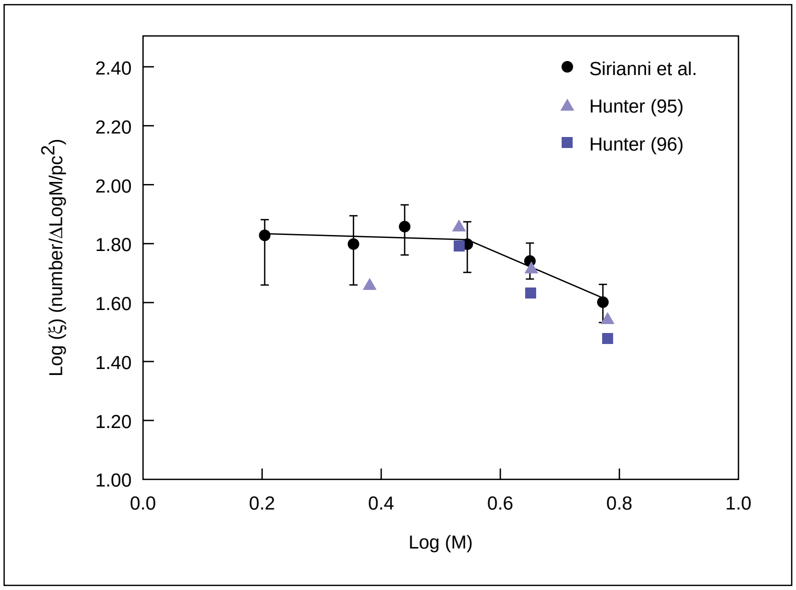

Figure 2: The IMF for the R136 cluster, defined as the number of stars per unit logarithmic mass per square parsec. The full circles indicate the completeness-corrected IMF, the triangles and squares are data from Hunter et al. 1995, 1996.

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Next Generation Space Telescope — Town Hall Meeting

American Astronomical Society Meeting
Austin, Texas
January 5, 1999, 4:30-6:00
Meeting Room 8

STEVE BECKWITH, Director
Space Telescope Science Institute

BERNIE SEERY, NGST Project Manger
Goddard Space Flight Center

It's been a busy year:

- two major architecture studies complete
- Design Reference Mission ready to publish
- scientist teams exploring seven innovative instrument concepts
- top-level project reviews by impartial scientists, engineers and industry representatives
- Space Telescope Science Institute selected to conduct NGST operations.

Come find out more. Ask questions. Find out how you can get involved.

Cycle 8 HST Proposals Submission Statistics

Number of proposals submitted: 1053

GO Proposals: 879
- Cycle 8 Orbits requested: 13,990
- Average orbits per proposal: 16.0
- Median orbits per proposal: 12

Major GO Proposals (> 60 orbits): .... 13 for 1,098 orbits
- Average orbits per major proposal: 84.5

Medium GO Proposals (30 to 60 orbits): .... 90 for 2,513 orbits
- Average orbits per medium proposal: 39.0

Small GO Proposals (<30 orbits): .... 773 for 9,379 orbits
- Average orbits per small proposal: 12.2

SNAP proposals: 64
- Total number of SNAP targets requested: 5,339

Target of Opportunity proposals: .... 21 for 387 orbits

Proposals requesting time in future cycles: 33

Proposals requesting Pure Parallel time: .... 3 for 1,276 orbits

Archival Proposals: 110
- Total archival funding requested: $6,457,495
- Average funding request: $58,841

Proposals by Country Breakdown:

Australia	12
Austria	1
Belgium	1
Brazil	4
Canada	19
Chile	4
China	2
Denmark	4
France	37
Germany	52
Greece	1
India	2
Israel	8
Italy	25
Japan	3
Korea	3
Netherlands	18
Norway	1
South Africa	1
Spain	8
Sweden	14
Switzerland	3
Russia	1
United Kingdom	70
United States	757

US PIs by State Breakdown:

AL	8
AZ	56
CA	128
CO	43
CT	11
DC	9
DE	4
FL	2
GA	2
HI	8
IA	4
IL	16
IN	7
KY	4
LA	7
MA	49
MD	187
MI	16
MN	7
NC	3
NE	2
NH	4
NJ	10
NM	7
NV	4
NY	31
OH	10
OK	2
OR	3
PA	34
SC	1
TN	1
TX	27
VA	10
VT	1
WA	17
WI	19

Breakdown By Instrument

Proposal Type	No. of Proposals	Total Request	Instruments: FGS	WPFC2	STIS/CCD	STIS/MAMA
GO Prime	879	13,990 orbits	356 (2.5%)	5,766 (41.2%)	3,794 (27.1%)	5,360 (38.2%)
GO Pure Parallel	3	1,276 orbits	0	40 (3.1%)	1,236 (96.9%)	0
SNAPs	64	5,339 orbits	30 (<1%)	3,024 (56.6%)	1,165 (21.8%)	1,155 (21.6%)

NGST Ad Hoc Science Working Group Wrestles with the Design Reference Mission

Peter Stockman, STScI stockman@stsci.edu

How do you define the science mission of a space telescope that will be deployed almost ten years in the future? Is this a useful activity? In the sultry heat of late July in Maryland, the Ad Hoc Science Working Group (ASWG) spent two days refining their vision of the NGST science mission.

In the process, they revealed the unique science that NGST could accomplish through deep visible imaging and infrared imaging and spectroscopy. Twenty-two programs had been submitted covering a wide range of astronomy topics. Some, like the study of Kuiper Belt objects, had been included in the first version of the Design Reference Mission (Stiavelli, Stockman and Burg, ST-ECF Newsletter, 1997, vol. 24, 4) and were much better developed by the ASWG in terms of observing strategies and science goals. Other programs, such as Peter Schneider's gravitational lens studies of dark matter on galactic and cosmological scales, were new and very exciting. After extensive discussion, these DRM programs were modified and merged into five major scientific themes:

- Cosmology and the Structure of the Universe
- The Origin and Evolution of Galaxies
- The History of the Milky Way and its Neighbors
- The Birth and Formation of Stars
- The Origins and Evolution of Planetary Systems.

The ASWG will continue to refine the DRM over the next two months in preparation for the NGST External Science Review on December 1 and 2, chartered by NASA HQ. The ultimate use of the DRM is providing concrete scientific goals and requirements for the engineers and scientists designing the NGST. By 2007, the nominal launch date for NGST, most of these programs will be affected by new discoveries. Nevertheless, the ASWG has chosen programs that should remain uniquely the province of NGST. Most of these will be done as part of the General Observer program, perhaps as Key Projects or Legacy Surveys. The current version of the DRM can be found through the NGST central Web site,

http://ngst.gsfc.nasa.gov

or the science page on

www.ngst.stsci.edu

New programs, comments, and suggestions are welcome and should be addressed to any of the specific science contacts and ASWG members. John Mather (*john.c.mather@gsfc.nasa.gov*) and Peter Stockman (*stockman@stsci.edu*) are Co-Chairs of the ASWG and welcome your comments. We also seek feedback at the NGST town hall meeting at the 1999 AAS meeting, in the afternoon of January 5 (see page 3).

Since the last STScI *Newsletter*, the ASWG has grown with the addition of science leads for the seven Integrated Science Instrument Module (ISIM) studies and scientists involved in international collaborative studies. The ASWG will continue its role in advising the NGST Project until the selection of the U.S. and international ISIM science teams in 2001.

The current ASWG membership is:

Jill Bechtold, Steward Obs.[1]
Mike Fall, STScI[1]
Robert Fosbury, ESO/STECF[2]
Jon Gardner, GSFC[2]
James Graham, UC Berkeley[1]
Tom Greene, Lockheed Martin[1]
Matt Greenhouse, GSFC[2]
Don Hall, Univ. Hawaii[2]
Avi Loeb, Harvard[2]
Peter Jakobsen, ESTEC[2]
Bob Kirshner, Harvard[3]
Simon Lilly, Univ. Toronto[3]
Bruce Margon, Univ. Washington[1]
John Mather, GSFC (Co-Chair)[1]
John MacKenty, STScI[1]
Michael Meyer , Steward Obs.[1]
Harvey Mosely, GSFC[1]
Phil Nicholson, Cornell Univ.[4]
Takashi Onaka, U. Tokyo[4]
Marcia Rieke, Steward Obs.[2]
Mike Rich, UC Los Angeles[2]
Peter Schneider, Max Planck Inst.[2]
Gene Serabyn, JPL[1]
Massimo Stiavelli, STScI[1]
Peter Stockman, STScI (Co-Chair)[1]
John Trauger, JPL[1]
Ewine van Dieshoek, Leiden[2]

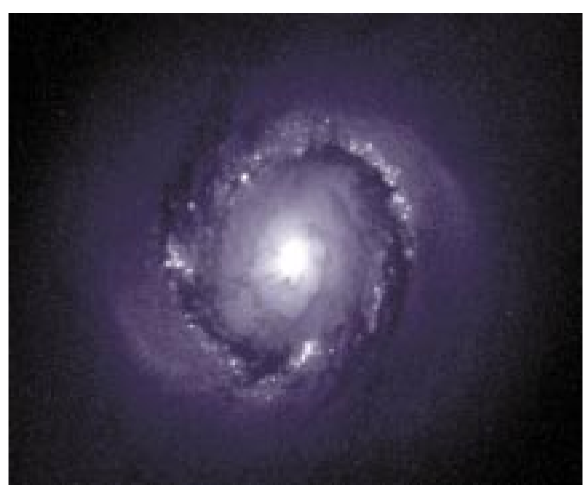
[1] ISIM Science Lead
[2] ESA Science Representative
[3] CSA Science Representative
[4] ASAS Science Representative

HST Recent Release: A bright ring of star birth around a galaxy's core

An image from NASA's Hubble Space Telescope reveals clusters of infant stars that formed in a ring around the core of the barred-spiral galaxy NGC 4314. This stellar nursery, whose inhabitants were created within the past 5 million years, is the only place in the entire galaxy where new stars are being born.

