WIYN OBSERVATORY

WISCONSIN INDIANA YALE & NOAO

Newsletter

September 2012

Director's News

Pat Knezek

FACING FUTURE

One of my favorite musical CDs is Israel Kamakawiwo'ole's "Facing Future," and it struck me that that is a very good title for my Director's Column this issue. In the six months since the last newsletter, there has certainly been a lot going on at WIYN. My emphasis here will be on those things that are helping us "face future."

One aspect of "facing future" that I bet every single reader of this article will be aware of is the National Science Foundation's Portfolio Review report. So I want to remind people of a couple of things before going on to some of the many activities that have been going on here at WIYN. Some of you may have already seen much of this in a message I sent to our partners shortly after the report was released. (1) WIYN is an excellent facility that is maintained at a very high level of efficiency, and we are very proud of the support we provide for the scientific goals of our partners. The report itself notes that WIYN, among the other facilities recommended for divestment, produces very valuable science, and that can continue in the decade to come. (2) The panel has made recommendations. These will take time to digest, and the NSF will have to decide how to implement the recommendations. In any case, things are not going to happen overnight. The timescale will likely be several years. Nevertheless, this must not stop us from developing a plan to move forward starting now. (3) We will move forward. A recommendation of divestment by the NSF is not the equivalent of closure of our facility. As you will see in the items mentioned below and the various articles in this issue, we are positioning ourselves well to look to the future!

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pODI Sees First Light

Daniel Harbeck

After a long and eventful history, the WIYN One Degree Imager with a partially populated focal plane (called pODI) has finally seen first star light at the WIYN telescope on the evening of August 3rd 2012. This marks a significant milestone for the WIYN Observatory, but also for me personally after spending seven years on this project.

Leading up to the first light were very busy weeks of installing new infrastructure at the WIYN facility (including finishing the new dome repair), packaging and shipping pODI to Kitt Peak, and then installing it at the telescope. While mounting the instrument to the telescope took only a day, more time was spent on establishing all the power, coolant, and signal connections, and then finally cooling the dewar for the first time on the mountain. Once the basic instrument functions (including glycol cooling) were tested, the four precious g', r', i', and z' band filters were installed. With the end of the installation phase we started to share some responsibilities for watching over the instrument with Kitt Peak support staff. As scheduled, it took us two weeks from shipping to the first on-sky image.

The first light marked the transition to the next stage that we call Engineering Commissioning. During this phase (until mid-September) the pODI team has exclusive access to WIYN, and we will use this time to ramp up the basic functions of the instrument. This includes ensuring that the thermal management system works, we can read out images within the noise specifications, and that the image quality is fundamentally sound. As of this writing, all the basics of the instrument seem to be fine: The throughput of the instrument is close to the prediction, image quality has been tested to a seeing-limited 0.6 arcseconds on-sky, and the read noise

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The WIYN Observatory is owned and operated by the WIYN Consortium, which consists of the University of Wisconsin, Indiana University, Yale University, and the National Optical Astronomy Observatory (NOAO).

pODI Sees First Light
(Continued)

is similar to the performance we saw in Tucson. We are now in the process of integrating and debugging the software system.

Beginning this October and lasting until February 2013, the pODI Commissioning Working Group (CWG) will engage in the scientific commissioning of the instrument, i.e, fully characterize the performance of the instrument. We have four-night commissioning runs reserved at the telescope every two weeks throughout the current semester. At first we will concentrate on the characterization and development of calibration strategies of the so-called static imaging mode, where pODI's detectors will be used like a conventional CCD imager. All lessons learned during the instrument commissioning will be applied to the commissioning of the automatic pipeline of pODI's Pipeline, Portal, and Archive system.

Later this year we will implement and commission the coherent Orthogonal Transfer (OT) correction mode of pODI, which will utilize the ability of pODI's Orthogonal Transfer Array (OTA) detectors to actively compensate image motion caused by guider errors or wind shake; this mode is expected to improve the image quality compared to passive static imaging.

Starting in the semester 2013A, pODI will be offered to the WIYN community on a shared risk basis, so please watch for details in the upcoming call for proposals.

