

Sloan Digital Sky Survey II
2006 SECOND QUARTER REPORT
April 1, 2006 – June 30, 2006

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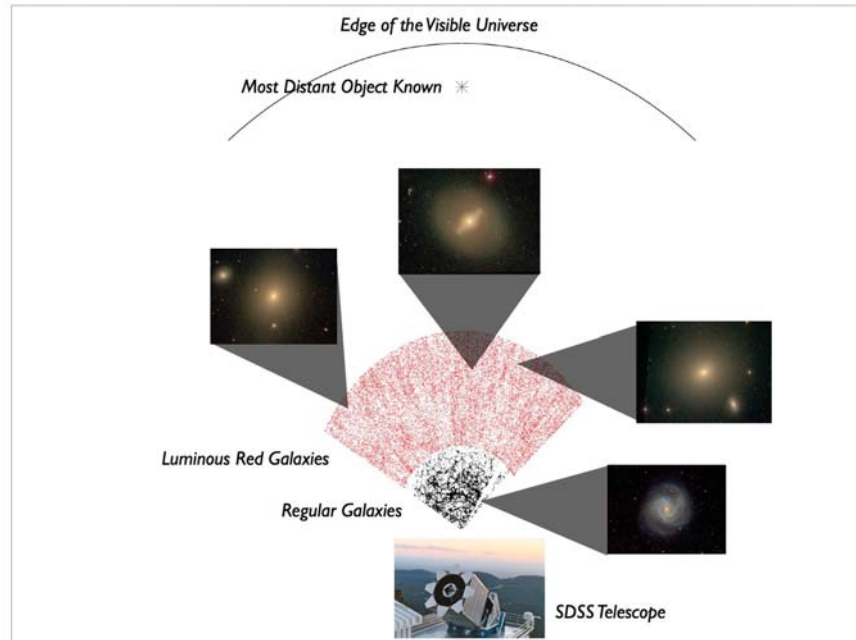
Q2 PERFORMANCE HIGHLIGHTS

- We obtained 16 square degrees of new Legacy imaging data, which filled in some of the small “missing areas” in the footprint. We also completed 78 Legacy spectroscopic plates against a goal of 81 plates. Through Q2, we have completed 1367 plates against the baseline goal of 1345 plates.
- We obtained 431 square degrees of new SEGUE imaging data, against a baseline goal of 225 square degrees. We also completed 13 SEGUE plates (5 bright and 8 faint). The combination is roughly equivalent to completing 7 SEGUE tiles, against a baseline goal of 13 tiles.
- We released DR5 to the general public on June 28, 2006, slightly ahead of the schedule in the approved distribution plan.
- We recorded over 30 million hits on our SkyServer interfaces and processed ~2.2 million SQL queries. We also transferred over 18 terabytes of data through the Data Archive Server interfaces.
- Q2 cash operating expenses were \$979K against a baseline budget of \$1,041K, excluding management reserve. In-kind contributions were \$170K against anticipated contributions of \$163K. No management reserve funds were expended.
- We initiated new content focused on Education and Public Outreach to our web site, at www.sdss.org/education.
- We had a strong presence at the Calgary AAS meeting. A special session was held on large scale structure with the SDSS, which featured presentations by five SDSS collaborators. We also conducted several training sessions on the use of the SkyServer. One training session occurred in the form of a “room presentation” and was attended by approximately 15-20 people; 6 or 7 additional sessions were held with smaller groups at the SDSS exhibit booth.
- The Supernova Team assembled at Fermilab May 31 – June 2 for a working meeting. The meeting began with small groups performing analysis and concluded with a group session in which results were summarized and remaining analysis work discussed.

1. SOME RECENT SCIENCE RESULTS

The following descriptions, with graphics, briefly highlight some of the scientific work accomplished during the reporting interval (bearing in mind that efforts often spill over into other quarters). Unlike the list of publications given in Exhibits 3 and 4, the topics selected here are by no means comprehensive, nor even representative, of the science being undertaken by the SDSS collaboration. These short science descriptions nevertheless augment our reporting of activities in SDSS-II.

Cosmic Structure on the Largest Scales: Luminous Red Galaxies



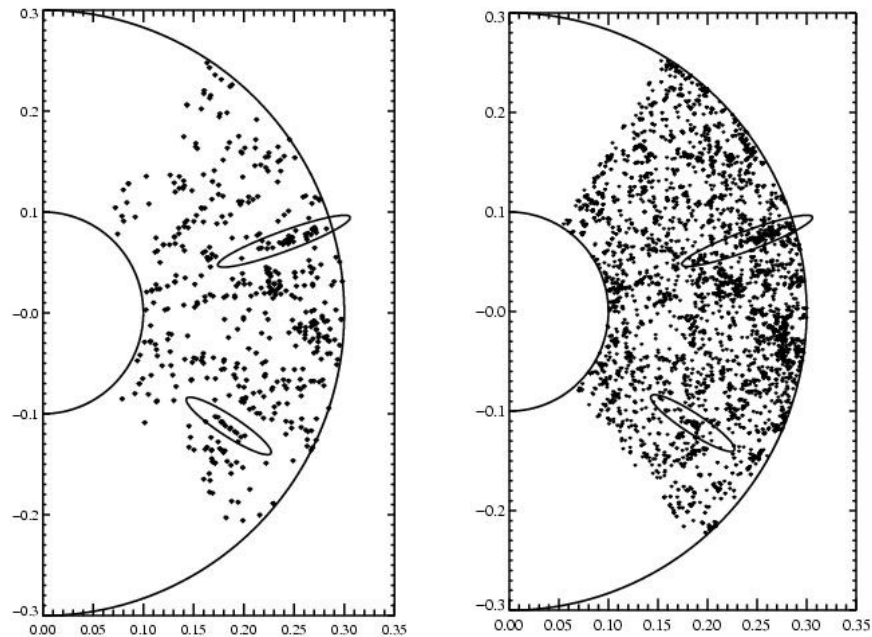
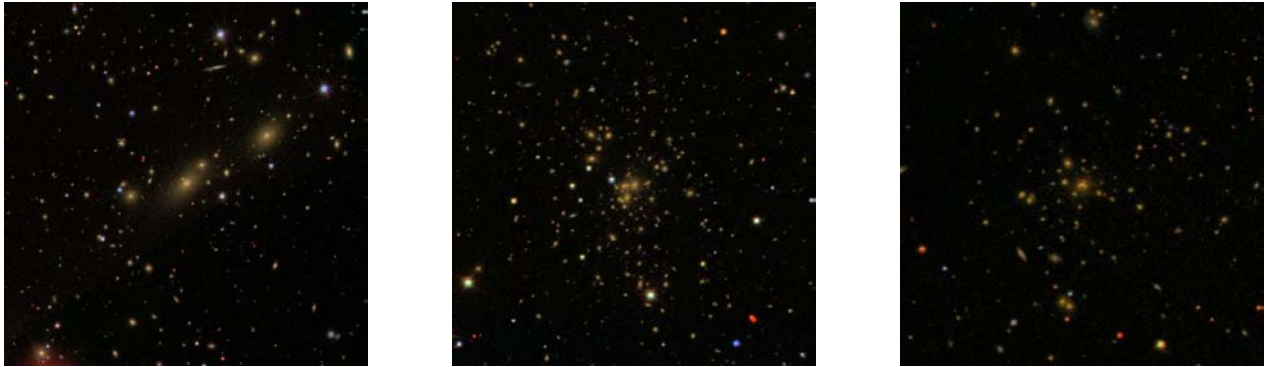
The SDSS galaxy redshift survey creates a 3-dimensional map of the distribution of galaxies in the traditional way: measuring the shifts of absorption and emission lines in galaxy spectra to determine how much their light has been shifted by the expansion of the Universe, which in turn depends on their distance. However, the old stellar populations in the reddest, most luminous galaxies produce very regular colors, so the precise photometric measurements from the SDSS imaging survey are enough to yield approximate redshift distances on their own. Princeton graduate student Nikhil Padmanabhan and his collaborators have used this fact to create an enormous map of the distribution of luminous red galaxies, extending one-third of the way to the edge of the visible Universe, and well beyond the boundary of the SDSS redshift survey itself. Light from the most distant galaxies in the above map has taken 5.6 billion years to reach Earth. This map reveals subtle fluctuations in the numbers of galaxies on scales of more than a billion light years. This is the largest scale on which structure in the galaxy distribution has ever been measured, and the measurements sharpen constraints on the average density of matter in the Universe.

An independent team led by Chris Blake of the University of British Columbia carried out a similar investigation using public SDSS data, with similar results. To calibrate the relation between galaxy color and redshift, both teams used data obtained in a collaborative program involving astronomers from the SDSS and the 2-Degree Field Galaxy Redshift Survey.

References

1. The Clustering of Luminous Red Galaxies in the Sloan Digital Sky Survey Imaging Data, by N. Padmanabhan et al., submitted to Monthly Notices of the Royal Astronomical Society, preprint astro-ph/0605302.
2. Cosmological Parameters from a Million Photometric Redshifts of SDSS LRGs, by C. Blake et al., submitted to Monthly Notices of the Royal Astronomical Society, preprint astro-ph/0605303

Cosmic Structure on the Largest Scales: Galaxy Clusters



The largest gravitationally bound structures in the Universe are clusters of galaxies, which contain tens or hundreds of bright galaxies orbiting in a potential well of dark matter and intergalactic gas. These clusters can be identified in SDSS images as unusually dense collections of galaxies of similar color. University of Michigan graduate student Ben Koester and his collaborators have used this approach to identify nearly 14,000 galaxy clusters in the main SDSS imaging survey, far more clusters than in any previous catalog. The clusters are of interest in their own right as laboratories for the interaction between galaxies, gas, and dark matter, and they serve as signposts by which one can trace still larger structures.

The top row shows SDSS images of three clusters identified by Koester et al.'s "MaxBCG" algorithm, at cosmological redshifts of 0.1, 0.17, and 0.28. In the bottom row, the left hand panel shows the spatial distribution of 492 clusters from the catalog (about 3.5% of the total) in a thin slice along the equator. The right hand panel shows the distribution of SDSS luminous red galaxies (LRGs) in the same region. Although cluster distances are estimated purely from galaxy colors and the LRG distances shown here are measured spectroscopically, there is good correspondence between the two maps.

References:

1. A MaxBCG Catalog of 13,823 Galaxy Clusters from the Sloan Digital Sky Survey, by B. Koester et al., submitted to the *Astrophysical Journal*

2. SURVEY PROGRESS

The period of accounting for this report includes three observing runs spanning the period from April 20 through July 4, 2006.

2.1. Legacy Survey

In Q2, we completed 78 Legacy spectroscopic plates against the baseline goal of 81 plates. We also obtained 16 square degrees of new imaging data. Table 2.1 compares the imaging and spectroscopic data obtained against the Legacy baseline plan.

Table 2.1. Legacy Survey Progress in 2006-Q2

	2006-Q2		Cumulative through Q2	
	Baseline	Actual	Baseline	Actual
Legacy Imaging (sq. deg)	0	16	7808	7577
Legacy Spectroscopy (tiles)	81	78	1345	1367

As noted in the Q1 report, when the baseline plan for SDSS-II was prepared, we estimated that the total area to be imaged was 7808 "footprint" square degrees; the actual area required to close the gap was 7561 square degrees. However, there are a few small "missing areas" in and around the footprint that we will continue to fill in over time on a lower priority basis. In Q2 we obtained an additional 16 square degrees in these areas, which increased the total area of the Legacy imaging survey to 7577 square degrees.

The SDSS-II Survey officially began on July 1, 2005; therefore, the end of 2006-Q2 marks the end of the first year of the SDSS-II Survey operations. In the first 12 months of SDSS-II, we obtained 143 square degrees of new Legacy imaging data against the baseline goal of 166 square degrees. We also completed 234 Legacy spectroscopic plates against the baseline goal of 211 plates. Over the last twelve months, the rate of progress on the Legacy Survey was in good agreement with the forecast in the baseline plan.

The following graphs show progress against the baseline plan. For the Legacy Survey, we have chosen to extend the progress charts from SDSS to include the three-year time extension. For the imaging survey, the baseline has been left unchanged. For the spectroscopic survey, we have set the baseline plan for SDSS-II equal to actual progress prior to July 2005. In addition to showing the rate at which we need to complete plates to finish the Survey, this shows the rate at which we completed plates in the past.