To see full-color image, go to:
http://oposite.stsci.edu/pubinfo/pr/1998/21

Credit: G. Fritz Benedict & Team (University of Texas) and NASA



Wide Field Camera 3

Ed Cheng (GSFC), John MacKenty (STScI), Robert O'Connell (UVa)

NASA has embarked on the construction of a new *HST* science instrument for the 2003 Servicing Mission, provisionally named the Wide Field Camera 3 (WFC3). Intended to replace the WFPC2, WFC3 will provide redundancy for the imaging capabilities of the Advanced Camera for Surveys (ACS), which will be installed in early 2000. WFC3 is part of a larger effort to ensure that *HST* is provided with hardware components capable of supporting a broad suite of science capabilities for the extended mission until 2010. This process was discussed by David Leckrone in the "Report from the Project Scientist" in the April, 1998, STScI *Newsletter*.

The WFC3 project is currently defining detailed requirements and studying alternative design options. The baseline design provides a 160 × 160 arcsecond field of view using a 4096 × 4096 pixel CCD detector with 0.04 arcsecond pixels. This detector is planned to be optimized for short wavelength sensitivity in order to provide an unprecedented wide field, near-UV (longward of 2000 Å) capability on *HST*. It will provide coverage to 1 micron, superior to the present WFPC2, but with slightly lower red sensitivity than the ACS WFC. A filter wheel assembly will provide a selection of 48 optical elements, including a broad range of filters and grisms to be defined with community input.

WFC3 is being constructed by an integrated product team consisting of NASA/Goddard Space Flight Center, the Space Telescope Science Institute, the Jet Propulsion Laboratory, and Ball Aerospace. This team is led by Ed Cheng (GSFC) with John MacKenty (STScI) as his deputy.

Following a solicitation of the astronomical community in March, 1998, sixteen astronomers were competitively selected from over sixty applicants to serve on the WFC3 Scientific Oversight Committee, with Robert O'Connell as its chair. The SOC members will provide the WFC3 project with guidance on the scientific consequences of design and construction decisions during the WFC3 development process. They are working as volunteers without pay or GTO time and serve to represent the astronomical community.

The WFC3 project is presently assessing the state of the returned WF/PC-1 hardware and de-integrating its major components. Together with the SOC, a set of science drivers for defining detailed requirements and metrics are being developed. Upon the advice of the *HST* Second Decade Study committee, and with the endorsement of the SOC, the WFC3 project is exploring the potential benefits and costs of extending the capabilities of WFC3.

WFC3 Science Oversight Committee Members

Bruce Balick
University of Washington

Howard E. Bond
Space Telescope Science Institute

Marcella Carollo
The Johns Hopkins University

Michael J. Disney
University of Wales at Cardiff

Michael A. Dopita
Mt. Stromlo & Siding Spring Obs.

Jay A. Frogel
Ohio State University

John J. Hester
Arizona State University

Jon A. Holtzman
New Mexico State University

Gerard Luppino
University of Hawaii

Robert W. O'Connell (Chair)
University of Virginia

Francesco Paresce
European Southern Observatory

Abhijit Saha
National Optical Astronomical Obs.

John T. Trauger
Jet Propulsion Laboratory

Alistair R. Walker
NOAO-CTIO

Rogier A. Windhorst
Arizona State University

Brad C. Whitmore
Space Telescope Science Institute

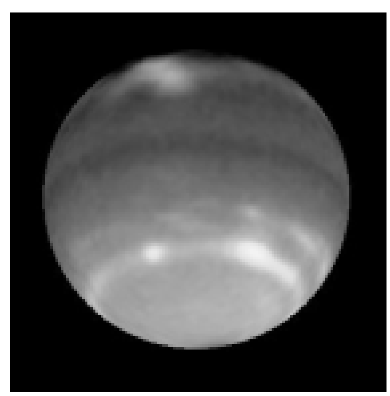
HST Recent Release: Hubble provides a moving look at Neptune's stormy disposition

Using powerful ground- and space-based telescopes, scientists have obtained a moving look at some of the wildest, weirdest weather in the solar system.

To see more in detail, go to:

http://oposite.stsci.edu/pubinfo/pr/1998/34

Credit: Larry Sromovsky (University of Wisconsin) and NASA



STIS Calibration Status

Henry C. Ferguson, STScI ferguson@stsci.edu

With winter drawing near and the hibernation of NICMOS nearly upon us, *HST* will soon turn its attention toward shorter wavelengths. Many STIS observers will be receiving their data and will have to remember what it was that they wanted to do with it. They will also have to face the task of understanding which features in their data bear the imprint of nature, and which are a ruse of the instrument and the imperfect calibration. With that in mind, we thought it useful here to highlight some of the good and bad news about the current state of calibration of STIS. Testing and updating calibration reference files for the pipeline has been a major activity over the last few months, and, while the HISTORY comments and Instrument Science Reports (ISRs) provide a wealth of technical detail, this seems a good forum for a less formal overview. We do this more or less in order of the way the data are processed.

Biases

These consist typically of a running (iteratively clipped) mean of more than 100 individual bias frames. The bias creation procedure gets rid of most of the hot pixels and hot columns. Hot columns are an artifact in the CCD due to the fact that the hottest hot pixels have a dark current that is so high that it adds appreciably to the flux in each pixel even during the 0.024 seconds it takes to transfer the charge during readout. Work is underway to see if the hot columns can be removed as part of the pipeline, but at the moment they are not removed. There are some other "bias" features (at a level of a few tenths of a data number) that are not removed. These are discussed on page 105 of the STIS Instrument Handbook and in STIS ISR 97-09.

Darks

The reference files used for subtracting CCD dark current are a combination of two components: one created from a month's worth of individual dark frames, and one created from a week's worth of dark frames. The former tracks the dark current in stable pixels at high S/N. The latter tracks the dark current in hot pixels. At any given time the dark frames in the archive are typically about 1 to 2 months out of date. If you wish to reprocess your data using darks taken around the time of your observations, you either need to wait for the reference files to appear in the archive, or extract the individual dark frames from the archive and combine them yourself. If your observations are dithered around sufficiently, you may not need to worry about reprocessing using the latest darks.

The pipeline darks do not get rid of hot pixels that appear on a timescale of days in CCD data. For that you need to extract individual dark frames from the archive and make your own "daily dark" using the "daydark" task in the STSDAS stis package. Even if you do that, you will still be left with a few dozen hot pixels. The IRAF "cosmicrays" task in the ccdred package does a pretty good job of finding these.

The existing dark-current reference file for the NUVMAMA was constructed from all the data that has been taken so far (the structure in the image has not evolved). The dark current is not constant but can be estimated pretty well from the temperature in one of the header parameters (OM2CAT). This temperature tracking will soon become part of the pipeline, but for now you will need to scale the dark current yourself and rerun CALSTIS (See chapter 7 of the STIS Instrument Handbook).

For the FUVMAMA, so far about 140 dark frames have been taken on orbit. Still, the S/N is not really high enough to track the variation in dark current pixel by pixel. Also, there is a "hot" region in the detector that shows a factor of ~10 variation in dark current over time (correlated somewhat with detector temperature). The latest pipeline reference to be delivered in late October is for most pixels set to a constant value, which is our best estimate for the mean dark current in

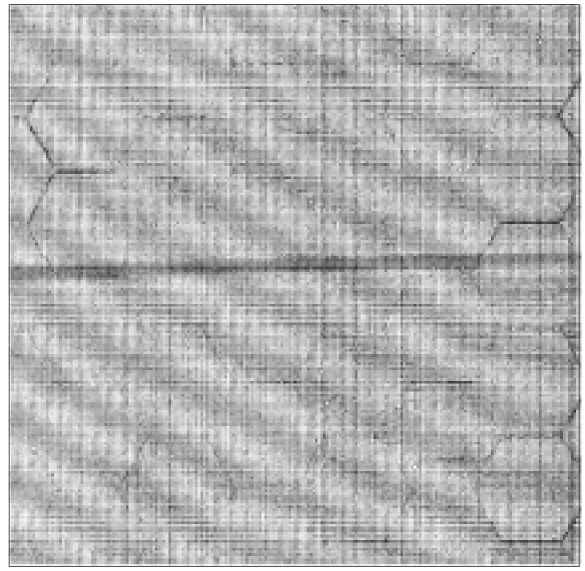


Fig. 1 — Preliminary FUVMAMA high S/N flat. The tightly woven grid pattern is due to sensitivity variations between high-resolution pixels. These variations are due mostly to the way the MAMA detectors centroid the individual charge clouds, and hence are not strictly speaking entirely due to sensitivity (i.e. counts are being redistributed between adjacent pixels rather than lost). However these variations largely go away when the data are binned 2 × 2 into the standard "lo-res" mode used by most observers. The hexagonal grid pattern is due to the way the fiber-optic cables are stacked in the MAMA manufacturing process. The wavy pattern is a beat pattern between the pores of the micro-channel plate and the anode array. The diagonal stripe is the shadow of the FUVMAMA repeller wire.

the quiet region of the detector. There are a few hot pixels that are evolving in this detector; the stable ones are included in the dark reference file and flagged in the associated data quality file. Nevertheless, it is worth inspecting your own data and some individual dark frames taken during the same month to see if there are others. The time-varying portion of the dark current (the hot region) appears to have

continued page 8

STIS *from page 7*

a constant shape, and in general you can subtract it using the "masterglow" image (available on the STIS web pages) following the procedures in Chapter 7 of the STIS Instrument Handbook.