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Stay up to date on the pODI commissioning effort! We are reporting our progress on the pODI deployment Blog: podideployment.blogspot.com.

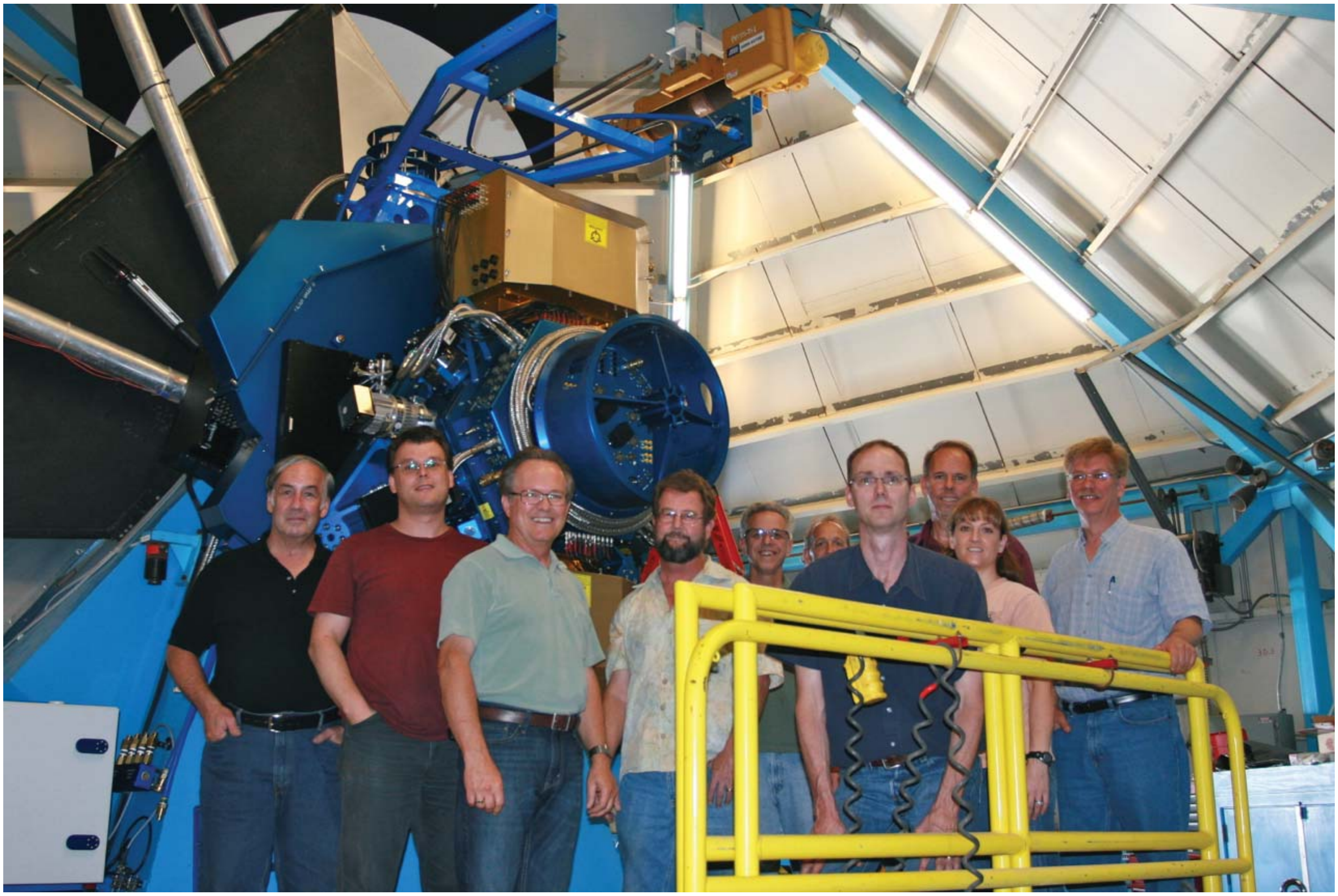

Figure 1 - The pODI installation crew in front of pODI at WIYN. From left to right: Shelby Gott, Daniel Harbeck, Bill Ball, Mark Hunten, Todd Boroson, Brent Hansey, Charles Corson, Gary Muller, Heidi Schweiker, and Andrey Yeatts. Numerous others not on the image contributed to the design, construction, and installation of pODI.

pODI Sees First Light
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Figure 2 - Gary Poczulp and Charles Corson install a filter into its mount.