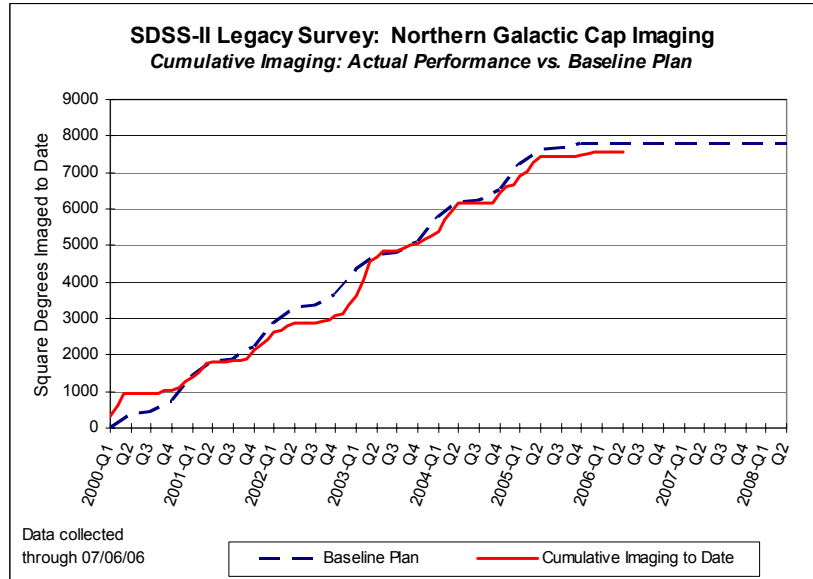


Figure 2.1. Imaging Progress against the Baseline Plan – Legacy Survey

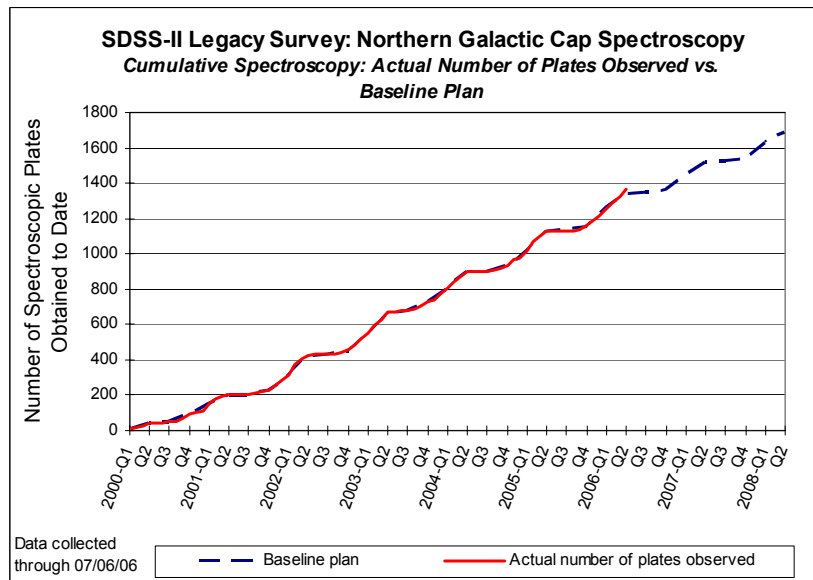


Figure 2.2. Spectroscopic Progress against the Baseline Plan – Legacy Survey

2.2. SEGUE Survey

Table 2.2 compares SEGUE progress against the baseline plan. The SEGUE Survey is ahead of the baseline in both imaging and spectroscopy due to the acquisition of SEGUE data in prior to July 2005, when commissioning and proof-of-concept observations were made.

Table 2.2. SEGUE Survey Progress in 2006-Q2

	2006-Q2		Cumulative through Q2	
	Baseline	Actual	Baseline	Actual
SEGUE Imaging (sq. deg)	225	431	1192	2271
SEGUE Spectroscopy (bright plates)	13	5	56	81
SEGUE Spectroscopy (faint plates)	13	8	56	73

SEGUE imaging data was obtained during the April and May observing runs. We obtained a total of 431 square degrees of new SEGUE imaging data against a baseline goal of 225 square degrees. Data were obtained on stripes 1062, 1188, 1260, 1600, and 1660.

SEGUE spectroscopic data were obtained during the April, May and June runs. A total of 13 SEGUE plates (5 bright and 8 faint) were completed. This is roughly equivalent to completing 7 SEGUE tiles against a baseline goal of 13 tiles. Recall that a SEGUE tile is considered complete when the faint and bright plate combination for a field is observed. Our observing strategy is arranged to complete plate pairs in roughly the same time frame, in order to maximize the scientific usefulness of each plate pair. However, given the many factors that affect observing operations (atmospheric conditions, available time, etc.), it is not always efficient to complete plates in “pair combinations.” Therefore, we have elected to separately report progress in terms of the number of bright and faint plates completed, as opposed to combined bright/faint plate pairs (i.e., SEGUE tiles).

In the first 12 months of SDSS-II, we obtained 967 square degrees of new SEGUE imaging data against the baseline goal of 1192 square degrees. We also completed 84 SEGUE plates (41 bright and 43 faint plates). This is roughly equivalent to completing 42 SEGUE spectroscopic tiles against the baseline goal of 56 tiles. The rate of obtaining new SEGUE data lagged the baseline due largely to weather limitations.

The following figure shows the current SEGUE layout and progress map, as of June 30, 2006. The plot can be found online at: <http://home.fnal.gov/~yanny/fut/layout.html>

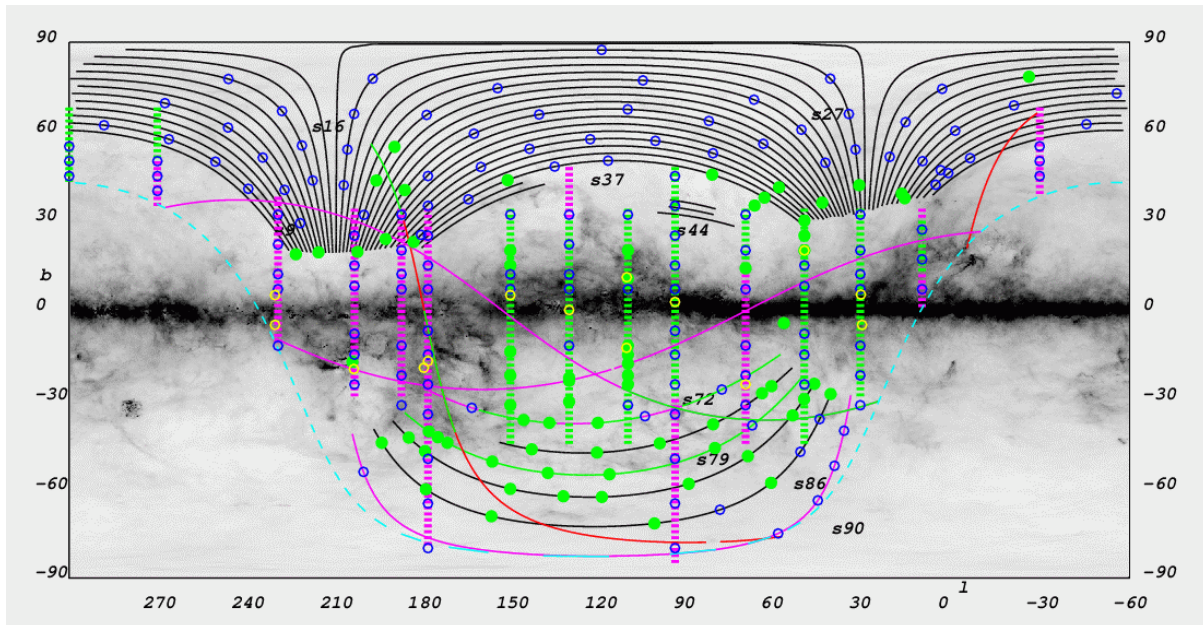


Figure 2.3. SEGUE imaging sky coverage and plate layout (as of June 30, 2006).

The following graphs illustrate SEGUE progress against the baseline plan. The imaging graph presents a straightforward comparison of imaging progress against plan. The spectroscopy graph shows the rate at which we have completed bright and faint plates separately.

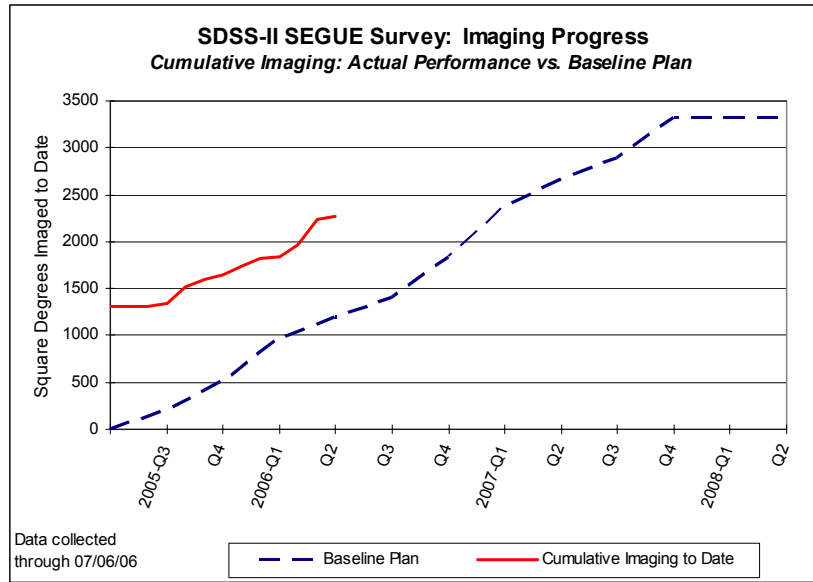


Figure 2.4. Imaging Progress against the Baseline Plan – SEGUE Survey

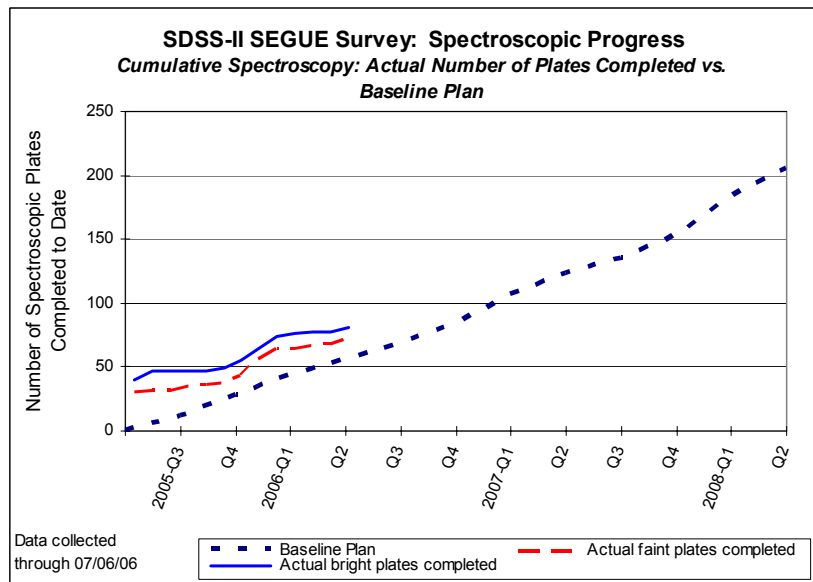


Figure 2.5. Spectroscopic Progress against the Baseline Plan – SEGUE Survey

In addition to supporting observing operations, the SEGUE team was involved in several other activities:

- Data processing and analysis is underway on several recently observed low-latitude target-selection algorithm plates.

- Observing with the USNO 1-meter telescope continued during dark time to obtain images of bright stars and cluster with the u'g'r'i'z' system, which will be used to refine the calibration of the SEGUE photometry and spectroscopy. A scientist and student at Fermilab are actively working to process these data.
- Software development work continued on the pipelines that will be used to process SEGUE imaging data obtained in crowded fields; to process spectroscopic data; and to estimate atmospheric parameters based on R=2000 spectroscopy and ugriz photometry. Software development work is described in detail in Section 5.1.1.

2.3. Supernova Survey

No observing time was allocated to the Supernova Survey in Q2, in accordance with the SDSS-II observing plan. Work during the quarter was devoted to continued analysis of the first season of data from the Supernova Survey, which ran from September 1 through November 30, 2005, and to prepare for more efficient data processing operations for the Fall 2006 run. Tools were developed to convert the outputs of 'final photometry' pipelines into standard data formats for use by those carrying out analysis of supernova light-curves. We also developed a Monte Carlo simulation package that will be used in the estimation of supernova rates and in determining Malmquist and light-curve fitter biases in supernova distance estimates. An initial estimate of the low-redshift supernova Ia rate was refined using the Fall 2005 data and a suite of artificial supernova images was developed to test the final photometry pipelines and estimate errors. We also worked on improved algorithms to detect moving objects (asteroids) in subtracted frames, which will be incorporated into the on-mountain data processing to reduce the number of 'false positive' supernova candidates.