Flats

Flatfielding an instrument with as many modes as STIS, and with count rate limitations to boot, is no easy task. Our approach is to assume (1) that the features that vary slowly across the detector are relatively time independent, but not necessarily wavelength independent and (2) that features that vary on the pixel-to-pixel level are relatively wavelength independent, but may vary more with time. The low-order-flat "LFL" files take care of (1) and the pixel-flat "PFL" files take care of (2). At the time this article is being written, the pipeline flats are entirely from the ground calibration.

PFL reference files for the CCD from on-orbit data will probably be in the archive by the time this article is out. These are based on on-orbit measurements and correct pixel-to-pixel fluctuations to a level of about 0.5%. They are in fact very similar to the ground flats; most of the improvement comes near the "dust motes" which are spots with a 5 to 20% decrease in throughput due to dust on the detector faceplate. Even the on-orbit flats do not remove the dust features completely. These may then appear as weak spectral features in your data, so it is worth taking a look at the flats to see if any dust motes lie on top of your spectrum. There are no LFL files for the CCD. Observations of standard stars taken at positions offset along the slit agree to within 2% of the on-axis measurements (ISR 97-14).

MAMA flats are under construction but should also be in the archive by the time this article comes out. They are constructed from on-orbit measurements of calibration lamps. A portion of the FUV MAMA flat is shown in Fig. 1. Tests have shown that, for typical point sources, S/N ~ 100 per resolution element in extracted spectra can be achieved without flatfielding, so on the pixel-to-pixel scale, the new flats may not give much improvement over the current pipeline (Kaiser et al. 1997, HST calibration workshop; ISR 98-16). They are most relevant if you are looking for precision of better than 1% on scales of a few pixels from undithered observations. For this application, we have yet to verify that the new on-orbit flats provide a real improvement, but we expect they will. For sources on axis, sensitivity variations on scales of ~30 pixels or more are accounted for by the sensitivity calibration (see below). Moving off axis, the sensitivity changes (on these scales) are less than ~2%, except near the edges of the FUVMAMA. Thus, for most modes, the LFL file is unity. For the FUVMAMA modes, we intend to update the LFL file based on recent calibration observations of stars off axis.

As for flatfield stability, there are not terribly much data. There is some evidence for changes of a few percent from the flats taken on the ground, but no evidence for changes larger than 3% in on orbit data.

Observers are advised to take contemporaneous "fringe flats" for spectroscopic observations longward of about 7000 Angstroms. There are tasks in the STSDAS STIS package to help with fringe removal (see STIS ISR 98-19). There are no calibrations at the moment to enable fringe removal for slitless spectroscopy.

Flats for Imaging

For the CCD, sensitivity variations on the pixel-to-pixel scale are monitored with the tungsten calibration lamp. The current ground calibration files are in the process of being updated with on-orbit lamp flats. The dust motes are not entirely removed by the lamp flats, so some caution is in order if you need photometric precision better than about 2% in the vicinity of the motes.

For the NUVMAMA, the current ground-calibration provides PFL files but not LFL files. The PFL files are soon to be updated with the on-orbit lamp flat. On larger scales, a check of the count rates for stars in a field that was observed with various offsets and rolls reveals sensitivity variations less than 1% for the NUVMAMA and variations of about 15% for the FUVMAMA. The FUVMAMA variations have been incorporated into an LFL file that will probably be in the archive by the time this article comes out.

On-axis Sensitivity for Spectroscopic Modes

The on-axis sensitivity has been measured for all STIS spectroscopic modes using observations of spectrophotometric standards, and the pipeline reference (PHT) files reflect these measurements. Various cross-checks with different standards give confidence in the absolute photometry, with wide slits and wide extraction boxes, at a level of 3 to 4% (see STIS ISRs 97-14 and 98-18). Figure 2 shows a comparison of STIS observations of G191B2B to a model and to previous observations. Repeated monitoring indicates that the sensitivity of G230L is increasing at a rate of about 1.6% per year and that the sensitivity in the G140L mode depends on the detector temperature (varying by about 3% over the range of temperatures encountered on orbit). These time variations are not (yet) tracked by the pipeline reference files.

The throughput of the various STIS apertures varies as a function of wavelength. This has been calibrated using a combination of on-orbit measurements of standard stars and a theoretical model of the PSF. The photometric repeatability of the slit transmissions improves with increasing aperture size from 12% rms for the 52 × 0.05 arcsec aperture to 2.7% rms

continued page 9

STIS *from page 8*

for the 52 × 0.5 slit to 1.3% rms for the 52 × 2 slit. The photometric repeatability of shorter echelle slits is probably comparable to the uncertainty in a long slit of similar width (STIS ISR 98-20).

Estimation of absolute fluxes also involves correcting for light lost outside of the spectral extraction aperture. This correction factor depends on the slit used and is accounted for in the pipeline by means of the PCT tables. These PCT tables are now based on on-orbit measurements of the cross-dispersion profile for various slits (ISRs 97-13 and 98-01). Typical uncertainties in relative throughputs are 1 to 2%.

On-axis Sensitivity for Imaging Modes

The absolute photometric calibration (on axis) at the moment is good to better than 5% for most modes. That is, for a known source spectrum, the predictions of the STSDAS synphot task and the STIS exposure time calculator should give count rates to within 5% of the observed rates. For the NUVMAMA imaging modes, there are some inconsistencies in the current data that force us to assign a larger error bar (15%). We hope to resolve those with further standard-star observations this winter. There are in any case only one or two standard star observations for each imaging mode, so the time variation is not yet measured (but since it is low in spectroscopic modes, it is probably stable in the imaging modes as well).

Absolute photometry with STIS is a tricky business because of the very wide bandpasses of the filters and the variation of the PSF in the different filters. The photometric zeropoints are all tied to a 3" radius aperture and thus do not account for the small fraction of flux that falls outside this aperture. Observers should also be cautious of background subtraction as the low count rate per pixel makes many of the common techniques for estimating the background fail (see WFPC2 ISR 96-03).

Wavelength Calibration

There are two aspects of wavelength calibration: the dispersion solutions and the wavelength offsets. The dispersion solutions in the archive DSP files at the moment are all from the ground calibration. The updated dispersion coefficients, based mostly on on-orbit lamp measurements, show no evidence of physical change relative to the pre-launch measurements but show small differences (at the sub pixel level) due to improvements in the fitting procedure. The updated dispersion files, due in the archive shortly, are based mostly on these on-orbit measurements. For some modes, there is an indication that an optical model of the instrument may produce a better dispersion solution than the actual calibration lamp data (STIS ISR 98-23), and the plan is to use the model where appropriate.

Dispersion solutions for the echelle modes have not yet been tested in great detail.

Shifts in wavelength are inevitable due to the non-repeatability of the grating wheel. These are calibrated by means of the standard wavecal observations that are taken with every spectrum. The calibration is done automatically by calstis and uses cross-correlation with a template lamp spectrum, together with a table of the known offsets of the different slits, to determine the wavelength shift. With the huge combination of apertures, gratings, and tilts that can be used by STIS, it has not been possible to test individually how well this calibration works for each mode. So it is worth looking critically at the wavelength calibration to make sure that it makes sense. It is sensible to try to apply the wavelength calibration to the wavecal exposure itself to see if you recover the right wavelengths, for example. Read STIS ISR 98-12 for the (gory) details of how the wavelength calibration is done in the pipeline.

