

DIRECTOR'S OFFICE

NATIONAL OPTICAL ASTRONOMY OBSERVATORY

The GSMT Science Working Group

Jeremy Mould

The Giant Segmented Mirror Telescope (GSMT) Science Working Group (SWG), under the chairmanship of Rolf Kudritzki, held its first meeting in Tucson on July 29–30.

Members are:

Betsy Barton—University of Arizona
Rolf Kudritzki—University of Hawaii
Jill Bechtold—University of Arizona
Claire Max—Lawrence Livermore National Laboratory
Michael Bolte—University of California Santa Cruz
Francois Rigaut—Gemini
Matthew Colless—Australian National University
Chick Woodward—University of Minnesota
Terry Herter—Cornell University
Doug Simons—Gemini
Paul Ho—Center for Astrophysics
Irene Cruz-Gonzales—Instituto de Astronomia (UNAM)

Although the McKee-Taylor Decadal Survey made GSMT its top priority ground-based optical/infrared (O/IR) facility, the report leaves great freedom of interpretation regarding the design and total cost of the telescope. Indeed, the O/IR panel report is more exact about the Large Synoptic Survey Telescope (LSST) than

GSMT. Therefore, the Science Working Group has to discern the relative scientific advantages of a number of different concepts in order to recommend to NSF its optimum investment in a public/private partnership.

Proponents will present the merits of

- “classical” versus multiconjugate adaptive optics
- a seeing-limited wide-field mode
- larger and smaller primary mirrors than 30 meters
- high-dynamic-range imaging performance.

The SWG will also be examining

- scientific complementarity with NGST and ALMA
- the suite of instruments needed to accomplish the scientific goals.

A number of these matters will require detailed study, for which the GSMT SWG will rely on a NOAO support group including Steve Strom, Joan Najita, Steve Ridgway, Knut Olsen, Sam Barden, and engineers led by Larry Stepp.

The charter of the GSMT SWG was published in the June *Newsletter*. The SWG is expected to furnish a report in July 2004.

The Physics of the Universe

Jeremy Mould

The new National Research Council (NRC) study, “Connecting Quarks with the Cosmos” is required reading for astronomers (www.nap.edu/books/0309074061/html/R1.html), regardless of whether cosmology is our field or high-energy physics our avocation. The Committee on the Physics of the Universe (CPU) has chosen an interesting way to highlight the significance of research at the interface of physics and astronomy.

The CPU has seized on 11 particularly direct questions:

1. What is the dark matter?
2. What is the nature of the dark energy?
3. How did the Universe begin?
4. Did Einstein have the last word on gravity?
5. What are the masses of the neutrinos and how have they shaped the evolution of the Universe?

6. How do cosmic accelerators work and what are they accelerating?
7. Are protons unstable?
8. Are there new states of matter at exceedingly high density and temperature?
9. Are there additional spacetime dimensions?
10. How were the elements from iron to uranium made?
11. Is a new theory of matter and light needed at the highest energies?

The CPU goes on to make seven recommendations to address these questions.

continued



Physics of the Universe continued

From NOAO's perspective, it is interesting to note the extent that our research community's current lines of investigation reflect these priorities. To test this, one need only look at the publication record in the NOAO 2001 annual report.

Until recently, dark matter was the biggest challenge astronomy had served up to physics. How dark matter manifests itself, on stellar scales to the scale of the Universe, was a theme of more NOAO scientific highlights of 2001 than any other. This includes the census of white dwarfs, the MACHO project follow-up, investigation of dwarf spheroidal galaxies (where the dark matter to baryon ratio seems highest), and the inventory of baryons in galaxy clusters.

Since 1998, when *Science* dubbed the accelerating universe theory the discovery of the year, the most blatant challenge has become dark energy. Distance indicator work (past and future) at NOAO probes the nature of cosmic expansion; of particular note are the Deep Lens Survey and its successor projects.

As the late Dave Schramm was fond of reiterating, "optical spectroscopy probes the epoch of nucleosynthesis in the early Universe." Observations of the cosmic helium abundance constrain the size of the neutrino family. Measuring the power spectrum at the redshift of Lyman-break galaxies constrains the mass of the dark matter particles. Both of these areas of investigation were among NOAO's publication highlights of 2001.