3.0 OBSERVING EFFICIENCY

Observing efficiency is summarized according to the categories used to prepare the baseline projection.

3.1. Weather

The weather category reports the fraction of scheduled observing time that weather conditions are suitable for observing. Table 3.1 summarizes the amount of time lost to weather and Figure 3.1 plots the fraction of suitable observing time against the baseline forecast. Averaged over the quarter, the fraction of available observing time was close to that predicted in the baseline plan. By month, weather conditions in April were as expected, were significantly better than anticipated in May, and significantly worse than anticipated in June. In fact, weather kept us closed on seven of the 20 scheduled observing nights in June. In addition, throughout the quarter, when weather was suitable for observing, conditions were often better suited for spectroscopy than imaging.

Table 3.1. Potential Observing Hours Lost to Weather in Q2

Observing Condition	Total hours potentially available for observing	Total hours lost to weather	Fraction of time suitable for observing	Baseline Forecast
Dark Time	285	114	60%	60%
Dark & Gray Time	386	165	57%	60%

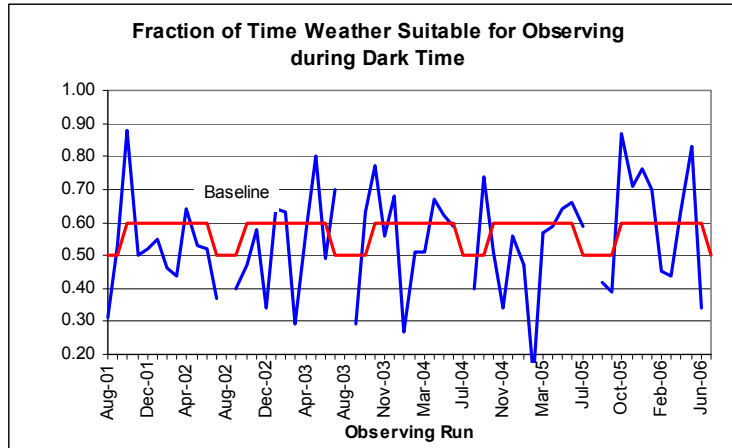


Figure 3.1. Percentage of Time Weather Suitable for Observing

3.2. System Uptime

System uptime measures the availability of equipment when conditions are suitable for observing. We averaged 96% uptime against a baseline goal of 90%. Table 3.2 summarizes the total amount of time lost to equipment or system problems and Figure 3.2 plots uptime against the baseline goal. System uptime continues to consistently exceed the baseline expectation.

Table 3.2. Potential Observing Hours Lost to Problems in Q2

Observing Condition	Total hours potentially available for observing	Total hours lost to problems	System Uptime	Baseline Forecast
Dark Time	285	10	96%	90%
Dark & Gray Time	386	11	97%	90%

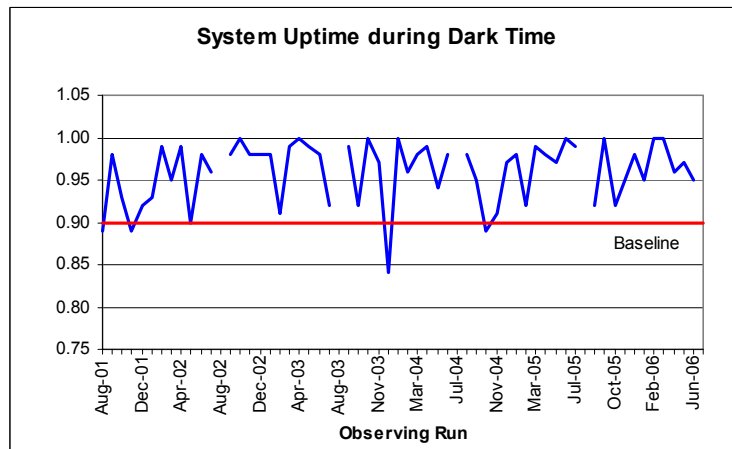


Figure 3.2. System Uptime

3.3. Imaging Efficiency

Imaging efficiency averaged 78% against a baseline goal of 86%. Efficiency was below the baseline due to a larger number of short imaging runs in the quarter. Shorter runs tend to drive down efficiency because setup and calibration time reflect a larger fraction of the total time spent per scan.

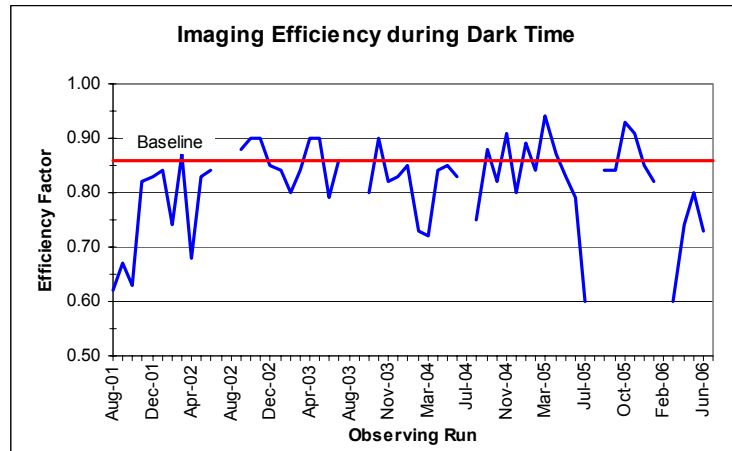


Figure 3.3. Imaging Efficiency

3.4. Spectroscopic Efficiency

Spectroscopic efficiency is derived by assessing the time spent performing various activities associated with spectroscopic operations. Table 3.3 provides the median time, by dark run, for various overhead activities associated with spectroscopic operations. Units for all categories are minutes except for efficiency, which is given as the ratio of baseline science exposure time (45 minutes) to total time required per plate. Using these measures, spectroscopic efficiency exceeded baseline goals; average efficiency in Q2 was 65% against the baseline goal of 64%.

Table 3.3. Median Time for Spectroscopic Observing Activities

<i>Category</i>	<i>Baseline</i>	<i>Run starting Apr 20</i>	<i>Run starting May 17</i>	<i>Run starting Jun 17</i>
Instrument change	10	5	5	5
Setup	10	11	9	12
Calibration	5	5	5	5
CCD readout	0	3	3	3
Total overhead	25	24	22	25
Science exposure (assumed)	45	45	45	45
Total time per plate	70	68	68	66
Efficiency	0.64	0.65	0.67	0.64

Figure 3.4 shows that efficiency continues to exceed the baseline due in large part to the quickness with which the observers perform spectroscopic cartridge changes.

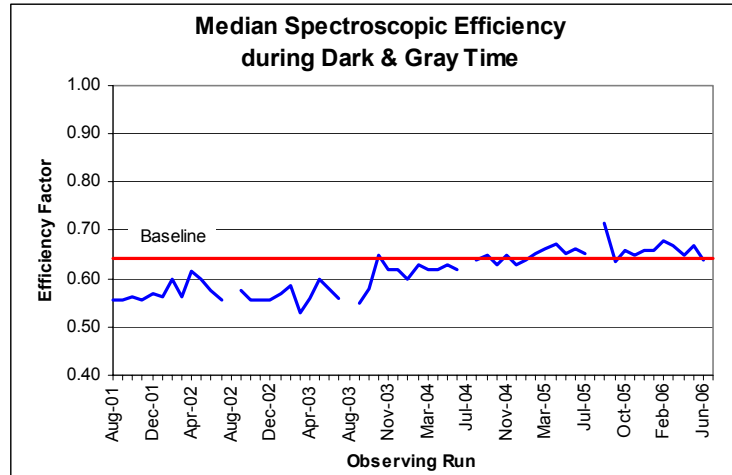


Figure 3.4. Spectroscopic Efficiency

4. OBSERVING SYSTEMS

Observing systems includes the instruments, telescopes, computers and various sub-systems that support observing operations at APO.

4.1. The Instruments

The Japan Participation Group (JPG) made a new set of six ‘u’ filters for the 2.5-meter telescope in April 2006. The manufacturer was Asahi Spectra Co. Ltd. Measurements of their transmission at the National Astronomical Observatory of Japan show that all of the new filters meet specifications. The new filters are currently at Princeton, where they will be held as spares should problems arise with the ‘u’ filters on the imaging camera. As of this writing, there are no plans to install the new filters into the camera.

The imager worked well throughout the quarter, with no problems to report. The spectrographs also worked well, although we had a few minor problems with various elements of the spectroscopic system that resulted in small amounts of lost sky time.

- In April, the spectroscopic system “hung” during bias readouts. The problem was resolved by rebooting the spectro DA crate and the guider Macintosh; ~30 minutes was lost to the troubleshooting exercise.
- In May, we experienced a problem with the outside manipulator that stopped the manipulator from working. As the manipulators are required to place fiber cartridges onto and off of the transfer cart, failure of the manipulator meant a stop in spectroscopic observing operations. Fortunately, the failure occurred at about the time that seeing conditions were improving, so we were able to switch to imaging mode and avoid lost sky time. The manipulator was repaired the following day by the engineering team; the cause of the problem was a faulty directional switch located inside the manipulator arm.
- Also in May, a problem with the LN2 autofill system caused the observers to suspend observing operations and perform a force fill. The force fill took ~30 minutes to complete. The problem was traced to a faulty fill sensor, which was promptly replaced the following day.
- In June, a power supply failed on Spectrograph #1. The faulty supply was replaced with a spare unit; approximately two hours were lost to diagnosing the problem and implementing the swap.

4.2. The 2.5m Telescope

In addition to responding to instrument problems and performing scheduled preventive maintenance, the on-site engineering team was engaged in a number of planned engineering activities. The following list highlights some of the more notable work performed during the quarter.

1. The engineering team continued to provide support for the feasibility studies associated with the Exoplanet Tracker (ET) project. Efforts consisted mainly of plate plugging during observing operations, and converting fiber cartridges during the transition between SDSS and ET observing runs. Overall, the ET project has had minimal impact on engineering activities.
2. We were successful in completing the development of a new dual gas lamp to support calibration of the spectroscopic system. The new lamps are helically-shaped neon/argon lamps employing 990 volt / 100 milliamp power supplies. The intensity of the new lamps meets or exceeds that of the original neon lamps. Cost per lamp has dropped from \$665.00 per unit to approximately \$300.00 with the added advantage of being able to choose which gas and/or combination of gasses we might need. Lamp housing modifications are necessary but housing design has kept pace with lamp development; new housings will be ready for the fall observing season.
3. We established a primary mirror cleaning schedule that was driven by dust events reported by the observers during night time operations. The engineering team monitors observer night logs and performs CO₂ cleaning as necessary. The new procedure is working well and the surface of the mirror appears much cleaner than in previous years, at this time in the observing season.
4. In preparation for the summer shut down, and the removal and reinstallation of the primary mirror thermal sensors, we designed and fabricated a new sensor mount that will eliminate sensor failure due to sensor disconnects after mirror installation. The new mount design will ensure proper sensor contact with the mirror surface and continued connection during the observing season.
5. We finished the installation and testing of the MCP Watch Dog Relay. The relay was incorporated into the slit bypass system so the relay can be bypassed if it fails. The relay is also being monitored by the interlock graphical display system, which makes it easier to identify as a failure point should the relay fail in the future.
6. We instituted a “hot swap” procedure for the M1 and M2 Galil controller systems, in order to periodically cycle the spare unit on the telescope to ensure that the spare remains in good working order. We will execute the exchange process every six months for the remainder of the survey.
7. New cover tarps were fabricated for the 2.5-m telescope wind baffle and secondary truss. The tarps allow us to more quickly and efficiently protect these telescope components and to move them around with the tarps in place.
8. A new telescope counterweight removal spreader bar was designed, fabricated, and tested during the quarter. The new bar is made of aluminum, which reduces the physical strain on the SDSS crew when moving the bar from its storage area to the telescope.

The majority of work in Q3 will be organized around the annual shutdown. In addition to re-aluminizing mirrors and support the annual work on the imaging camera and spectrographs, planned tasks include re-organizing cabling in the 2.5-m telescope primary mirror support structure (PSS); and performing maintenance work on the 2.5-m enclosure, namely replacing the threshold on the east rollup door and making repairs to the aluminum floor.

4.3. The Photometric Telescope

The Photometric Telescope (PT) worked well throughout the quarter, with no significant problems to report.

To improve reliability, we installed a thermal controller for the PT dome vent fan. The controller will energize the fan if the dome temperature exceeds 80 degrees F and the humidity stays below 65%. Better control of the dome environment will protect the lubricants in the telescope axes bearings.