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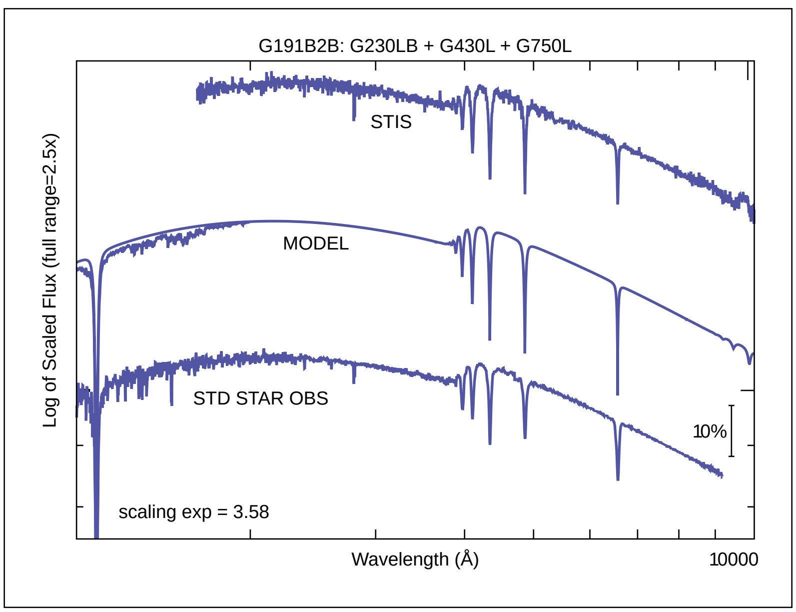

Fig. 2. STIS CCD spectrophotometry. The top curve is a composite of STIS CCD observations of G191B2B observed with G230LB, G430L, and G750L, and calibrated using the pipeline reference files (which were not derived from G191B2B observations). The middle curve is the G191B2B model, with the wavy curve in the FUV being a line-blanketed model. The STIS observations agree with the model to within 2%. The bottom curve shows observations of G191B2B taken by Oke (1990) and taken previously by FOS (Bohlin et al. 1990).

Instrument News

Spectrographs

Stefi Baum, sbaum@stsci.edu

STIS has observed steadily and successfully throughout the summer, oblivious to the approach of what we have affectionately been calling "STISMAS" - the time this fall when STIS observing will accelerate as NICMOS completes its observations and goes into hibernation. To help observers get on track for reduction of their upcoming STIS data, we are preparing in several ways:

- First, in a separate article (see "STIS Calibration Status" by Harry Ferguson on page 7) we describe in some detail — and from a user perspective — the current state of the calibration of STIS provided by STScI.
- Second, we plan to issue a major update to the STIS section of the *HST* Data Handbook around the beginning of the year.
- Third, we plan an update of our Analysis section of our Web page to respond to the data reduction questions we anticipate from the eager pool of observers with new STIS data.
- Finally, we have been steadily improving the performance of our data reduction pipeline, wringing out the bugs and slowly but steadily enhancing its capabilities (look under the Pipeline button in the Calibration section of the STIS WWW Instrument Page).

Please note that the Hubble Deep Field-South observations will execute in late September and be released at the end of November. These include STIS echelle (E230M) observations, CCD and MAMA imaging, and first-order spectroscopy of the quasar and its surrounding field (see the article on HDF-S in the July, 1998, issue of the STScI *Newsletter*). Working on these observations is providing a testbed for some of the new capabilities we hope to bring on-line for the general community early next year including, among others, optimal extraction for point source spectroscopy and automated removal of the trailing hot pixels in CCD observations. All in all, we are eagerly awaiting the STIS science tidal wave that is approaching.

NICMOS

Keith Noll, noll@stsci.edu

NICMOS observations have continued at a steady and high rate with the expected completion of nearly the entire NICMOS science program by November 15, 1998. A very small number of observations with tightly constrained windows will be done after November 15 as long as cryogen remains. In addition, a stepped-up program of routine monitoring will be conducted as described in detail below. The predicted date of exhaustion of cryogen is near the end of December 1998 with about a 30-day uncertainty. Internal temperatures and cryogen outflow rates continue to follow predicted curves. The focus in all three NICMOS cameras has remained stable despite some small fluctuations in the best-derived NIC3 focus.

Planning for the end of NICMOS operations is nearly complete. The overall goal of the end-of-life planning is to obtain data that will help characterize NICMOS in the temperature range likely to be achieved by the NICMOS Cryocooler and to leave the instrument in the safest possible configuration while warm. Starting on 15 October 1998, a dark current monitoring program will run several times per day during occultations when no other observations are possible. This will provide a source of data in the unlikely event that the cryogen runs out before 15 November. Temperature data from thermal sensors will be monitored at an increased frequency to look for signs of cryogen exhaustion, although models predict that a detectable change in temperature may occur only days in advance. Starting on 15 November, after the cessation of the NICMOS science program, an increased calibration program will go into place. Dark current will be measured 12 to 14 times per day. Flat fields will be taken four times per day, and focus sweeps will be obtained twice per week. In addition, NIC3 generic parallel observations will be taken whenever possible. This heightened monitoring will continue through cryogen exhaustion. Once the onboard temperature sensors are no longer within their calibrated range (i.e., at temperatures of about 80K or higher), observations with NICMOS will be discontinued. The NICMOS filter wheel will be stowed in the BLANK position as a hedge against additional contamination of the filters. The Pupil Alignment Mechanism (PAM) Mirror will be moved to the NIC1/2 compromise focus. No harm to either the filter wheel mechanism or the PAM is expected during warm up and subsequent cool down. NICMOS will remain in this configuration until the Cryocooler is installed during the next servicing mission, now expected in the spring of the year 2000.

In addition to changes in the NICMOS instrument, the NICMOS group at STScI has experienced some recent changes in personnel. Bill Sparks, who headed the NICMOS group from its inception before launch, is now enjoying a well-deserved sabbatical leave. The NICMOS group lead position has been taken over by Antonella Nota, an experienced observer who previously headed the Faint Object Camera group at STScI. In June, Torsten Boeker, an infrared astronomer and former AURA

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Next Generation Space Telescope

TOWN HALL MEETING

AMERICAN ASTRONOMICAL SOCIETY MEETING

Austin, Texas

January 5, 1999
4:30-6:00

Meeting Room 8

STEVE BECKWITH, Director
Space Telescope Science Institute

BERNIE SEERY, NGST Project Manger
Goddard Space Flight Center

IT'S BEEN A BUSY YEAR:

- two major architecture studies complete
- Design Reference Mission ready to publish
- scientist teams exploring seven innovative instrument concepts
- top-level project reviews by impartial scientists, engineers and industry representatives
- Space Telescope Science Institute selected to conduct NGST operations.

COME FIND OUT MORE. ASK QUESTIONS.
FIND OUT HOW YOU CAN GET INVOLVED.

Instrument News

NICMOS *from page 10*

fellow, joined the group. Andy Fruchter has moved to NICMOS from the WFPC2 group and, more recently, Brian Monroe has signed on as a data analyst. By the time you read this, Mark Dickinson will have joined the NICMOS Group as well. The NICMOS group has had to say goodbye to several long-term members. John MacKenty has taken the position of WF3 Instrument Scientist, Joan Najita has accepted a position at NOAO, and Dave Axon has returned to Manchester to take up his faculty position there.

Fine Guidance Sensors

Ed Nelan, nelan@stsci.edu

HST's Fine Guidance Sensor #3 (FGS3) continues to operate as the observatory's astrometer and high-angular-resolution interferometer. Routine monitoring of its interferometric response (TRANSfer mode) and astrometric stability (POSition mode) continue. The instrument is performing satisfactorily in both modes. We recently modified all of the TRANSfer Mode calibration observations to include POSition mode measurements of the calibration stars to enable a more precise empirical determination of the so-called POS/TRANS link. This is important for GOs observing a binary system in TRANSfer mode along with reference stars in POSition mode. By combining TRANSfer Mode data, which yield the binary's orbital elements, with POSition mode observations of the reference stars, which yield the binary's parallax, or distance, the mass and luminosity of the system can be determined.

Upon completion of Cycle 7 in June 1999, FGS3 will be replaced by FGS1r in its capacity as a science instrument for Cycle 8. (FGS1r is an enhanced unit installed in *HST* during the Second Servicing Mission.) FGS3 remains aboard *HST* and will continue to be used to guide the telescope. As discussed in the July 1998 STScI *Newsletter*, FGS1r has demonstrated its superior performance relative to FGS3 in its ability to detect structure in objects down to 7 milliseconds of arc (mas) and its ability to measure, with 1 mas accuracy, the angle between two point sources separated by as little as 10 mas. FGS1r's faint limiting magnitude (*V*=16), astrometric performance, large field of view (69 sq arcmin), and superb angular resolution combine to make this a unique instrument, well suited to address specific scientific objectives which cannot be achieved by any other means.

WFPC2

John Biretta, biretta@stsci.edu

WFPC2 continues to perform extremely well with approximately 20 orbits per week being devoted to WFPC2 observations. This rate is expected to increase significantly in the next few months as NICMOS observations wind down.