There are several candidates for the cosmic accelerators that produce beams of highly energetic particles. Among those studied with NOAO telescopes were supermassive black holes and gamma ray bursters.

Stellar-mass black holes and neutron stars are the laboratories of choice for ultrahigh density and temperature. In 2001, GRO J1655-40 yielded its black hole mass (6.3 solar masses) and 3EG J2227+6122 (a young neutron star with a bow shock) was imaged at Kitt Peak.

Finally, stellar nucleosynthesis has had its Nobel laureates in physics, and continues to be a rich subject for high-resolution spectroscopy. Workhorse echelle spectrographs enabled astronomers at NOAO to find the onset of the main r -process at iron abundances one-thousandth that of the Sun; this onset is consistent with the suggestion that low-mass Type II supernovae are responsible for the r -process.

All this is not to pretend that physics is the driving force behind all research with astronomical facilities. The full picture of NOAO's research endeavor also includes such unashamed orgies of baryons as the Magellanic Clouds, young stellar associations, the WIYN open clusters, Milky Way cannibalism, stellar mass loss, damped Lyman- α galaxies, and the ecology of disk galaxies. In addition, there is no doubt that the "Origins" theme in NASA astronomy has an appeal to both the science community and the public that transcends its impact on physics.

Furthermore, a number of the 11 questions are currently untouched by optical/infrared astronomers: cosmic inflation and proton stability are two prime experimental examples, particularly since the CPU sees microwave background polarimetry as the most promising

probe of photon properties in the era of inflation when the Universe began.

However, one of the seven CPU recommendations (which has much in common with the astronomy decadal survey) is going to have a very major impact on NOAO's community:

"The Committee supports the Large Synoptic Survey Telescope (LSST) project, which has significant promise for shedding light on the dark energy.

"A ground-based wide-field telescope has its greatest power in studying the dark energy at redshifts of less than about 1. It can discover tens of thousands of supernovae out to redshifts of about $z \sim 0.8$ and follow them up (though not with the same control of systematics that can be done in space). It can carry out weak-gravitational lensing surveys over thousands of square degrees to moderate depth."

In fact, LSST will serve NOAO's community in a wide variety of ways, perhaps the greatest of which will be to open the observational time domain routinely and comprehensively. For all of these reasons, NOAO will aggressively pursue LSST design, construction, and operation. Our near-term goals are to submit a fully engineered and fully costed proposal to funding agencies by the end of 2004, and to begin work immediately on items with the longest lead-times.

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TSIP Launched!

Todd Boroson

The Telescope System Instrumentation Program (TSIP), the highest-priority moderate initiative of the McKee-Taylor Decadal Survey, has become a reality.

At the request of the astronomy division of the NSF, NOAO took on the administration of this program, and a solicitation for proposals was issued in December 2001. Proposals in this first year were limited to instruments or improvements for telescopes with six-meter apertures or greater.

The goals of TSIP are threefold. First, TSIP aims to provide new, scientifically important capabilities to the system of ground-based optical/infrared (O/IR) facilities. Second, TSIP acknowledges and rewards the huge investment made by independent observatories in building the current generation of large telescopes. Third,

TSIP strengthens the public-private partnership by broadening access to the independent observatory facilities. These three goals are jointly served by the requirement that telescope time equal in value to half of the funds awarded for new instrumental capabilities will be made available to the entire astronomical community.

In early May, a panel met to review and rank the proposals received. Alan Dressler, chair of the Decadal Survey panel on Optical and Infrared Astronomy from the Ground, chaired the review committee. Two proposals were selected for funding, resulting in total awards of \$3.89 million. The remaining funds will be carried over to supplement the FY 2003 TSIP allocation.

The two funded proposals involve OSIRIS, an integral field spectrograph for the Keck II Telescope; and

KIRMOS, a near-IR imager and multi-object spectrograph for the Keck II telescope—Phase B. The OSIRIS award is \$2,749,200 to fund the fabrication of this instrument, which is currently completing its design phase. The KIRMOS award is \$1,137,600 to fund one year of preliminary design work for this instrument.