4.4. Operations Software and the Data Acquisition System

Changes in observing software consisted of minor bug fixes, including the following:

- A bug was fixed that interfered with writing the logs used by the APO-to-Fermilab data transfer process.
- Code changes were made to improve robustness to slow responses from the Photometric Telescope's Telescope Control System (TCS).
- A bug was fixed that prevented the efficiency measurement software from running properly on some nights.
- On several occasions during the quarter, the MCP delayed acknowledging a command from the Telescope Control Computer (TCC). The fix, documented in PR6995, involved removing the opening and closing of an unused log file.
- A bug was discovered in the version of idlspec2d running at APO that caused erroneous signal-to-noise values on some plates. The "spline bug" had been diagnosed and fixed in v5_1_3 of idlspec2d, but this version of the code had not yet been installed on SoS at APO. The fix, documented in PR6991, was to install v5_1_3 at APO.
- Large gaps in arc line coverage were discovered while looking at engineering data. It was found that tests in SoS for large gaps in line coverage were not comprehensively checking the red end of the spectra. The problem and fix were documented in PR 7031.

No work was required or performed on the Telescope Performance Monitor (TPM). Potential work in Q3 involves upgrading the DM display tool to a new 24-bit version that was created at Los Alamos National Laboratory to accommodate a migration from Solaris to Linux. When implemented at APO, the upgrade will fix a long-standing color map problem on the TPM display.

Work on the data acquisition system (DA) included retiring the Silicon Graphics (SGI) host computer at APO, resolving a couple of long-standing operational problems with the DA, and recovering from several hardware problems at the Fermilab test stand.

Many of the changes needed to remove all dependence on the SGI were in place or in progress at the end of last quarter. These changes were finalized during Q2 and the changes installed at APO.

Operational problems that were resolved are as follows:

- In the fall, the observers discovered that when the spectro pool disk neared its capacity, the system refused to take any more data instead of deleting archived frames as needed to free up space. It turns out that there is a limit on the number of unique MJDs allowed in the pool, and the limit was set too low. The limit was increased and we now see archived frames being deleted as needed. It is likely that this issue pre-dated the DA upgrade, although it is not clear why it wasn't observed previously.

- When the PT CCDs were saturated, readout of PT exposures would fail. This was traced to debug code that was reporting on the presence of saturated values; the debug code was removed.
- Since the new DA was installed, the scrolling displays at APO have shown occasional spurious horizontal lines at the left side of the display. This problem became much worse this spring for unknown reasons. Changing some characteristics of the data transfer from the process board to the video interface board fixed the problem.
- Occasional problems with missed interrupts from VCI boards in various systems (spectro, PT, photo) caused the readout in the affected system to fail. These were traced to a timing problem in the watchdog process on the processor board. Basically, the watchdog was claiming that an interrupt had been missed when it had not, and the subsequent attempt to recover would catastrophically confuse the VCI readout.

At the Fermilab test stand, an MVME712M board went bad, and a cooling unit failed causing overheating and failures on two MVME5500 boards. The 5500s were repaired and the 712M was replaced with a spare at the test stand. Currently, the simulator system is functional and we are able to take simulated imager data with two 5500 boards. (For reference, the 712M is used on the back of a VME crate to interface the processor board to the SCSI pool disk.)

4.5. Observatory Operations

Observatory operations ran smoothly in Q2. A new observer, Mr. Shannon Watters, started work in April. This returns to the observing staff to full strength (8.5 FTEs). Looking forward, however, we will lose one observer in mid-July when John Barentine begins graduate studies. We also anticipate losing one observer in late September, when Jurek Krzesinski returns to his native Poland. We have evaluated our staffing needs going forward and believe that we will be able to fully support operations for the remaining two years with the reduced staffing level.

Given the persistence of drought-like conditions in the Sacramento Mountains, we have grown increasingly concerned about the risk of forest fires around the observatory. To help mitigate this risk, the APO Site Safety Officer performed a risk self-assessment in Q1 and issued a written report with recommendations. Based on these recommendations, we completed several fire-protection measures at the observatory:

- 1) With permission from the National Forest Service (NFS), we removed 29 trees from around the observatory. These trees were selected based on the risk they posed to the observatory in the event of a fire, namely their close proximity to operationally critical buildings.
- 2) We installed steel shutters over all of the windows on the Operations Building and Plug Plate Support Lab, and over the dormitory windows that face the forest. The shutters will reduce radiant heating into the buildings, which reduces the potential for spontaneous combustion of the building contents. The buildings themselves are fairly fire-resistant, being built of stucco walls with metal roofs.
- 3) We purchased (9) above-ground sprinklers and placed them on the ridgeline around the observatory. Each sprinkler head is mounted on a tripod stand that positions the head approximately one meter off the ground, and each sprinkler is capable of spraying a water stream with 50-foot radius. The sprinklers can be quickly connected to the observatory's 25,000-gallon water storage tank in the event of an approaching fire and can be run flat out for approximately 8 hours.
- 4) One of the Sunspot Volunteer Fire Department fire trucks has been stationed at Apache Point.

- 5) We upgraded the observatory forest fire response and evacuation procedures for observatory personnel.

A tragic accident occurred immediately south of the observatory on April 24, when two linemen from a local electric company were killed while performing maintenance on a damaged power pole. The workers were removing power lines from the top of the pole when the pole broke near its base. The linemen were strapped to the pole near its top and were crushed when the pole hit the ground. Three individuals from APO were among the first responders and administered first aid to the injured workers until emergency personnel arrived. The event represented a major blow to the local community, as both men were in their early 20's and lived in Cloudcroft with their families.

5. DATA PROCESSING AND DISTRIBUTION

5.1. Data Processing

5.1.1. Software Development and Testing

No changes were made to the production Legacy photometric or spectroscopic pipelines in Q2.

Development work continues at Princeton on the spectroscopic pipeline, the photometric pipeline, and photometric calibration. With regard to the spectroscopic pipeline, new code has been written and tested that correctly deals with the scattered light problems from bright stars in the blue halves of the spectrographs. Work is underway to fix similar problems in the red spectrographs. This should be done in the first half of Q3 – a solution has been developed and implementation is underway. Pipeline testing has been postponed pending completion of this work, with the exception of some work on the radial velocity determination. Accurate radial velocities are being obtained for a small number (about 100) of the brighter SEGUE stars as a byproduct of work on abundances by Beers and collaborators. Comparison of these with the results of Spectro v5 shows that some of the Elodie templates appear to have zero-point problems, while the SDSS templates do not. This remains to be tracked down. The scatter is still about 1.5 times larger than expected for the errors produced by Spectro v5, so this too has to be tracked down. It may be due to scattered light problems, since these tend to be bright stars, so we will re-examine this problem when v5 is fixed and re-run. Finally, a problem was found with a hitherto undocumented bad column in one of the blue CCDs, which has caused small and unnoticed glitches in some of the spectra. This time it produced a big glitch, as established by a test APO spectrum observed by a student. To address the problem, code was modified to mask out the bad column.

On the photometry front, the code to handle crowded-field photometry on low latitude scans was adapted to handle multiple bands. Testing has been done using test fields and reductions. Remaining work includes packaging the code for inclusion into production data processing operations.

On the calibration front, an immense amount of data processing and testing has had a good final result: ubercal is now essentially done, and the data model changes have been propagated into the Photo documentation. A technical paper describing this effort has been written. The final task is to export ubercal to the production data processing operation; we anticipate completing this in the next couple of months.

Work continued by the JINA-MSU team on the development of the stellar atmosphere pipeline that will be used for SEGUE observations in order to estimate atmospheric parameters (T_{eff} , $\log g$, $[\text{Fe}/\text{H}]$) based on $R = 2000$ spectroscopy and $ugriz$ photometry. A major milestone was achieved in Q2 when v1.0 of the stellar atmosphere pipeline was completed and delivered to Fermilab for verification. The pipeline is

presently based on a number of independent methods (obtained from different calibrations) for each parameter, which are then suitably averaged in the final estimation process. Estimates of the internal scatter in the determination of a given parameter are also kept track of. Highlights of Q2 progress are as follows:

- Version 1.0 of the stellar atmosphere pipeline, which runs in IDL, was delivered to Fermilab, tested and verified. Parameters for present SEGUE stars were made available to the Collaboration. Documentation for the pipeline is being drafted.
- We continued obtaining high-resolution spectroscopy of SEGUE stars with predicted parameters from the present pipeline, so that calibration and refinement of these estimates can be carried out. To date, some 30 stars have available Keck spectroscopy, and of greatest importance, over 70 HET spectra have been obtained in the first and second (of three) trimesters anticipated to be obtained over the course of the coming half year. The parameters derived from these spectra will be used to evaluate the predictions of the SEGUE pipeline, and to derive corrections (if needed). These same spectra will be of use for establishing the actual velocity errors in SEGUE spectra, since the high-resolution data have errors on the order of 1 km/s. At present, it appears that we have already identified a zero point offset on the order of 7-10 km/s for SEGUE spectra. The origin of this offset (probably in the correlation templates) is being sought.
- Continued development and testing of an Artificial Neural Network (ANN) approach to parameter estimation from spectroscopy alone. We expect that this will soon be ready for implementation in the pipeline.
- Continued work to extend the "reach" of the current pipeline to include stars with $T_{\text{eff}} > 10,000$ K. This work presently has resulted in techniques that take us to $T_{\text{eff}} = 25000$ K. We expect to push for higher T_{eff} 's in the near future.
- Worked with a number of members of the SEGUE team in order to refine methods for estimation of stellar parameters based on ugriz photometry alone. These look to be quite useful in the metallicity interval $-2.3 < [\text{Fe}/\text{H}] < 0.0$. Application of these techniques to the entire DR5 database is expected soon. This should result in many tens of millions of photometric abundance estimates.
- Worked with a number of members of the SEGUE team at the University of Washington in order to rationalize measurement of indices for late-type stars. This has already resulted in the incorporation of their preferred indices into the v1.0 pipeline. We plan on further testing and integration of late-type stellar work in the near future, including incorporation of the UW spectral classifications.
- Provided a first pass of the stellar parameters list for the DR6 data model, with documentation. This is presently under review by other members of the SEGUE team and will hopefully become finalized in the next quarter.

Our primary goal for Q3 is to finish observations of first-pass calibration stars now being obtained with HET. These data will be reduced and analyzed so that, when combined with previous Keck data, we will have over 100 high-res spectra of SEGUE stars with which to evaluate the success of the SEGUE spectroscopic pipeline. These data will be incorporated in a publication of the SEGUE pipeline techniques.

We plan to finish incorporation of the ANN from MPIA (Heidelberg), as well as the "hot extension" and separately the "cool extension", into the next version of the pipeline, which we envision to be v1.5. Unless other techniques come forward, we hope to "freeze" the present set of techniques during Q3, at least for determination of the basic atmospheric parameters T_{eff} , $\log g$, and $[\text{Fe}/\text{H}]$. We will then begin

developing and refining techniques for obtaining estimates of additional abundances of interest (e.g., [C/Fe], [Mg/Fe], [Na/Fe], [Sr/Fe], etc).

Finally, we plan to freeze the list of SEGUE parameters for the DR6 data model. The proposed list, which is currently under review, includes the following:

1. Data from the line index file, including all line indices, average S/N, radial velocity flag, measurement errors, and maskbit flag;
2. Stellar parameters:
 - SPEC_NAME -- Spectrum name without 'spSpec', and '.fit'.
 - Targeting Type.
 - Color flag = C if reported g-r doesn't match expectation based on H-alpha strength; N if color is OK.
 - G-band flag = g if star possibly mildly G-band strong relative to expectation
= G if star is likely G-band strong
= N if star is normal
 - Adopted [Fe/H]. Set to -9.99 if not available. Note that this should be regarded with suspicion for $\sim B-V > 1.2$, since calibrations in this color range do not exist.
 - Standard deviation in adopted [Fe/H], based on the spread of the estimates that are used. Set to -9.99 when only 1 estimator is used.
 - Number of estimators used for adopted [Fe/H].
 - Adopted temperature estimate, set to -9999 if missing.
 - Estimated standard deviation of adopted temperature, based on the spread of two estimates, if both are present. Set to -9999 when only one or none are used.
 - Number of temperature estimators used.
 - A very simple temperature estimate, useful for stars that are too hot or too cool for the other techniques. Based on extrapolations of other estimates for colors outside their range of applicability.
 - Indicator variable (1 if prediction is OK, 0 if not).
 - Adopted log g estimate, based on several techniques; - 9.99 if missing.
 - Estimated standard deviation of adopted gravity, based on techniques used; set to -9.99 if only one (or none) of the estimates are used.
 - Number of log g estimators used.
 - Dwarf distance estimate in kpc according to Chiba & Beers (2000).
 - Turnoff distance estimate in kpc according to Chiba & Beers (2000).
 - Giant distance estimate in kpc according to Chiba & Beers (2000).
 - AGB distance estimate in kpc according to Chiba & Beers (2000).
 - FHB distance estimate in kpc according to Chiba & Beers (2000).
3. Radial velocity and color parameters:
 - Spectrum name
 - Radial velocity flag
 - Adopted heliocentric radial velocity
 - Calculated radial velocity
 - Error estimate in the calculated RV
 - Radial velocity obtained from Spectro v5 pipeline
 - Error in radial velocity from Spectro v5 pipeline
 - Radial velocity estimated from ELODIE template
 - Error in ELODIE RV
 - Radial velocity estimated from cross correlation, from spec1d pipeline

- Error in RV1d
- g magnitude
- V magnitude from $V = g - 0.561*(g-r) - 0.004$
- g-r color
- Color prediction from half power point
- Color flag if column 15-16 > 0.15 or < -0.15 , set to COLSW
- B-V color from $B-V = 0.916*(g-r) + 0.187$
- RA
- DEC

5.1.2. Data Processing Operations at APO

No data were processed at APO as we were not collecting new supernova data.