Since WFPC2 has been operating on-orbit nearly five years and is approaching the 60,000 image mark, it becomes increasingly interesting to examine issues related to long-term performance and health. A current study examines the long-term photometric stability, and the results are quite excellent. Sylvia Baggett and Shireen Gonzaga examined the WFPC2 photometric monitoring data from the last 4 years and looked for trends in both the "uncontaminated" throughput as well as the rate at which contaminants accumulate between the monthly decontaminations. The clean throughputs (i.e., immediately after decontaminations) show peak-to-peak fluctuations of 2% or less in most filters between 1994 and 1998. A curious result is that the far-UV throughput in the PC camera continues to slowly increase with time. That is, the clean count rates have increased by ~12% in the F160BW filter, and by ~9% in F170W, over the last four years. A likely explanation is that some UV-absorbing contaminant is slowly evaporating from the PC camera. The contamination growth rates between the monthly decontaminations also appear to be decreasing with time which mostly affects far-UV observations. The CCD assemblies are decontaminated (warmed to +20C for several hours) once a month to remove contaminants on the cold CCD windows; these contaminants then slowly re-accumulate after each "decon." For example, in the F160BW filter the rate at which contaminants accumulate has slowed from 0.9% throughput loss per day to 0.6% loss per day in the PC camera. Separate studies are also underway to examine the long-term stability of the flat fields.

Another area of concentration is to improve our understanding of various low-level photometric anomalies in the camera. A recent report by Stefano Casertano and Max Mutchler examines the so-called "long versus short" exposure effect. The effect gains its name from early evidence that long duration exposures of a star tended to give brighter magnitudes than shorter exposures (e.g., a 1000s vs. 10s exposure). This appears to be distinct from the Charge Transfer Efficiency (or CTE) anomaly whose primary signature was a photometric term related to the target's position on the CCDs. In contrast, the long versus short effect is independent of detector position. They conclude that the long vs. short

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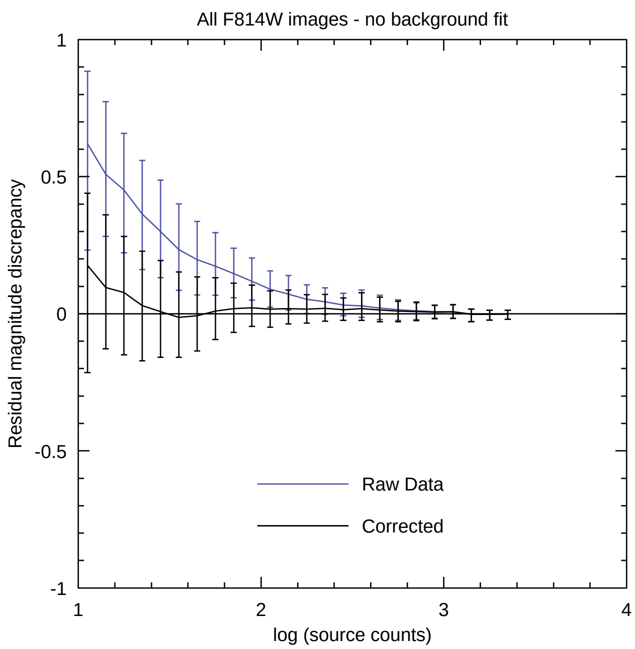
Instrument News

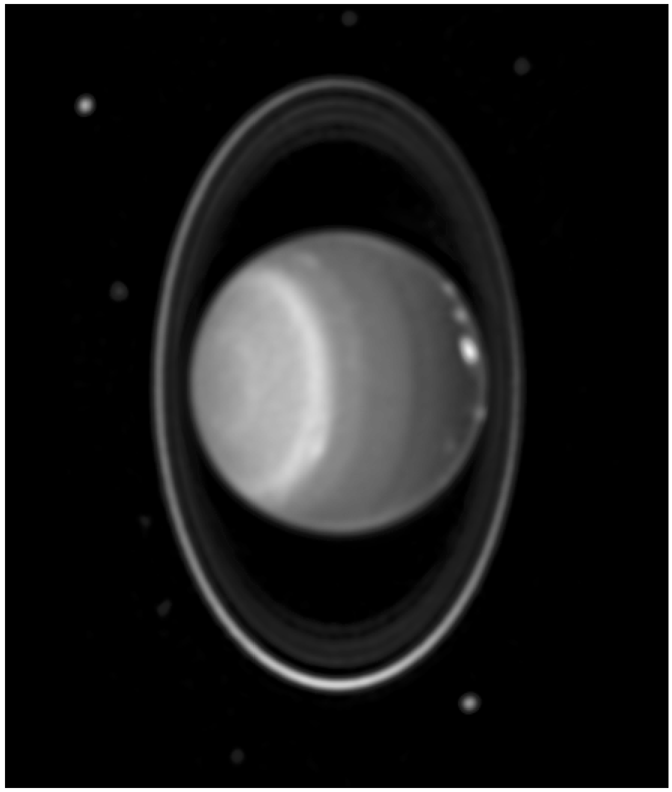
WFPC2 *from page 11*

effect is a non-linearity of the detector+signal chain that is primarily a function of the total number of source counts. It can be represented as the loss of a fraction of the target signal where the fraction increases for fainter signal. The effect ranges from < 0.02 magnitude for star images containing > 300DN to as much as ~0.4 magnitude for images containing only 10 DN. A simple formula has been derived to correct stellar photometry to an accuracy of a few percent for faint sources. Figure 1 illustrates the magnitude discrepancies before (colored line)



and after (black line) correction for observations of the Omega Centauri cluster as a function of target counts (gain 7; DN); the error bars indicate the Poisson noise (quartile points) for this data set. The complete report can be found on our WWW site as Instrument Science Report 98-02 at the WFPC2 documentation page:

http://www.stsci.edu/ftp/instrument_news/WFPC2/wfpc2_doc.html.



HST Recent Release: Hubble finds many bright clouds on Uranus

A recent Hubble Space Telescope view reveals Uranus surrounded by its four major rings and by 10 of its 17 known satellites. This false-color image was generated by Erich Karkoschka using data taken on August 8, 1998, with Hubble's Near Infrared Camera and Multi-Object Spectrometer. Hubble recently found about 20 clouds - nearly as many clouds on Uranus as the previous total in the history of modern observations. The orange-colored clouds near the prominent bright band circle the planet at more than 300 mph (500 km/h), according to team member Heidi Hammel (MIT). One of the clouds on the right-hand side is brighter than any other cloud ever seen on Uranus.

The Hubble image is one of the first images revealing the precession of the brightest ring with respect to a previous image. Precession makes the fainter part of the ring (currently on the upper right-hand side) slide around Uranus once every nine months. The fading is caused by ring particles crowding and hiding each other on one side of their eight-hour orbit around Uranus.

The full-color image can be found at:

http://oposite.stsci.edu/pubinfo/pr/1998/35

Credit: Erich Karkoschka (University of Arizona) and NASA

The Editor notes, with regret, an error that appeared in the last Newsletter. In the July issue, page 18, it was incorrectly reported that Greg Bryan received his PhD from Princeton. Greg received his PhD from the University of Illinois at Urbana-Champaign. His thesis advisor was Prof. Michael Norman.

Report From The HST Project Scientist

David Leckrone dleckrone@hst.nasa.gov

At about 2:00 pm this coming October 29, the shuttle Discovery will lift off from launch pad 39B at the Kennedy Space Center on mission STS-95. The most famous crew member on board will be former Senator and former Mercury astronaut John Glenn. Coincidentally, STS-95 will also be carrying cargo of considerable significance to the *Hubble Space Telescope*. Mounted on the Hubble Orbiting Systems Test (HOST) platform in Discovery's payload bay are three *HST* spacecraft subsystems which we plan to integrate into the observatory during the third servicing mission (SM3) in 2000 — the new 486 spacecraft computer, the spare Solid State Recorder (SSR), and the NICMOS Cooling System (NCS).

The 486 computer will replace the current, archaic DF224 in *HST*, giving us vastly improved capability for onboard commanding and control of the spacecraft. It is the cornerstone of the joint effort between the *HST* Project and STScI to reduce dramatically the cost of day-to-day Hubble operations, enabling the operation of our new Vision 2000 ground system. It goes without saying that we do not take lightly the task of performing this "brain transplant" on *HST*. One way we have of minimizing risk is to operate and monitor the performance of the flight 486 in the actual radiation environment encountered in *HST*'s orbit. This is why we've included the new computer in the HOST mission. STS-95 will fly in an orbit nearly identical to that of *HST*. Similarly, we want to obtain in-orbit measurements of the radiation susceptibility of the SSR to compare the performance of this spare unit to that of the primary SSR which was placed on the *HST* in 1997.

The NICMOS Cooling System has successfully passed a battery of ground tests, both in an ambient environment and in a thermal vacuum chamber, while hooked up to a high-fidelity thermal and mechanical simulator of the NICMOS cooling loop. The Project encountered several mechanical and operational glitches during the testing of the kind that are very typical of the development and integration of any new system. But these were overcome, and the NCS demonstrated a cooling capability that should be more than sufficient to achieve the operational temperature (nominally 72K) required for the NICMOS detectors. To bystanders such as me, it is almost miraculous to see this very advanced new cooling technology evolve from a "glimmer in the eyes" of the engineers to a working, flight-qualified spacecraft subsystem in about one year. The entire NCS team, and especially Project Scientist Ed Cheng, deserve the gratitude of the astronomical community for their effort and personal sacrifices in bringing the NCS this far. Now we need to see how it operates in the orbital environment of HOST. We cannot give an iron-clad guarantee that the NCS will actually succeed in giving NICMOS additional years of scientific life. But we are determined that there will be no harm done to the *HST* or its operations by the attempt.