Each night on one of the Keck telescopes is valued at \$47,400. Therefore, the two awards will provide a total of 41 nights on one of the Keck telescopes. See the article in the Observational Programs section of this *Newsletter* for the announcement of availability of the first 12 nights of this time.

Check the NOAO TSIP office Web site at www.noao.edu/system/tsip for ongoing information about the awards, the status of TSIP-funded instruments, and program news.

LSST Science Working Group

Jeremy Mould

We received a very healthy response during July to the request published in the AAS e-news for membership of a Science Working Group (SWG) for the Large Synoptic Survey Telescope (LSST). The SWG will provide advice in the areas outlined in the formal charge below. Establishing the relationship between the scientific opportunities arising from the Decadal Survey's LSST and those of other related surveys will be a key task. Another crucial product of the SWG's work will be a Design Reference Mission (DRM). The challenge with the DRM is to balance the science so that all of the objectives—cosmology, solar system exploration, and time domain astrophysics—are met. Although survey objectives tend to be synergistic, they do become competitive when one attempts to optimize a finite duration experiment.

The composition of the SWG is:

- Gary Bernstein—University of Pennsylvania
- David Morrison—NASA Astrobiology Institute
- Andy Connolly—University of Pittsburgh
- Mike Shara—American Museum of Natural History
- Kem Cook—Lawrence Livermore National Laboratory
- Alan Stern—Southwest Research Institute
- Peter Garnavich—University of Notre Dame
- Fiona Harrison—California Institute of Technology
- Alan Harris—NASA Jet Propulsion Laboratory
- Michael Strauss (Chair)—Princeton University
- Dave Jewitt—University of Hawaii
- Chris Stubbs—University of Washington
- Steve Larson—University of Arizona LPL
- Tony Tyson—Bell Labs
- Dave Monet—US Naval Observatory
- Dennis Zaritsky—Steward Observatory
- Nick Kaiser—University of Hawaii

continued



LSST SWG continued

The SWG will be supported by NOAO staff members:

Chuck Claver
 Dave De Young
 Dick Shaw
 Richard Green
 Chris Smith
 Buell Jannuzi
 Nick Suntzeff
 Abhijit Saha
 Sidney Wolff

I'm very grateful to the large number of people who offered their services to the SWG, and I'm confident there will be other roles for them in the LSST enterprise as it moves forward.

LSST SWG Charge

The NSF has authorized NOAO to establish and maintain a Science Working Group for the Large Synoptic Survey Telescope. This working group is intended to be the community-based body that will develop the science case and justification for federal investment by NSF, NASA, and other agencies in LSST. The SWG will represent the US community in assembling relevant partnerships for describing and advocating the appropriate federal role in this project. This guidance is intended to be a product of all public, private, and international groups that expect to play a role in the LSST. SWG members are expected to actively participate in technical, observational, and theoretical astrophysical studies that will be useful in defining and focusing the scientific objectives for the LSST.

Although not limited to these areas, the LSST SWG has been assigned the following specific tasks:

1. Develop the science cases and scientific priorities for an LSST, and refine the science goals outlined in earlier reports prepared by participating institutions. This includes evaluation of the likely impact that advances expected with existing and near-term studies will have on the science goals of LSST, along with consideration of the costs and benefits of alternative approaches. It also includes working with the scientific community to ensure that the goals continue to be exciting, important, and representative of the highest scientific priorities for a survey telescope.
2. Develop a "flowdown" from key science to top-level engineering goals and requirements. Develop performance metrics for the LSST telescope, instrumentation, software, operations, data management, and other aspects of the program; and, assess performance against these metrics.
3. Identify the key instrumentation capabilities for a LSST. Review the currently proposed survey camera and propose alternate designs or complementary instrumentation that would enhance scientific usefulness, improve observing efficiency, or lead to potential cost reduction.
4. Prepare a design reference program for a 10-year LSST mission. The DRM should be the optimum science program achievable with the LSST for the recommended design, cost and schedule. The DRM should be planned in sufficient detail that it is possible to specify the total data product of the telescope, the parameter space surveyed, and the predictable discovery set.
5. Establish the scientific relationship between LSST and other major facilities (SNAP, Gemini, POI, GSMT, VISTA, etc.).
6. Identify any priorities for technology development.
7. Provide scientific assessments of design concepts and implementation plans for their impact on the overall scientific performance. This includes the calibration plan and the data management plan.
8. Assemble appropriate community-wide partnerships for preparation of any proposals to NSF and NASA for funding activities related to LSST.