5.1.3. Data Processing Operations at Fermilab

In Q2, we processed 637 square degrees of SEGUE imaging data plus an additional 55 square degrees of Legacy imaging data. We also processed data from 109 spectroscopic plates: 15 SEGUE and 94 Legacy plates. All spectro data were processed using existing Legacy versions of the spectroscopic pipelines (idlspec2d v4_10_4 and spectro 1D v5_9_4) and flat fields from 2004-2005 observing season. All imaging data were processed with the Legacy version of the photometric pipeline (photo v5_4_28). All data successfully passed the suite of standard QA tests.

The PT observed 52 secondary patch sequences over the course of the second quarter; of these, 26 were deemed survey quality after processing. The PT also observed 38 manually targeted open star cluster sequences for the SEGUE program over this time period; of these, 12 were deemed survey quality after processing.

There were 24 nights provided by USNO-Flagstaff Station for the USNO-1m telescope SEGUE campaign during this quarter; potentially useful data were obtained on 19 of these nights. Data processing has commenced on the backlog of USNO-1m SEGUE data. Although this backlog encompasses roughly a year's worth of data, the processing is moving quickly, and we anticipate that the backlog will be removed within the third quarter.

We continue to transfer data from the observatory to Fermilab over the Internet. When the microwave link at APO is up and running properly, the bandwidth is sufficient to transfer the data at a comfortable rate. As described later in Section 5.1.5, the faster link went down for roughly one week this quarter, and the older, slower T1 link was too slow to keep up with the acquisition of new data. When the faster link returned, we completed the backlog of transfers quickly.

We continue to back up important data and refine our backup process. Backed-up data includes all of DR5 and the operations database (OPDB). We continue to further automate the backup process.

We physically moved the second set of DLT tapes (the backup tapes) from an external storage warehouse to a storage location in the Fermilab Feynman Computing Center (FCC). We are copying all of the data from these tapes to new tape media in the tape robot, which will result in a total of three copies of the data. As of this writing, we have completed the transfer of 379 out of 545 tapes with gang, log, spectro, and TPM data, and 21 out of 329 tapes with imaging data.

We have made a number of improvements to the organization of our software products to simplify the installation and distribution of SDSS software to different operating system versions and architectures.

The migration of data processing to the Grid has succeeded to the extent that we are now running all production data processing on the Grid. However, minor issues persist and we continue to expend effort refining the process.

We are expanding our efforts to cross train members of the Fermilab Experimental Astrophysics Group (EAG). In particular, additional members of the group are learning data processing and system administrations tasks.

We purchased eight new data processing nodes and have completed the installation of six of these. The installation of the remaining two is in progress. We retired eight older machines and migrated the data from them on to other nodes.

5.1.4. Data Processing Operations at Princeton

Legacy and SEGUE data are also being processed at Princeton. The reduction environment for imaging data is being used to support work on ubercalibration and the photometric pipeline, Photo. The reduction environment for spectroscopic data is being used to process spectroscopic data from the Legacy and SEGUE Surveys through `idlspec2d v4_10_9` and `v5_1_3`, as development work on Spectro v5 continues.

5.1.5. Data Transfers from APO

We experienced two interruptions in data transfers from APO during the quarter. The first interruption occurred on May 23, when a transceiver failed on the downstream end of the microwave link from APO to Alamogordo. Once the loss of transmission was discovered, site staff switched the connection to a land-based T1 line. Although bandwidth was greatly reduced, the switch-over allowed data transfers to continue, albeit at a much slower rate. The switch-over also required the modification of the script used at Fermilab to pull data from APO. Now, if the copy script detects that transmission is occurring over the T1 line, the script throttles back the load on the network by implementing `rsync` transfers in series; when on the microwave link, `rsync` transfers are done in parallel to take advantage of the greater bandwidth. After several days of troubleshooting, the ISP provider completed the installation of the new transceiver on May 31 and the site staff switched transmissions back to the microwave link. No data were lost during this period.

The second interruption occurred on June 4 as the result of scheduled downtime to separate NMSU-NET routing from CHECS-NET. The downtime was scheduled during bright time to minimize impact on operations. On the scheduled night, APO computer professionals switched to the T1 line so APO would run uninterrupted. However, when the switch back from the T1 line to the microwave link was made, it was apparent that something was wrong in the configuration at NMSU. The problem was found and the fix implemented that afternoon. Shortly thereafter, we found that data speeds from APO to Princeton University were about 200 kilobytes/second (about a factor of 10 too low). The NMSU network administrator found a configuration problem within a day of being notified of the second problem and we were quickly restored to full bandwidth. The interruption caused no loss in Internet connectivity with the site and no data were lost as a result of the downtime.

In making the transition from writing data to tape, to transferring data over the Internet, we factored the possibility of lost Internet connectivity into the new system design. Two dedicated file servers are in place at APO to stage data prior to transfer. One server is configured as the main storage server; the second is in place as a hot spare. Both machines are capable of hosting up to nine full nights of imaging data, which means we can stage up to 18 nights of imaging data at APO. The machines are also configured with hot-swap drive bays, so we could easily replace full disks, should an extended outage

occur. Thus, we can withstand an extensive Internet connection outage without risk of losing data due to inadequate storage capacity.

On the receiving end at Fermilab, the Enstore tape robot provides sufficient capacity to buffer new data prior to processing. Thus, if we experience an extended outage and if data processing cannot keep up with the flow of new data once the connection is restored, new data being received will simply be spooled to Enstore and then retrieved for processing as resources became available. In summary, the new process in place for transferring data over the Internet has built into it sufficient data storage capacity to accommodate extended connection outages.

5.2. Data Distribution

5.2.1. Data Usage Statistics

Through June, the general public and astronomy community have access to the EDR, DR1, DR2, DR3, DR4, and DR5 through the DAS and SkyServer interfaces. In addition, the collaboration has access to the Runs DB. A helpdesk has been established at Fermilab to respond to user questions, or to system problems reported by users. On average, the helpdesk continues to respond to 1-2 requests per day for help or information.

Figure 5.1 plots the number of web hits we receive per month through the various SkyServer interfaces. In Q2 we recorded 30 million hits, compared to 23.4 million hits in Q1 and 16.4 million hits in Q4. May was an exceptionally heavy month; we received 12.4 million hits in the month of May alone.

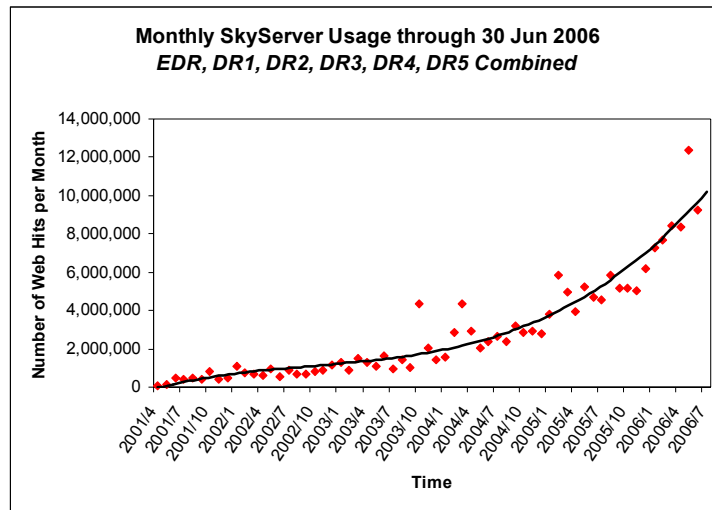


Figure 5.1. SkyServer usage per month, for all public releases combined.

Figure 5.2 shows the total number of SQL queries executed per month. We executed 2.2 million queries in Q2, compared to 0.9 million queries in Q1 and 1.7 million queries in 2005-Q4. Again, May was exceptionally busy; in May alone, we processed 1.4 million SQL queries.

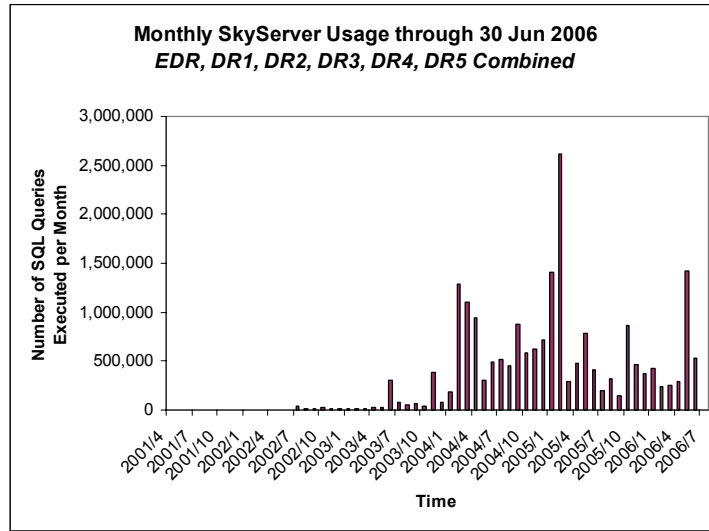


Figure 5.2. SkyServer usage, measured by the number of SQL queries submitted per month.

Through June 30, 2006, the SkyServer interfaces have received a total of 180 million web hits and processed over 21 million SQL queries. Over the past six months, the SkyServer sites received an average of 8.9 million hits and processed 526,000 SQL queries per month.

Figure 5.3 shows the volume of data transferred monthly from the DAS through the rsync server. A total of 10.84 TB of data were transferred via rsync in Q2. It is likely that the volume transferred would have been higher, were it not for hardware problems that took the rsync server offline for the first 20 days of June.

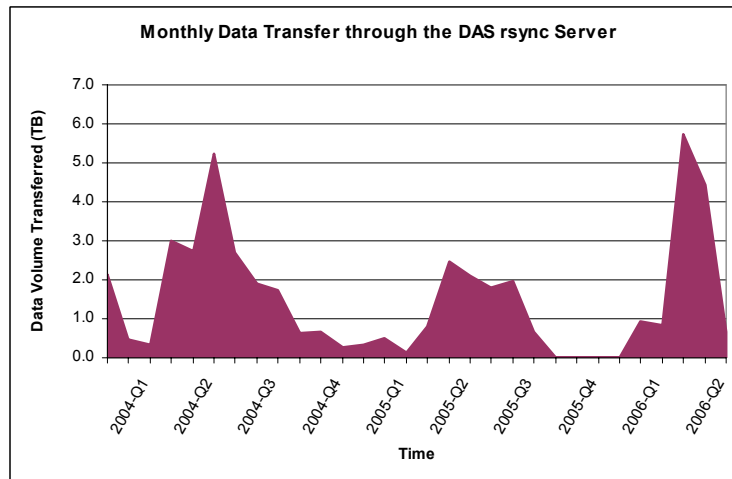


Figure 5.3. Monthly volume of data transferred via the DAS rsync Server.

Figure 5.4 shows the volume of data transferred monthly through the DAS web interface. A total of 7.04 TB of data were transferred via the web interface in Q2. As hardware problems took the wget server offline for the first 7 days of June, it is likely that our data transfer volume would have been higher through this interface as well.