After the completion of the HOST flight, and after we have had some time to collate all the test results for the NCS, STScI will reconvene the NCS Independent Science Review (ISR) team, chaired by Martin Harwit, to assess the data and to advise the Project as we make the final decision about placing the NCS on *HST* in 2000. In the meantime a small, independent committee, chaired by Mike Fall of STScI, has spent several months reviewing the current technical performance and scientific output of NICMOS to determine if it is meeting the original expectations of the community. Bluntly stated, they were asked to determine, "Is this instrument worth saving?" On August 7 Mike and Keith Noll (also from STScI) presented the results of this study to the senior management of the Goddard Space Flight Center (see page 17). The following quotes from their written report capture their conclusions:

"*from a scientific perspective, NICMOS is a success.*"

"*NICMOS will deliver important scientific results for as long as its performance remains at current levels.*"

"*NICMOS on HST is the most direct predecessor of NGST.*"

I want to thank Mike, Keith, and the rest of their team for providing NASA with a dispassionate, thorough, and scholarly evaluation which gave us more than sufficient scientific justification for proceeding with the HOST test flight of the NCS. Mike's team will continue their work in support of Martin Harwit's ISR early next year.

The Next STScI May Symposium

Mario Livio, STScI mlivio@stsci.edu

The next STScI May Symposium will be on the topic of: "The Largest Explosions Since the Big Bang: Supernovae and Gamma-Ray Bursts." The Symposium will take place at the Institute from May 3 to 6 1999. Both supernovae and gamma-ray bursts will be discussed, as well as possible connections between the two classes of objects. The deadline for registration is April 1, 1999. People interested in participating should contact Lorraine Garcia at STScI by e-mail (garcia@stsci.edu), telephone (410-338-4402), or mail (STScI, 3700 San Martin Drive, Baltimore, MD 21218).

The registration fee is $175 before April 1, 1999, and $200 thereafter.

The Multi-Mission Archive at the Space Telescope Science Institute (MAST)

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The Hubble Data Archive (HDA), as of September 1998, contains over 5.3 Terabytes of science and engineering data for a total of approximately 150,000 science exposures. In the past few months, the volume of archived data has reached average rates of about 4 to 5 Gigabytes/day while 4 to 5 times as much data per day have been retrieved by archive users.

Based on the success of the HDA, and taking advantage of its existing archive infrastructure, the STScI archive has recently expanded by providing access to non-*HST* datasets. With the support of funding from NASA Headquarters, we have created the Multi-Mission Archive at the Space Telescope Science Institute (MAST). The data available through MAST, in addition to those in the HDA, include:

- *The International Ultraviolet Explorer (IUE) Final Archive.* This contains over 104,000 spectral images of approximately 10,000 individual astronomical sources (covering the 1200 to 3350 Å range) obtained by IUE over the course of its lifetime (from 1978 to 1996). The IUE World Wide Web (WWW) interface is located at *http://archive.stsci.edu/iue*. Experienced IUE staff members are also available to assist researchers working on IUE data. The data are currently accessible via links to the NDADS system at the National Space Science Data Center (NSSDC) but will be made available directly from MAST in the coming months. (See the January 1998 STScI *Newsletter* for a more detailed description of the IUE archive at STScI.)
- *The Extreme Ultraviolet Explorer (EUVE) Archive*, which at present contains spectroscopic observations (in the 70 to Å range) of about 300 sources, mostly Galactic. EUVE, launched in 1992, is still operational. The EUVE WWW interface at STScI is located at *http:/archive.stsci.edu/euve*. Damian Christian, formerly at the Center for Extreme Ultraviolet Astrophysics (CEA) of the University of California at Berkeley, the institute that has managed the EUVE mission, has recently joined the Archive Branch at STScI and brings EUVE expertise to MAST. EUVE data are physically stored at the High Energy Astrophysics Science Archive Research Center (HEASARC) at NASA GSFC which also provides Web-based access.
- *The Copernicus Archive*. This includes far-UV (900 to 1,560 Å) and near-UV (1,650 to 3,150 Å) spectra of 551 objects, primarily bright stars, obtained by the Copernicus satellite, otherwise known as the Orbiting Astronomical Observatory 3 (OAO-3), from 1972 to 1981. Access to the data is provided at *http://archive.stsci.edu/copernicus*.
- *The Ultraviolet Imaging Telescope (UIT) Archive*. This contains about 1,600 images of more than 200 targets (covering the 1,200 to 3,300 Å range) obtained by UIT as part of the ASTRO-1 and ASTRO-2 Space Shuttle missions. The UIT WWW interface is located at *http://archive.stsci.edu/astro/uit*.
- *The Hopkins Ultraviolet Telescope (HUT) Archive*. This includes about 500 ultraviolet spectra (in the 825 to 1,850 Å range) of more than 300 targets obtained by HUT as part of the ASTRO-1 and ASTRO-2 Space Shuttle missions. The HUT WWW interface is located at *http://archive.stsci.edu/astro/hut*.
- *The Wisconsin Ultraviolet Photo-Polarimeter Experiment (WUPPE) Archive*. WUPPE was designed to obtain simultaneous ultraviolet spectra and polarization measure ments from 1,400 to 3,200 Å. It collected about 400 observations of roughly 200 targets during the ASTRO-1 and ASTRO-2 Space Shuttle missions. The WUPPE WWW interface is located at *http://archive.stsci.edu/astro/wuppe*.
- *The Digitized Sky Survey (DSS)*. The Catalogs and Surveys Branch of the STScI has been digitizing the photographic Sky Survey plates from the Palomar and UK Schmidt telescopes in order to support *HST* operations and provide a service to the astronomical community. Archive users can easily retrieve image data for any part of the sky at *http://archive.stsci.edu/dss*.
- *The Faint Images of the Radio Sky at Twenty-centimeters (FIRST) Archive*. The FIRST project is designed to produce a radio survey at 20 cm (1.4 GHz) of over 10,000 square degrees down to a flux of 1 mJy. STScI provides access to the radio images and the source catalog, which currently includes about 437,000 entries, at *http://sundog.stsci.edu*.

The main MAST WWW page, available at *http://archive.stsci.edu/mast.html*, provides links to the pages of the various archives plus general information. It also includes a "quick search" interface which allows a search for a target, by name or coordinates, in the currently available MAST databases and links to various plots that show the data characteristics of the missions and instruments in the MAST archive. For example, Figure 1 shows the *V* magnitude range versus spectral resolution for the spectrographic data in MAST. This overview should help a user to select the archival data of interest for her or his research. The single WWW pages contain links for users to search the database, obtain help, retrieve data,

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MAST *from page 14*

and get access to on-line documentation and analysis software.

It is now easier to look for data for particular classes of astronomical sources in the *HST* and the other MAST archives. As a first step towards taking advantage of various archives at one site and enhancing the potential of the single archives, we have in fact started a project which allows the cross-correlation of astronomical catalogs with the archives available at MAST. This interface, available at *http://archive.stsci.edu/search/*, enables at present the cross-correlation of an Active Galactic Nuclei (AGN) catalog, a galaxy cluster catalog, and a star catalog, plus a user-supplied list of positions, with the *HST*, IUE, EUVE, and other MAST archives.

Using this interface, one can now select AGN by class, redshift, magnitude, and 6-cm radio flux from a catalog heavily based on the Veron-Cetty & Veron (1996, ESO Scientific Report n. 17) catalog (see Padovani, Giommi & Fiore, 1997, Mem. Soc. Astron. It., 68, 147), and cross-correlate them with the *HST*, IUE, and EUVE archives. For example, one can look for all radio-loud quasars at redshift > 4 observed by *HST* or all Seyfert galaxies brighter than 15th magnitude with IUE spectra. (For *HST*, one can select individual instruments, each with a different correlation radius.) Multiple missions can also be selected, with the option to show only those AGN that cross-correlate with every selected mission (so one can look for AGN that have been observed with both *HST* and IUE, or for AGN observed with either *HST* or IUE.) After the correlation is performed, the user can preview the images/spectra (at present only in the case of *HST* data) and retrieve the data.

The Abell catalog, a catalog of rich clusters of galaxies (Abell, Corwin & Olowin, 1989, ApJS, 70, 1), can also be cross-correlated with *HST* and other MAST archives. The cluster selection can be done in terms of redshift, richness, magnitude of the tenth brightest cluster member, and Galactic coordinates. Finally, the user can also cross-correlate the Hipparcos catalog (1997, ESA SP-1200), selecting stars on the basis of magnitude, *B-V* color, parallax, spectral type, and coordinates, with the MAST archives to look for objects with the relevant data.

We remind our readers that the Archive publishes a newsletter, which is distributed electronically via a mailing list, to provide information about our activities. If you would like to subscribe to the archive newsletter, please send e-mail to *archive_news-request@stsci.edu* and put the single word SUBSCRIBE in the BODY of the message. You can also read the newsletter on the WWW at *http://archive.stsci.edu/archive_news/archive_news.html*.