Director's Office



Alan B. Whiting
CTIO Postdoc

Alan Whiting arrived in La Serena in October 2001, after having spent the last four years teaching physics and astronomy at the US Naval Academy (where he also did his undergraduate studies). Before his teaching stint, Alan spent 11 years at sea and then completed the graduate program at the University of Cambridge Institute of Astronomy.

Alan's scientific focus is mainly in the dynamics of nearby galaxies; current projects include finishing a search for small, faint galaxies in the Local Group with Mike Irwin (University of Cambridge Institute of Astronomy) and George Hau (European Southern Observatory); and investigating the dynamics of the region within 10 megaparsecs of the Milky Way.



What are the roots of your interest in astronomy?

When I was about 12, I visited a cousin in Los Angeles. He had a six- or eight-inch Newtonian that, strangely, he was willing to let me play with. I pointed it at the first "star" I saw, which turned out to be Jupiter; and after that it was all over. I still look at Jupiter whenever I can.

How did your Navy career prepare you—good or bad—for the life of an astronomer? Did you have any especially memorable experiences with the night sky during your time at sea?

There really is little directly comparable between the job of a seagoing officer and that of an astronomer. On a ship you work closely with many people, within strict lines of authority and responsibility, and the job pressures are immediate. In the end, doing an outstanding job may only mean the ship got from there to here on time, and now you've got to do it over again. Being a scientist is creative, and you can actually accomplish something you can point to later. You provide your own motivation. But if you do a good job there are fewer people to share it with.

Indirectly, having been a Naval officer proved to be useful at graduate school. I had a solid base of self-confidence; setbacks didn't threaten my whole world, as they might to someone who had only been a student.

There are awesome things to be seen at sea, by day and night, and if I were a poet I would tell you about them. But the Captain (quite properly) becomes upset if he finds his watch officers looking up at the stars, rather than out at the sea where there are things to run into.

What are the main results to date from your survey work with Irwin and Hau?

We found the dwarf galaxies in Antlia and Cetus, for a start.

The Antlia dwarf had been catalogued before, and someone had suggested that it was in the Local Group based on radial velocity, but no one had followed it up. From the distance we derived that it appears to be on the border of the Group.

But what may be more important are all the dwarfs we didn't find. Popular kinds of galaxy-formation scenarios seem to require more Local Group dwarfs than are known, by an order of magnitude or so—we can now say that they aren't there. We've looked over the whole southern sky and most of the northern, so this is a full-sky effort. Thus, the result of a very local search has cosmological implications.

What are your service duties at CTIO?

I work with Nicole van der Bliik and Chris Smith in the Research Experiences for Undergraduates (REU) program. Nicole has done the most work this past year, an incredible amount; unfortunately, I found myself travelling for most of the ten-week period. Next year I should be more useful.

I've also become the staff contact for the 0.9-meter telescope, taking some of the load off Nick Suntzeff.

What are the most sharp comparisons or contrasts between life in the military and working for a civilian astronomical research organization?

As I've mentioned, in the Navy there is much more immediate pressure, and your accomplishments are, at best, temporary, but always shared in some way with the rest of the crew. Here the scientific work is done in much smaller groups and you can be (indeed, have to be) creative.

But in both I find a sort of selflessness, a willingness to work longer and harder than is strictly necessary, in order to get something worthwhile done. No one joins the Navy or becomes an astronomer to get rich or famous; to be successful in either you have to find your satisfaction in other ways.

What are your main interests away from work?

I probably spend most my money, if not time, on photography. I have two old cameras that take superb pictures (you have to pay attention, nothing is automatic on them), and there are wonderful pictures waiting to be taken where I find myself often going, such as mountaintops at sunrise and sunset.

But I've only begun to explore what there is to do and see in Chile, so anything might catch my attention. I may even succeed in establishing a local fencing club.