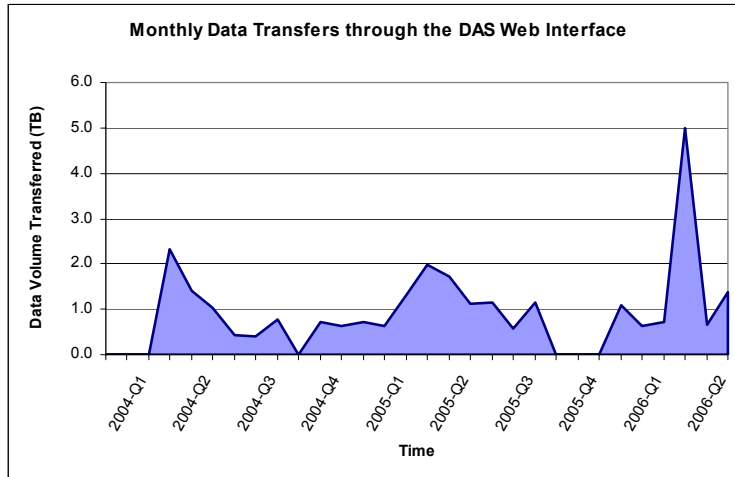


Figure 5.4. Monthly volume of data transferred via the DAS web interface.

Figure 5.5 shows the total volume of data transferred from the DAS through the two access portals combined. In addition to showing total volume transferred, the stacked-area chart shows the fraction transferred via each method (rsync vs. web interface). Historically, the majority of data transfers have been made using rsync, suggesting that rsync is the preferred transfer method for large data transfers. In Q2, 61% of the data transferred was through the rsync interface and 39% through wget, suggesting that providing both access portals better serves our user community.

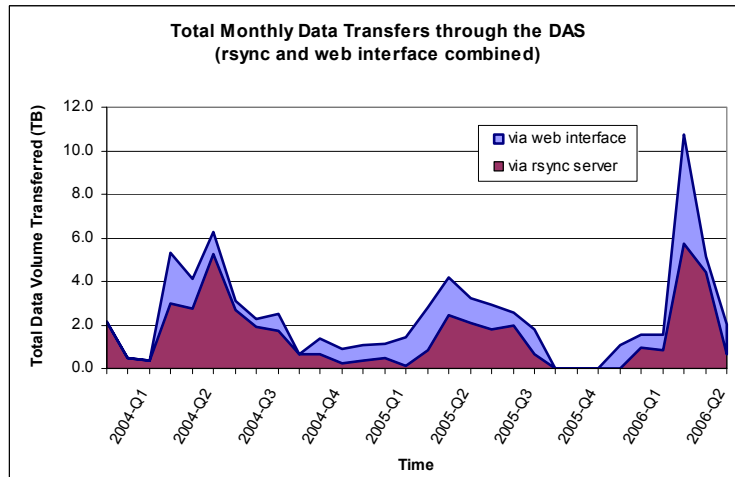


Figure 5.5. Total monthly volume of data transferred via the DAS (rsync and web interface combined).

The SDSS project remains highly visible and continues to have a significant impact on the community. Through June 26, 2006, the Smithsonian/NASA Astrophysics Data System (ADS) reported a total of 1120 refereed papers that mention 'SDSS' or 'Sloan Survey' in their title or abstract; collectively, these papers have over 32,350 citations. The website, www.alexacom, lists www.skyserver.org in the top

300,000 web sites in terms of site traffic¹ and our main web site, www.sdss.org, is listed by Google as number one in terms of page rank for astronomy data archives².

5.2.2. Data Release 5

DR5 was made available to the general public on June 28, 2006, slightly ahead of the July 1 release date in the approved data distribution plan. DR5 contains all survey quality imaging data collected through June 30, 2005, and the corresponding spectra. DR5 comprises the final Science Archive of the SDSS-I. As such, all SDSS-I data are now in the public domain.

DR5 contains approximately 20% more data than DR4. The contents of DR5 were summarized in the Q1 report and are posted on the DR5 home page and so are not repeated here. DR5 also contains several enhancements over DR4, including the addition of photometric redshifts for galaxies, which were provided by two different groups within the SDSS; and detailed coverage masks that allow researchers to easily quantify the sky coverage of the spectroscopic survey, needed for statistical studies of the spectroscopic samples. Details of these and other enhancements are described in the "About DR5" web page. In Q3, we plan to further enhance DR5 by making repeat scans on the equator available to the public through the DAS.

A paper describing DR5 is being prepared for publication. A draft of the paper is currently being circulated for review and comment.

5.2.3. Data Archive Server

Development continued on software that checks first, that the files that we serve as part of a data release include all files that should be part of that data release and none that are not; and second, that none of these files are corrupt. One tool developed as part of this effort now checks the integrity of every 30th file each night, such that the integrity of every file is verified every month. Further development on these tools will reduce the labor required to analyze and correct detected problems and extend the scope of the data integrity checks to include other data on the cluster but not (yet) served as part of a data release.

Hardware problems, including a bad network interface card on the DAS server and bad hard drives on both the SDSS cluster that hosts the data and the DAS server itself, occupied much of our attention this quarter. The newly developed data integrity software played an important role in determining which data could be recovered from corrupted hard drives and which needed to be restored from tape backup.

To avoid future problems associated with the aging DAS server, we are now using one of the new servers, sdssdp50, as the DAS server. A new server with specifications more appropriate to use as a DAS server will replace it so that sdssdp50 may be returned to its roll as a data reduction node.

We released the fifth data release through the DAS on June 28. Problems resolved in preparation for DR5 were not innately connected with DR5, but with the DAS generally; discovery and restoration of corrupt data and replacement of unreliable hardware, as described above, were the primary obstacles.

1

http://www.alexa.com/data/details/traffic_details?&compare_sites=&y=r&q=&size=medium&range=3m&url=skyserver.sdss.org

2

http://google.com/Top/Science/Astronomy/Data_Archives/

5.2.4. Catalog Archive Server

Work on the Catalog Archive Server (CAS) included addressing problem reports, finishing the enhanced version of the DR5-CAS for public release, preparing for the DR6 data load, and providing general support for data distribution operations.

In Q2, 21 problem reports filed through the SDSS Problem-Reporting Database were fixed and closed, including nine that were classified as critical/high, eight that were classified as serious/high and one filed against CasJobs that was classified as critical/medium.

A significant amount of work went into final preparations for the DR5 public release, including:

- creating and applying a patch to the database to add missing entries in the QSO catalog;
- applying a patch to the photoauxall table to fix several instances of swapped l,b columns;
- applying the “spectra of everything” patch;
- running final checksum comparisons and diagnostics;
- updating the algorithms page on the SkyServer website with documentation on match tables, sectors, and the QSO catalog;
- reviewing the results of the 35-query test suite run against the final release version of BestDR5, and assessing system performance;
- cutting updated versions of the SkyServer sites for DR5 from the CVS code repository and testing for release readiness;
- updating “push” and “rcopy” scripts on the skyserver3 web server to improve robustness; and
- updating the CasJobs front page for the DR5 release.

In preparation for mirroring DR5 at JHU, the latest versions of BestDR5 and TargDR5 were copied from Fermilab to JHU over the Internet. The copies are made by breaking the ~2.5-terabyte databases into sets of 60 files, copying the smaller files over the internet, and then restoring the database by re-assembling the files. This process has been used successfully many times to copy and restore the database in a relatively short amount of time. At quarter’s end, copies of BestDR5 and TargDR5 were spinning on disk at JHU. In Q3, we will test the switch-over from FNAL to JHU to verify that the mirror site is fully operational.

To improve database performance and the overall user experience, we have developed procedures to partition the large databases into three volumes. Tests on development versions of BestDR5 indicate a factor of 2 increase in performance between a 3-volume vs. single volume copy. In Q3, we will implement the partitioning scheme on the production copies of BestDR5. We anticipate a further improvement in performance (another factor of 2) when we migrate the database from Microsoft SQL Server 2000 to SQL Server 2005. Testing is currently underway, with the intent of completing the platform migration in Q3.

Several enhancements were made to CasJobs in Q2. CasJobs v2_9_6 was installed on the CasJobs test server, skyserver3, with the following main changes (in addition to many other items listed on the CasJobs front page):

- A fix was implemented for the distributed transaction error encountered in the previous version. The fix allows compound queries (i.e., multiple queries within the same buffer) to work as expected when separated by a GO command.
- Support for multiple (named) job schedulers was added, thereby allowing the query jobs and output jobs to be handled by separate processes (so query jobs won’t have to be killed if the output queue gets stuck). This also allows the test site to be run independently of the production site.

A modest amount of progress was made on preparations for DR6, given the focused efforts to finish DR5. We procured, installed and configured three new database servers that will be used to support DR6 loading and hosting. Previous data releases were made using Microsoft SQL Server 2000 as our database application. We configured our new servers with Microsoft SQL Server 2005, as we will load and deploy using this version of the application for DR6 and beyond. Internal comparison tests show a factor of 2 increase in performance between SQL 2000 and 2005. Additional tests started in Q2 include running our 35-query test suite on an instance of the final version of DR5 installed on machine running SQL Server 2005, in order to benchmark performance.

We also finalized the list of data model changes for DR6 and are close to finalizing the list of SEGUE data parameters, as earlier noted. Data model changes were documented by filing change-request PRs in the SDSS GNATS database. With DR5 behind us, we will shortly begin the process of upgrading the sqlLoader to accommodate the changes.

5.2.5. Runs Database

We continued incrementally loading imaging data into the runs database, RunsDB. This database, which is available for CAS-style SQL queries and CasJobs batch queries, will eventually contain the data from all imaging scans obtained with the 2.5-meter telescope, regardless of data quality. On June 2, we released to the collaboration an updated version of the runsDB that contained 306 runs. In addition to standard Legacy survey scans, the June 2 release included repeat Stripe 82 scans (67 runs), many of the SEGUE low-latitude imaging scans (49 runs), and essentially all of the Legacy imaging scans obtained after June 30, 2005 that “filled in the gap” in the Legacy survey footprint (11 runs).

In parallel with preparing for the June 2 RunsDB release, we continued loading additional runs into the master copy of the database. By quarter’s end, an additional 64 runs were loaded and the “Finish” step was in process. We anticipate releasing this enhanced version to the collaboration in July. In parallel, we will continue incrementally loading additional runs. We plan to continue the incremental loading and release process until all imaging data are loaded and available to the Collaboration.

6. SURVEY PLANNING

6.1. Observing Aids

Several programs are used to aid in planning and carrying out observations. No significant changes were made this quarter.

6.2. Target Selection

For this quarter, 75 plates were designed and drilled in two drilling runs. Of these, 57 were for the Northern survey area, eight were for the normal exposure SEGUE “bright” plates, eight were for double length exposure SEGUE “faint” plates, and two were for the ET program.

6.3. Survey Planning

The software that is used to track survey progress is also used to prepare monthly observing plans. No changes were made.

Agreement was reached last quarter on modifying the observing strategy next autumn to increase the likelihood that the SEGUE program will obtain important imaging data during time that overlaps the Supernova program while ensuring that the Supernova program still obtains data with the proper cadence for its program. Based on the imaging data that were obtained this quarter, this plan will still be needed, starting in August.

7. EDUCATION AND PUBLIC OUTREACH

The education section of the [sdss.org](http://www.sdss.org/education) web site (<http://www.sdss.org/education>) was launched in April 2006. It contains brief descriptions of and links to various SDSS resources that can be used by formal and informal educators and others (COSMUS, SkyServer, AMNH, etc.). There are also links to Microsoft PowerPoint presentations, lesson plans, workshop outlines, a bookmark and other resources that can be used by SDSS scientists and educators for their E/PO work. A reporting form for SDSS E/PO events and products is also on the [sdss.org](http://www.sdss.org/education) Education page. Our EPO Coordinator, Julie Lutz, is conducting a campaign to raise awareness among SDSS researchers about the availability of this site and the reasons for reporting E/PO events and new products.

We are also working on getting the education page and the SDSS education resources used by teachers and other educators and students. Our EPO Coordinator publicized the [sdss.org](http://www.sdss.org) and SkyServer web sites in the Washington NASA Space Grant Consortium educator electronic newsletter in late May (the newsletter also goes to many teachers in Oregon). We also conducted a 6-hour workshop on SDSS education (focused mainly on SkyServer) on June 30. Eight educators attended the workshop: four high school teachers, three faculty members from undergraduate institutions and one informal educator.

The interest group and mailing list, sdss-epo, was started on the SDSS web site in June. So far 14 people have signed up for the list.

Our EPO Coordinator gave a 10 minute talk about SDSS E/PO at the Northwest Astronomers Meeting (attendance 60) on May 6 in Everett, WA. She collected the names of about 15 attendees who want to get e-mail messages on SDSS E/PO (workshops, new features, etc.). These are a mixture of faculty, graduate students, undergraduates and high school teachers.

In May, our EPO Coordinator joined the LSST Education group and started attending the telephone conferences. She contributed a letter of support on behalf of SDSS E/PO to the Adler/Northwestern University proposal on CI that went to the NSF early in June. She has started to collaborate with Yerkes Observatory on a possible Research Experiences for Teachers proposal to NSF Astronomy that would involve training teachers to use telescopes for SDSS follow-up observations at Yerkes Observatory and the University of Washington's Manastash Ridge Observatory.