STScI plans to incorporate additional ultraviolet and optical data sets into MAST in the future, including data from the Orbiting and Retrievable Far and Extreme Ultraviolet Spectrometers (ORFEUS) and the Far Ultraviolet Spectroscopic Explorer (FUSE), currently scheduled for launch in early 1999.

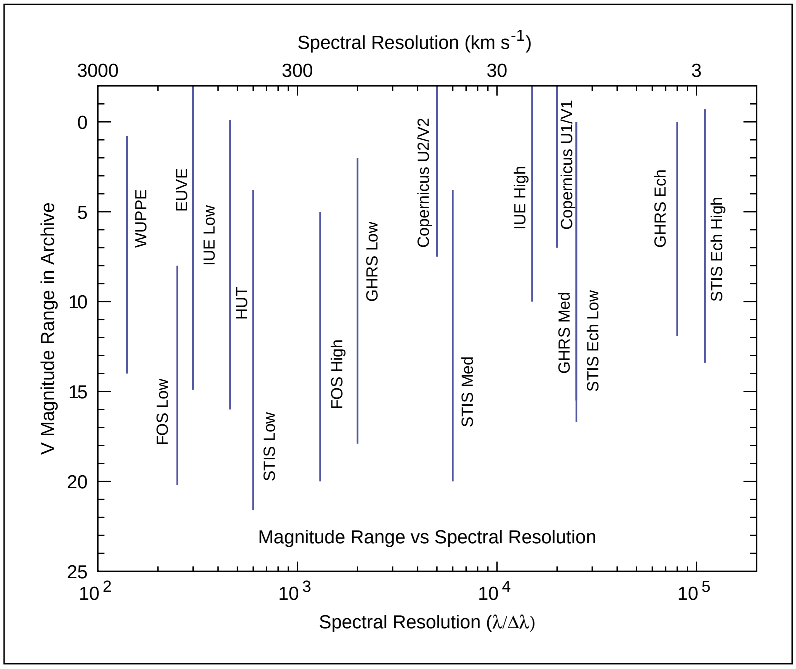

Figure 1: V magnitude range versus spectral resolution for the various spectrographic data in the Multi-mission Archive at the Space Telescope Science Institute. The range shown covers 95% of the actual range, to exclude extreme sources.

E-mail inquiries and comments about the STScI data archives can be directed to *archive@stsci.edu*. MAST is supported by NASA under grant NAG5-7584 to the Space Telescope Science Institute. We are also grateful for the support and cooperation of the Astrophysics Data Facility and NSSDC staff at NASA GSFC in the transition of several of the optical/UV data sets to MAST.

Dave Axon, ESA Astronomer

Dave Axon came to STScI in 1992 as an astronomer from the European Space Agency. "It was an opportunity to work on the world's most exciting astronomical project," he says. He is best known here for his work in support of NICMOS, as shown by the many recent NICMOS-related papers for which he is a co-author.

Dave Axon

Dave's early interest in astronomy is another instance of the fascination engendered by shows like the "Violent Universe" that he saw. Patrick Moore's writing was a motivation too, one that endured the well-meaning advice of 15 career counselors who, upon hearing that he wanted to be an astrophysicist, suggested that he look into weather forecasting.

Fortunately, he ignored that advice and pursued a degree in physics at the University of Durham, working with Wolfendale on photon-nuclear interactions in the early universe (or, "Are gamma rays extragalactic?"). That didn't go far and he built an imaging polarimeter and measured the magnetic field in the Galaxy and the structure of M82. He received his Ph.D. in 1977, then went on to become a Research Fellow at the University of Sussex (1976-79), and SERC Fellow (1979-80) at University College, London, working with Boksenberg on the Imaging Photon Counting System (IPCS). He continued at UCL for an additional year and then was on the verge of going to the Institute for Astronomy, in Cambridge, when he received a tenure-track offer from Manchester.

His research interests have grown to include active galaxies, regions of star formation, polarimetry, galactic dynamics, and massive black holes. Here are examples of this work:

"Discovery of a Family of Herbig-Haro Objects in M42: Implications for the Geometry of the High Velocity Molecular Flow?" Axon, D. J., and Taylor, K. 1984, MNRAS, 207, 241-261.

"The Extended Narrow-Line Region in Radio Seyferts: Evidence for a Collimated Nuclear UV Field?" Unger, S. W., Pedlar, A., Axon, D. J., Whittle, M., Meurs, E. J. A., and Ward, M. J. 1987, MNRAS, 228, 671-679.

"A Plasmon Driven Bowshock Model for the Narrow Line Region of NGC 5929" Taylor, D., Dyson, J. E., Axon, D. J., and Pedlar, A. 1989, MNRAS, 240, 487-499.

"Is There Really a Supermassive Black Hole in M87?" Marconi, A., Axon, D. J., Macchetto, F. D., Capetti, A., and Sparks, W. B. 1997, MNRAS, 289, L21-L25.

"Jet-Driven Motions in the Narrow-Line Region of NGC 1068" Axon, D. J., Marconi, A., Capetti, A., Macchetto, F. D., Schreier, E., and Robinson, A. 1998, ApJ, 496, L75-L78.

Dave is married. He is a Life Master at bridge and also likes to hike and find the better vintages to taste. Among his other achievements, he walked forty miles in a day to raise funds for victims of the Oklahoma City bombing.

As this is written, Dave Axon has returned to the University of Manchester as a Senior Lecturer. We're sorry to lose him, but he is eager to return here to continue the many collaborations he has begun, so we expect to see him again soon.

Hubble Postdoctoral Fellowship Program

Howard Bond, STScI *bond@stsci.edu*

The Hubble Postdoctoral Fellowship program awards Fellowships to recent PhDs in astronomy, physics, and related disciplines. Hubble Fellows take up their appointments at participating host institutions in the U.S.to undertake research that is broadly related to the mission of the Hubble Space Telescope. The Fellowship duration is three years (subject to annual review and to availability of funds from NASA).

The next round of selections has now begun for Hubble Fellows who will begin their appointments in September 1999. Candidates must have completed their PhD degree (or expect to complete it) no earlier than January 1, 1996. The application deadline is November 16, 1998. Full details of the application procedure are given at our web site, *http://www.stsci. edu/stsci/hubblefellow.html*

The Hubble Fellows meet annually at STScI to present brief summaries of their research at the Hubble Fellows Symposium. The Symposium is open to all interested astronomers, and was held this year on Thursday and Friday, October 8 and 9, 1998.
A detailed program, including abstracts of talks, is posted on the STScI web site.

Space Telescope Science Institute 1999 Fellowship

Ron Allen, STScI rjallen@stsci.edu

Applications are invited for the 1999 INSTITUTE POSTDOCTORAL FELLOWSHIP, tenable at STScI, which is on the campus of the Johns Hopkins University in Baltimore. Fellowships provide support for up to 3 years with an annual stipend of $42,000 plus benefits. An annual allocation of $12,000 for research travel and related costs is also available.

Institute Fellows are chosen on the promise of their research program and the strength of their accomplishments in observational astronomy or theoretical astrophysics. No additional duties are required. Applicants must have a PhD or equivalent degree by the date of appointment. There are no restrictions on citizenship.

Applications must include a signed cover letter, a curriculum vitae, a list of publications, a summary of previous and current work (limited to 3 pages), and a description of the research program to be carried out at STScI (also limited to 3 pages). Applicants must arrange for three letters of reference to be sent directly to STScI.

Applicants for Institute Fellowships may also be considered as candidates for other, more project-oriented, postdoctoral positions available at STScI.

Applications may be sent by regular mail to the Institute Postdoctoral Fellowship Committee, c/o Human Resources, at the address below. Applications received by 1998 December 1 will receive full consideration. Letters of reference should also arrive by December 1. Offers of appointments will normally be made by 1998 February 1.

Further questions may be directed to Ron Allen at the STScI Research Programs Office, 410-338-4574 (rjallen@stsci.edu).

The Space Telescope Science Institute is operated by the Association of Universities for Research in Astronomy, and is an affirmative action-equal opportunity employer. Women and members of minority groups are strongly encouraged to apply.

Please, send your application to:

Institute Postdoctoral
Fellowship Committee

c/o Human Resources

Space Telescope Science Institute
3700 San Martin Drive
Baltimore, MD 21218, USA.

NICMOS Science Review

Michael Fall, STScI fall@stsci.edu

In the spring of this year, STScI conducted a review of the scientific performance and productivity of the Near Infrared Camera and Multi-Object Spectrometer (NICMOS).

This science review is one element of a comprehensive evaluation by NASA of a program to develop a mechanical cooler for NICMOS and to install it during the third servicing mission of *HST* (now scheduled for May 2000). The other elements of the evaluation are a review of technical feasibility and a comparison with ground-based instruments with adaptive optics systems. The team that performed the science review was led by Michael Fall (STScI) and included Daniela Calzetti (STScI), Mark Dickinson (JHU), Keith Noll (STScI), and Marcia Rieke (University of Arizona). The results were presented to the Program Management Council of the Goddard Space Flight Center.

The charge to the committee was to “assess the significance and value of NICMOS as a science instrument” as of May 1998. Because at that time only a small fraction of NICMOS observations had been analyzed, interpreted, and disseminated to the scientific community, the committee decided to approach its task by two different routes. First, it sought to determine how well NICMOS performed on orbit relative to expectations at the time the observing programs were selected by the Cycle 7 and Cycle 7-NICMOS Time Allocation Committees. The emphasis here was on the ability of the instrument to make astronomical measurements (i.e., on its sensitivity, image quality, photometric accuracy, etc.). Second, the committee examined a significant number of the actual scientific results that were available to it and assumed these were representative of the larger number that would eventually become available. Here, the committee relied on published articles and preprints, presentations at scientific meetings, press releases, and especially discussions with NICMOS users.

The principal conclusion of the review is that NICMOS has the capability of delivering important scientific results and is in the process of doing so. By these measures, the instrument is a success. NICMOS has several anomalies, but solutions have been found for most of them and all important capabilities have been recovered. In most respects, NICMOS achieves or even exceeds the astronomical performance (sensitivity, image quality, photometric accuracy, etc) assumed by the Cycle 7 and Cycle7-NICMOS Time Allocation Committees when they selected a large number of excellent observing programs. The scientific results that have been obtained thus far bear out these high expectations.

Keith Noll Promoted to Tenure

Keith Noll was recently promoted to Associate astronomer with tenure at STScI. He's been here since 1991, having started in the Science Planning Branch to help plan observations of moving targets, a need which was especially critical in those early years after launch. After a couple of years, he became a WFPC2 Instrument Scientist, and he recently moved over to the NICMOS Group because of his own interest in infrared astronomy.

Keith Noll

Keith grew up in Wilmington, Delaware, not far from Baltimore, with two younger brothers. His parents stressed the importance of higher education, and a high school physics teacher motivated his interest in science, reinforced by the Moon landings going on at that time.

His science specialties include the atmospheres of the outer planets, especially questions relating to composition and chemistry, and the surfaces and tenuous atmospheres of icy satellites and their interactions with the space environment. This experience with molecular spectroscopy has led naturally to the study of brown dwarfs, which share many similarities with the giant planets. He is also investigating the apparently diverse composition of Kuiper belt objects. These recent papers illustrate his work:

Noll, K. S., Geballe, T. R., Knacke, R. F., and Pendleton, Y. J. "Titan's 5-micron Spectral Window: Carbon Monoxide and the Albedo of the Surface," 1996, Icarus, 124, 625-631.

Noll, K. S., Johnson, R. E., Lane, A. L., Domingue, D., and Weaver, H. A. "Detection of Ozone on Ganymede," 1997, Science, 273, 341-343.

Noll, K. S., Geballe, T. R., and Marley, M. S. "Detection of Abundant Carbon Monoxide in the Brown Dwarf Gl 229B," 1997, ApJ, 489, L87-L90.

Noll, K. S., and Knacke, R. F. "Response to Comment by Beer and Taylor on 'Carbon Monoxide in Jupiter after Comet SL-9'," 1998, Icarus, 133, 322-324.

STIS *from page 9*

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Geometric Distortion

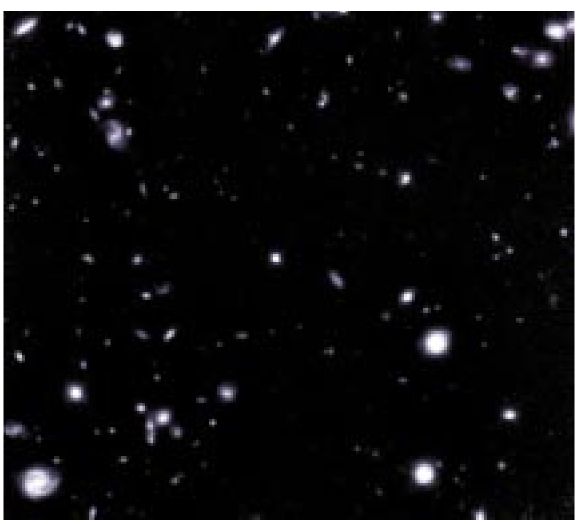
The image-mode geometric distortion corrections given in the STIS Cycle 8 Instrument Handbook have been tested by comparing geometrically-corrected WFPC2 images to geometrically-corrected STIS images of the same star field. Relative distortions at a level of about 0.02 arcsec exist across the field. The source of the disagreement is not yet understood, and it is not yet clear if the STIS geometric distortion needs modification.

In spectroscopic mode, the geometric distortion in the cross-dispersion direction is handled by means of "spectral trace" tables (1DT). These versions of these files from ground testing have been recently updated, and the new 1DT files should keep the spectral extraction boxes centered on the aperture to a small fraction of a pixel across the whole detector.

References:

Oke, B. 1990, AJ, 99, 1621

Bohlin, R. C., et al, 1990, ApJS, 73, 413.



HST Recent Release:
Hubble goes to the limit in search of farthest galaxies

A long exposure infrared image taken with Hubble's Near Infrared Camera and Multi-Object Spectrometer (NICMOS) has uncovered the faintest galaxies ever seen.

To see more in detail, go to:

http://oposite.stsci.edu/pubinfo/pr/1998/32

Credit: Rodger Thompson (University of Arizona) and NASA

Hubble Deep Field South

Harry C. Ferguson

Observations of the southern Hubble Deep Field completed successfully on October 10; a few of the flanking field observations will trickle in as late as October 29. No significant problems were encountered, and the data reduction is well underway. The raw and reduced data will be released on November 23. Further information can be found on the HDF-S web page at *http://www.stsci.edu/ftp/science/hdf/hdfsouth/hdfs.html.*

HST Recent Release:
Nearby massive star cluster yeilds insights into early universe

NASA's Hubble Space Telescope has taken a "family portrait" of young, ultra-bright stars nested in their embryonic cloud of glowing gases. N81 is located 200,000 light- years away in the Small Magellanic Cloud (SMC). These are probably the youngest massive stars ever seen in the SMC.

The nebula offers a unique opportunity for a close-up glimpse at the "firestorm" accompanying the birth of extremely massive stars, each blazing with the brilliance of 300,000 of our suns.

To see full-color image, go to:
http://oposite.stsci.edu/pubinfo/pr/1998/25

Credit: Mohammed Heydari-Malayeri (Paris Observatory, France) and NASA

Calendar

HOST Mission to Test *HST* Components	Oct. 29 to Nov. 5, 1998 (tentative)
Last Cycle 5 Observation Executed	August 15, 1998

Cycle 8

Proposers notified	December 15, 1998 (tentative)
Phase II Proposals Due	February 18, 1999 (tentative)

Cycle 9

Call for Proposals issued	June, 1999 (tentative)
Phase I proposals due	September, 1999 (tentative)
Proposers notified	December, 1999 (tentative)
Phase II Proposals Due	February, 2000 (tentative)
Routine Observing Begins	June, 2000 (tentative)

Meetings and Symposia

Space Telescope Users Committee	Nov. 9-10, 1998
May Symposium (see p. 13)	May 3-6, 1999

ST-ECF Newsletter

The Space Telescope — European Coordinating Facility publishes a quarterly newsletter which, although aimed principally at European Space Telescope users, contains articles of general interest to the HST community. If you wish to be included in the mailing list, please contact the editor and state your affiliation and specific involvement in the Space Telescope Project.

Robert Fosbury *(Editor)*
Space Telescope — European Coordinating Facility

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D-85748 Garching bei München
Federal Republic of Germany

E-Mail: rfosbury@eso.org

Contents

How to contact us:

First, we recommend trying our Web site: *http://www.stsci.edu*
You will find there further information on many of the topics mentioned in this issue.

Second, if you need assistance on any matter send e-mail to *help@stsci.edu* or call 800-544-8125. International callers may use 1-410-338-1082.

Third, the following address is for the *HST* Data Archive:
archive@stsci.edu

Fourth, if you are a current *HST* user you may wish to address questions to your Program Coordinator or Contact Scientist; their names are given in the letter of notification you received from the Director, or they may be found on the Presto Web page *http://presto.stsci.edu/public/propinfo.html*.

Finally, you may wish to communicate with members of the Space Telescope Users Committee (STUC). They are:

Fred Walter (chair), SUNY Stony Brook,
fwalter@sbast1.ess.sunysb.edu

John Bally, U. Colorado
John Clarke, U. Michigan
Bob Fosbury, ESO
Marijn Franx, Kapteyn Astron. Inst.
Laura Kay, Barnard College
Pat McCarthy, O.C.I.W.
Regina Schulte-Ladbeck, U. Pittsburgh
Sue Tereby, Extrasolar Research Corp.
Rodger Thompson, U. Arizona
Will van Breugel, Lawrence Livermore
Bruce Woodgate, GSFC

The Space Telescope Science Institute *Newsletter* is edited by David Soderblom, to whom correspondence may be sent (*soderblom@stsci.edu*). To record a change of address, please contact Ms. Nancy Fulton (*fulton@stsci.edu*).

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