Looking ahead to Q3, we have submitted session proposals (a 90 minute workshop and a poster) for the Astronomical Society of the Pacific (ASP) meeting in Baltimore September 16-18. We plan to attend the ASP meeting on behalf of SDSS; and will be involved in planning for the AAS/AAPT meeting that will take place in Seattle January 7-11, 2007. Our EPO Coordinator will help support the SDSS workshop sessions at the January meeting and will hold a workshop of her own on the University of Washington campus shortly before the AAS/AAPT meetings begin officially.

During the next quarter our EPO Coordinator will concentrate on getting SDSS scientists and educators to report on events and the development of new products by using the form on [sdss.org/education](http://www.sdss.org/education). One incentive for reporting is that the "outcomes" (be they PowerPoint presentations, lesson plans or new visualizations) can be featured in the [sdss.org](http://www.sdss.org/education) education section and will be disseminated to the SDSS community and beyond.

Our EPO Coordinator also plans to add a section to the sdss.org education section which summarizes some venues that SDSS scientists and educators might use to get their E/PO work disseminated more widely. These venues include National Science Teachers Association meetings, state science teachers' associations meetings, the Astronomical Society of the Pacific Meetings and journals such as The Science Teacher and Astronomy Education Review. Links to Web sites and some practical tips (such as how long before the meeting session proposals are due) will be provided.

Another thrust will be to write a Research Experience for Teachers proposal to NSF AST. If funded, what is developed and learned will be valuable to others in the SDSS consortium and beyond.

8. COST REPORT

The operating budget that the Advisory Council accepted and the Board of Governors approved for SDSS-II activities during the period January 1 through December 31, 2006 consists of \$640K of anticipated in-kind contributions from Fermilab, the US Naval Observatory (USNO), the University of Chicago (UC), the Johns Hopkins University (JHU), the University of Washington (UW), and the Joint Institute for Nuclear Astrophysics (JINA); and \$4,620K for ARC-funded cash expenses.

Table 8.1 shows actual cost performance for ARC-funded cash expenses in Q2. More complete tables comparing actual to baseline performance are included in the appendices of this report. Appendix 1 compares cash expenses to the budget and presents the revised cash forecast for 2006. Appendix 2 compares actual in-kind contributions to the budget and presents the revised in-kind forecast for 2006.

Table 8.1. Q2 Cash Expenses and Forecast for 2006 (\$K)

Category	2006 – 2 nd Quarter		2006 Operations Budget Total (for the period Jan-Dec 2006)	
	Baseline Budget	Actual Expenses	Baseline Budget	Current Forecast
1. Survey Management	92	83	460	410
2. Survey Operations				
2.1. Observing Systems	216	185	725	666
2.2. Observatory Operations	418	423	1,670	1,632
2.3. Data Processing	160	143	775	746
2.4. Data Distribution	81	92	305	325
2.5. ARC Support for Survey Ops	21	4	95	32
3. New Development				
3.1. SEGUE Development	29	15	102	87
3.2. Supernova Development	0	0	0	0
3.3. DA Upgrade	0	(5)	0	10
3.4. Photometric Calibration	13	15	53	64
4. ARC Corporate Support	11	24	45	61
Sub-total	1,041	979	4,230	4,034
5. Management Reserve	98	0	390	390
Total	1,138	979	4,620	4,424

8.1. Q2 Performance - In-kind Contributions

The sum of in-kind contributions in Q2 was \$170K against the baseline forecast of \$163K and was provided by Fermilab, JHU, UW, and Michigan State University (MSU) for JINA, as follows:

- Fermilab provided support for survey management, data processing and data distribution activities. Effort was also provided to support oversight and planning, and development work for the SEGUE and Supernova projects. The level of effort provided to support data processing and distribution operations was greater than anticipated, as were some of the salary costs of the individuals performing this work.
- JHU provided support for the development, loading and hosting of the databases associated with the CAS, CasJobs, and SkyServer, at the anticipated level.
- No support was provided by USNO in Q2; no support was required.
- UW contributed the overhead associated with the plate drilling operation as anticipated.
- MSU provided support for the development of the spectroscopic pipelines that will be used for SEGUE observations in order to estimate atmospheric parameters. The level of effort provided was as anticipated.

8.2. Q2 Performance – ARC Funded Cash Expenses

ARC-funded expenses were \$979K, or \$62K (6%) below the budget of \$1,041K, before management reserve.

Survey management costs were \$83K against a budget of \$92K. Expenses for the Director, Project Scientist, Public Information Officer, project management support staff, and Collaboration Affairs were less than anticipated. Expenses for the ARC Business Manager and ARC Office of the Secretary/Treasurer were as anticipated. Expenses for Education and Public Outreach were higher than anticipated; we hired an additional staff member to assist with upgrading the SDSS website to reflect SDSS-II and to add education and public outreach content. Expenses for Public Affairs were higher than anticipated due to a one-time expense for new brochures describing the SDSS-II Survey. For the year, the revised forecast for Survey Management expenses is \$410K, or \$50K (11%) below the baseline budget.

Observing Systems costs were \$185K against a budget of \$216K. UW costs were less than budgeted, as the amount of UW engineering and technical effort required to support on-going operations was less than anticipated. FNAL expenses were also less than budgeted; salary costs were lower because one staff member spent much of June on medical leave. Expenses on other accounts were in reasonable agreement with budgets. The ARC account holding funds for observing systems support shows a small credit in Q2. In Q1 we had charged costs associated with APO fire protection upgrades to this account. In Q2, the charge was moved to the Capital Improvements account, resulting in the credit against the Observing Systems account. For the year, the revised forecast for Observing Systems expenses is \$666K, or \$59K (8%) below the baseline budget of \$725K.

Observatory Support costs were \$423K against a budget of \$418K, which brings us cumulatively (since 1 January) to 49% of the approved budget for 2006. Salaries were slightly above the budget forecast for the quarter, reflecting administrative corrections to an under-run reported in Q1. Travel expenses were as budgeted, related to relocation expenses and Collaboration Meeting travel. Other cost categories showed under-runs, except equipment where an encumbrance was placed for an order for the replacement of the site's pickup truck. The forecast for Q3-4 remains unchanged from the approved baseline budget. For the year, the forecast for Observatory Support expenses is \$1,632K, or \$40K (2%) below the baseline budget of \$1,672K.

Data Processing costs were \$143K against a budget of \$160K. Actual expenses at Fermilab were below budget because miscellaneous hardware expenses for DLT tapes and other computer hardware in Q2 were less than anticipated; the budget for DLT tapes has been carried forward into Q3. Actual expenses at Princeton were below budget because the level of effort required to support ongoing operations was less than anticipated. Expenses at the University of Chicago were higher than budgeted in Q2 due to a concentration of effort associated with preparations for the fall Supernova Survey run. For the year, the revised cost forecast for Data Processing is \$746K, or \$31K (4%) below the baseline budget of \$777K.

Data Distribution costs were \$92K against a budget of \$81K. Fermilab expenses were slightly higher than budget because computer hardware purchases that had been anticipated in Q1 actually occurred in Q2. For the year, hardware expenses are in line with expectations. JHU expenses were higher than budgeted due to a cost transfer associated with a computer purchase made last year using SDSS-I funds. Given the timing of the purchase, the cost should have been charged against the SDSS-II budget. The cost transfer was completed in Q2 to properly align costs. For the year, the cost forecast for Data Distribution is \$325K or \$19K (6%) above the baseline budget of \$306K. The increase is related to additional computer hardware purchases needed to support the Runs database loading/hosting operation and the JHU mirror site for public data distribution.

Minimal expenses were incurred against the ARC accounts holding funds for additional Survey Operations support (specifically, Additional Scientific Support and Observers' Research Support). Unspent funds from the Observers' Research Support budget have been carried forward into the forecast for Q3-4. Unspent funds from the Additional Scientific Support budget are not being carried forward in the forecast, as the baseline budget for Q3-4 should adequately meet needs in this area. As a result, we predict that actual expenses will be substantially less than budgeted for. Overall, the revised forecast for Survey Operations support is \$32K, or \$64K (67%) below the baseline budget of \$96K.

Expenses associated with development work for the SEGUE Survey were \$15K against a budget of \$29K. Expenses to support development work at Princeton were in close agreement with the budget. Funds had been budgeted for development work at Fermilab related to SEGUE data distribution; no costs were charged against this account in Q2 as Fermilab data distribution efforts were focused on DR5 preparations. For the year, the Fermilab forecast for SEGUE development work has been revised downward as experience is indicating that the amount of effort to incorporate SEGUE data into the CAS will be less than earlier predicted. The Princeton forecast for Q3-4 reflects the addition of a post-doc in the latter half of the year to augment the level of effort going into software development.

The budget report shows a credit of \$5K against the DA upgrade development budget. Salary costs were incorrectly charged against this account in Q1; the work performed was associated with ongoing maintenance and support of the DA system, not development. These costs were transferred to the correct account in Q2, hence the credit. As of this writing, all development work is complete and the cost account for these expenses has been closed.

Expenses associated with photometric calibration efforts at Princeton were in agreement with the budget. For the year, the revised forecast is \$64, or \$11K (20%) above the baseline budget of \$53K. The forecast for the latter half of the year reflects the addition of a post-doc to support the calibration effort.

Miscellaneous ARC corporate expenses (i.e., audit fees, bank fees, petty cash, and APO trailer rentals) were as expected. Charges shown as Capital Improvements are related to the fire protection upgrades implemented at APO to mitigate forest fire risks. For the year, the revised forecast is \$61K against the baseline budget of \$46K. The increase largely reflects the addition of the capital improvement expenses.

8.3. Q2 Performance - Management Reserve

No management reserve funds were expended in Q2. Unspent management reserve has been carried forward into Q3-4.

9. PUBLICATIONS

In Q2, there were 15 papers based on SDSS data that were published by members of the SDSS collaboration. There were also 28 papers published by individuals outside of the collaboration, using publicly available data. Exhibit 3 lists papers published by members of the SDSS Collaboration; Exhibit 4 lists papers published by individuals outside of the SDSS collaboration.

As of July 18, 2006, there are 1148 published refereed papers that include 'SDSS' or 'Sloan' in their title and/or abstract. These papers have been cited a total of 33,316 times, including 65 papers cited more than 100 times.

Exhibit 1. CY2006 Cash Budget Forecast (in \$000s)

SDSS-II CY2006 Budget Forecast as of July 18, 2006

	Inst	Qtr 1 Jan-Mar			Qtr 2 Apr-Jun			Qtrs 3-4 Jul-Dec			CY2006 Total		
		Actual		Variance (%)	Approved Budget		Actual Expenses	Variance (%)	Approved Budget		Jun-2006 Forecast	Variance (%)	
		Expenses	Baseline Budget		Expenses	Baseline Budget			Forecast	Forecast			
OPERATIONS BUDGET - CASH EXPENSES													
1.0 Survey Management													
SSP-221	ARC	2	3	2	3	-37%	2	6	6	6	12	10	-12%
SSP-234	ARC	17	16	15	15	-6%	15	33	35	35	65	67	2%
SSP-246	PU	2	4	3	3	-93%	3	66	68	68	73	68	-6%
SSP-248	FNAL	12	15	8	15	-48%	8	30	30	30	60	50	-18%
SSP-267	UC	11	14	12	14	-11%	12	51	51	51	79	75	-5%
SSP-270	UW	4	8	18	8	133%	18	18	26	26	35	49	39%
SSP-291a	ARC	2	8	17	8	115%	17	0	0	16	16	20	26%
SSP-291b	ARC	1	4	2	4	-55%	2	7	4	6	14	6	-54%
SSP-291c	ARC	4	11	5	11	-58%	5	22	3	44	44	11	-74%
SSP-291i	ARC	10	7	4	7	-51%	4	15	12	30	30	25	-15%
SSP-291L	ARC	4	2	0	2	-100%	0	30	29	33	33	29	-13%
Survey Management Sub-total		63	92	83	92	-9%	83	277	263	263	460	410	-11%
2.0 Survey Operations													
2.1 Observing Systems													
SSP-231	UW	36	100	88	82	-12%	88	91	82	82	235	206	-12%
SSP-232	PU	11	11	11	25	2%	11	25	25	25	46	46	0%
SSP-242	FNAL	91	85	70	175	-17%	70	175	175	175	345	337	-2%
SSP-261	FNAL	10	3	17	8	397%	17	8	3	3	16	31	93%
SSP-291d	ARC	17	18	(1)	44	-107%	(1)	44	31	84	84	47	-44%
Observing Systems Sub-total		166	216	185	343	-15%	185	343	315	315	725	666	-8%
2.2 Observatory Support													
SSP-235	NMSU	373	418	423	836	1%	423	836	836	836	1,672	1,632	-2%
2.3 Data Processing													
SSP-240	FNAL	187	118	93	218	-21%	93	218	225	225	519	505	-3%
SSP-238	PU	22	31	20	135	-35%	20	135	135	135	212	177	-17%
SSP-239	UC	11	11	29	21	165%	29	21	24	24	46	64	39%
Data Processing Sub-total		220	160	143	374	-11%	143	374	384	384	777	746	-4%
2.4 Data Distribution													
SSP-268	FNAL	84	72	77	95	6%	77	95	95	95	257	256	0%
SSP-237	JHU	14	8	15	27	85%	15	27	39	39	49	69	40%
Data Distribution Sub-total		98	81	92	123	14%	92	123	135	135	306	325	6%
2.5 ARC Support for Survey Operations													
SSP91f	ARC	2	18	1	35	-96%	1	35	16	16	82	19	-77%
SSP91h	ARC	0	4	3	7	-11%	3	7	10	10	14	13	-6%
Data Distribution Sub-total		2	21	4	42	-81%	4	42	26	26	96	32	-67%
Survey Operations Sub-total		858	896	847	1,718	-5%	847	1,718	1,696	1,696	3,577	3,401	-5%

Exhibit 1. CY2006 Cash Budget Forecast (continued)

SDSS-II CY2006 Budget Forecast as of July 18, 2006

Inst	Qtr 1 Jan-Mar			Qtr 2 Apr-Jun			Qtrs 3-4 Jul-Dec			CY2006 Total		
	Actual Expenses	Approved Baseline Budget	Variance (%)	Actual Expenses	Approved Baseline Budget	Variance (%)	Jun-2006 Forecast	Approved Baseline Budget	Variance (%)	Jun-2006 Forecast	Variance (%)	
OPERATIONS BUDGET - CASH EXPENSES												
3.0 New Development												
3.1 SEGLUE Survey Development												
PU	14	13	14%	15	15	14%	39	27	45%	53	68	28%
FNAL	0	16	-100%	0	19	0%	19	19	0%	49	19	-61%
SEGLUE Development Sub-total	14	29	-48%	15	46	26%	58	46	26%	102	87	-15%
3.2 Supernova Survey Development												
No allocation	0	0	--	0	0	--	0	0	--	0	0	--
Supernova Development Sub-total	0	0	--	0	0	--	0	0	--	0	0	--
3.3 Data Acquisition System Upgrade												
SSP-161	15	0	(5)	(5)	0	--	0	0	--	0	10	--
DA Upgrade Sub-total	15	0	(5)	(5)	0	--	0	0	--	0	10	--
3.4 Photometric Calibration Development												
PU	14	13	14%	15	15	14%	35	27	30%	53	64	20%
Photometric Calibration Sub-total	14	13	14%	15	15	14%	35	27	30%	53	64	20%
New Development Sub-total	44	42	-41%	25	72	28%	92	155	28%	162	162	4%
4.0 ARC Corporate Support												
ARC	14	11	33%	14	17	39%	23	17	39%	46	52	13%
ARC Capital Improvements	0	0	--	10	0	--	0	0	--	0	10	--
ARC Corporate Support Sub-total	14	11	124%	24	17	39%	23	17	39%	46	61	34%
Cash Budget Sub-total	980	1,041	-6%	979	2,084	0%	2,074	4,238	0%	4,034	4,034	-5%
5.0 Management Reserve												
ARC	0	98	-100%	0	195	100%	390	390	100%	390	390	0%
TOTAL CASH BUDGET	980	1,138	-14%	979	2,279	8%	2,464	4,628	8%	4,628	4,424	-4%

Exhibit 2. CY2006 In-Kind Contribution Forecast (in \$000s)

SDSS-II CY2006 Budget Forecast as of July 18, 2006

	Inst	Qtr 1 Jan-Mar			Qtr 2 Apr-Jun			Qtrs 3-4 Jul-Dec			CY2006 Total		
		Actual		Variance (%)	Approved Baseline		Actual	Variance (%)	Approved Baseline		Jun-2006 Forecast	Variance (%)	
		Expenses	Budget		Expenses	Budget			Forecast	Forecast			
OPERATIONS BUDGET: IN-KIND													
1.0 Survey Management													
SSP-248	FNAL	35	33	-1%	32	32	-1%	68	68	0%	133	136	2%
		35	33	-1%	32	32	-1%	68	68	0%	133	136	2%
		Survey Management Sub-total											
2.0 Survey Operations													
2.1 Observing Systems													
SSP-231	UW	15	15	0%	15	15	0%	30	30	0%	60	60	0%
		Observing Systems Sub-total											
2.3 Data Processing													
SSP-239	UC	0	5	-100%	0	10	0%	10	10	0%	19	10	-50%
SSP-240	FNAL	79	46	51%	70	93	0%	93	93	0%	185	242	30%
SSP-257	USNO	0	11	-100%	0	21	0	21	21	-100%	42	0	-100%
SSP-269	MSU	0	0	---	0	31	0%	31	31	0%	31	31	0%
		79	62	13%	70	154	13%	133	133	-13%	278	283	2%
		Data Processing Sub-total											
2.4 Data Distribution													
SSP-237	JHU	26	26	9%	28	31	59	88%	82	112	36%	112	36%
SSP-240	FNAL	9	7	32%	9	13	26	31	26	16%	31	31	0%
		34	32	14%	37	45	59	32%	109	143	31%	143	31%
		Data Distribution Sub-total											
		129	109	11%	122	229	-3%	447	486	9%	486	486	0%
		Survey Operations Sub-total											
3.0 New Development													
3.1 SEGUE Survey Development													
SSP-237	JHU	0	6	-100%	0	12	0	100%	23	0	-100%	0	-100%
SSP-269	MSU	16	16	0%	16	0	---	31	31	0%	31	31	0%
		16	21	-27%	16	12	0	-100%	55	31	-43%	31	-43%
		SEGUE Development Sub-total											
		16	21	-27%	16	12	0	-100%	55	31	-43%	31	-43%
		New Development Sub-total											
		179	163	4%	170	308	-6%	635	652	3%	652	652	0%
		TOTAL IN-KIND CONTRIBUTIONS											
		1,160	1,301	-12%	1,149	2,587	6%	5,076	5,263	-4%	5,263	5,076	-4%
		TOTAL OPERATING BUDGET (Cash and In-kind)											

Exhibit 3. Papers from within the SDSS Collaboration

1. Two Additions to the New Class of Low Accretion-Rate Magnetic Binaries. ApJ submitted - G. Schmidt, et al.
2. Broad Absorption Line Variability in Repeat Quasar Observations from the SDSS. ApJ submitted - Britt Lundgren, et al.
3. Characterizing Three Candidate Magnetic CVs from SDSS: XMM-Newton and Optical Follow-up Observations. AJ submitted - Lee Homer, et al.
4. Density profiles of galaxy groups and clusters from SDSS galaxy-galaxy weak lensing. MNRAS submitted - Rachel Mandelbaum, et al.
5. Probing the Evolution of IR Properties of $z \sim 6$ Quasars: Spitzer Observations. AJ submitted - Linhua Jiang, et al.
6. Model Atmosphere Analysis of the Weakly Magnetic DZ White Dwarf G165-7. ApJ submitted - Patrick Dufour, et al.
7. The Clustering of Photometric Luminous Red Galaxies in the Sloan Digital Sky Survey. MNRAS submitted - Nikhil Padmanabhan, et al.
8. A Faint New Milky Way Satellite in Bootes. ApJL in press - V. Belokurov, et al.
9. The Origin of the Bifurcation in the Sagittarius Stream. ApJ in press - M. Fellhauer, et al.
10. The Field of Streams: Sagittarius and its Siblings. ApJL 642:137 (2006) - V. Belokurov, et al.
11. Hot DB White Dwarfs from the Sloan Digital Sky Survey. AJ accepted - Daniel Eisenstein, et al.
12. A Catalog of Spectroscopically Confirmed White Dwarfs from the SDSS DR4. ApJS submitted - Daniel Eisenstein, et al.
13. What triggers galaxy transformations? The environments of post-starburst galaxies. ApJ in press D. Hogg, et al.
14. Panchromatic Properties of 99,000 Galaxies Detected by SDSS, and (some by) ROSAT, GALEX, 2MASS, IRAS, GB6, FIRST, NVSS and WENSS Surveys. MNRAS accepted - Mirela Obric, et al.
15. The Rest-frame Optical Colors of 99,000 SDSS Galaxies. MNRAS accepted - Vernesa Smolcic, et al.

Exhibit 4. Publications Based on Public Data

1. A Curious New Milky Way Satellite in Ursa Major. ApJL submitted - D. B. Zucker, et al.
2. The effect of FIR emission from SDSS galaxies on the SFD Galactic extinction map. PASJ submitted - Kazuhiro Yahata et al.
3. QSO Absorption lines from QSOs. ApJL in press - David V. Bowen, et al.
4. Optical and Infrared Diagnostics of Low Redshift SDSS galaxies in the SWIRE Survey. MNRAS accepted – Payam Davoodi, et al.
5. The oxygen abundance calibrations and N/O abundance ratios of ~40,000 SDSS star-forming galaxies. ApJ in press – Y. C. Liang, et al.
6. Cosmological Evolution of the Duty Cycle of Quasars. ApJL accepted- Jian-Mim Wang, et al.
7. Neutral gas density in Damped Lyman Alpha systems. A&A accepted – M. Trenti, et al.
8. The Virial Mass Function of Nearby SDSS Galaxy Clusters. ApJ submitted – Kenneth Rines, et al.
9. Robust Machine Learning Applied to Astronomical Datasets I: Star-Galaxy Classification of the SDSS DR3 Using Decision Trees. ApJ accepted – Nicholas M. Ball, et al.
10. Properties of Galaxy Groups in the SDSS: II.- AGN Feedback and Star Formation Truncation. MNRAS submitted – Simone M. Weinmann, et al.
11. New perspectives on strong $z=0.5$ MgII absorbers: are halo-mass and equivalent width anti-correlated? MNRAS accepted – Nicolas Bouche, et al.
12. Properties of galaxies in SDSS Quasar environments at $z < 0.2$. MNRAS submitted – Georgina V. Coldwell, et al.
13. Precision Measurements of Higher-Order Angular Galaxy Correlations Using 11 Million SDSS Galaxies. ApJ Accepted - Ashley J. Ross, et al.
14. Spatial and Velocity clumping in an SDSS blue horizontal branch star catalogue. MNRAS Letters Accepted- L. Clewley, et al.
15. Spectral analyses of eighteen hot H-deficient (pre-) white dwarfs from the Sloan Digital Sky Survey Data Release 4. A&A accepted - S. D. Huegelmeier, et al.
16. Dissecting Galaxy Colors with GALEX, SDSS, and Spitzer. ApJL accepted - B. D. Johnson, et al.
17. Inflation model constraints from the Wilkinson Microwave Anisotropy Probe three-year data. PRD, 74, 023502 (2006) – William H. Kinney, et al.
18. Isophotal Shapes of Elliptical/S0 Galaxies from the Sloan Digital Sky Survey. MNRAS accepted – C. N. Hao, et al.

19. Cosmological parameters from a million photometric redshifts of SDSS LRGs. MNRAS submitted – Chris Blake, et al.
20. Ages and metallicities of early-type galaxies in the SDSS: new insight into the physical origin of the colour-magnitude and the Mg2-sigmaV relations. MNRAS accepted – A. Gallazzi, et al.
21. A FIRST-APM-SDSS survey for high-redshift radio QSOs. MNRAS accepted – R. Carballo, et al.
22. Searching for modified gravity with baryon oscillations: from SDSS to WFMOS. PRD submitted – Kazuhiro Yamamoto, et al.
23. Properties of Hickson Compact Groups and of the Loose Groups within which they are Embedded. A&A accepted – H. Tovmassian, et al.
24. The O VI Absorbers Toward PG0953+415: High Metallicity, Cosmic-Web Gas Far From Luminous Galaxies. ApJL submitted – Todd M. Tripp, et al.
25. Extinction and metal column density of HI regions up to redshift $z \sim 2$. A&A accepted – Viladilo, et al.
26. Two extremely metal-poor emission-line galaxies in the Sloan Digital Sky Survey. A&A accepted – Y. I. Izotov, et al.
27. Power spectrum of the SDSS luminous red galaxies: constraints on cosmological parameters. A&A submitted – G. Huetsi.
28. Semi-empirical analysis of Sloan Digital Sky Survey galaxies: IV. A nature via nurture scenario for galaxy evolution. MNRAS submitted – A. Mateus, et al.