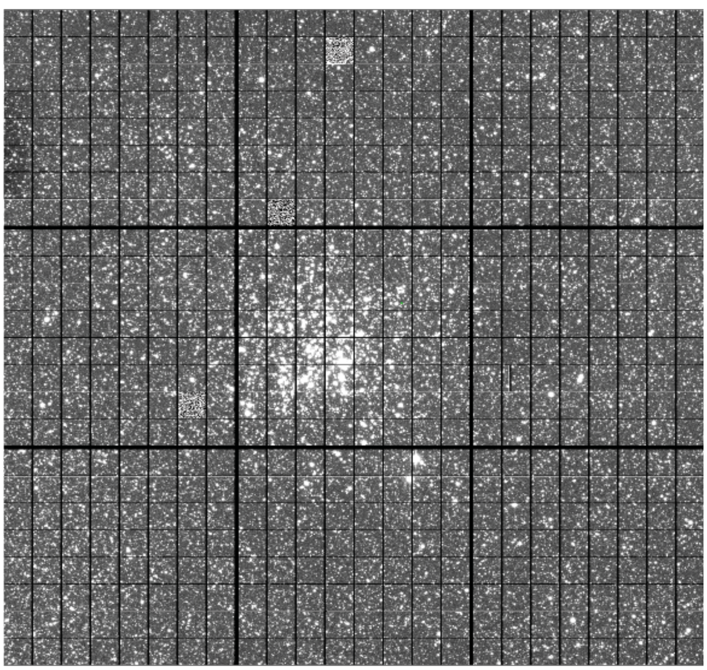

Figure 3 - pODI's first light image: the open star cluster M11 in the g' band. The central 3x3 arrays of detectors is shown here, and is about 24'x24' in size, and has about 12000 x 12000 pixels^2.

Science Highlights
Jayadev Rajagopal

WIYN Hydra Spectrograph Study
Ryan Keenan, Amy Barger, Lennox Cowie, Wei-Hao Wang, Isak Wold, and Laura Trouille

In the August 2012 issue of the Astrophysical Journal, Ryan Keenan and collaborators from ASIAA Taiwan, UW Madison, CfA Hawaii, and Northwestern in Chicago, published a study using the WIYN Hydra spectrograph to measure the near-infrared luminosity density as a function of redshift in the local universe. Their study was prompted by recent cosmological modeling efforts that have shown that a local underdensity on scales of a few hundred Mpc (out to a redshift of z ~ 0.1) could produce the apparent acceleration of the expansion of the universe, observed via type Ia supernovae, even when no dark energy is present (e.g. Bolejko & Sussman, 2011). Several studies of galaxy counts in the near-infrared, including their

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WIYN Hydra Spectrograph Study

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own work, have found that the local universe appears under-dense by ~ 25 – 50% compared with regions a few hundred Mpc distant. According to the aforementioned models, a void of this scale and amplitude would be sufficient to produce the apparent acceleration of the expansion of the universe. In Keenan et al. (2012), they show that previous measurements suggest a rising luminosity density (and hence mass density) out to z ~ 0.1, and that their own measurements of the luminosity density at z ~ 0.2 are some 30% higher than locally measured values (see Figure 4). While this demonstrates that a large local void is certainly a possibility, the systematic errors due to cosmic variance in their study are still too large to make their result conclusive. In the coming semesters, they will be using the WIYN / Hydra spectrograph to make a more precise measurement of the luminosity density at z = 0.2. If they detect a rising luminosity density as a function of redshift, this could have profound implications for our understanding of cosmology. If, instead, they find a constant luminosity density as a function of redshift, they will be able to rule out a whole class of void cosmologies.

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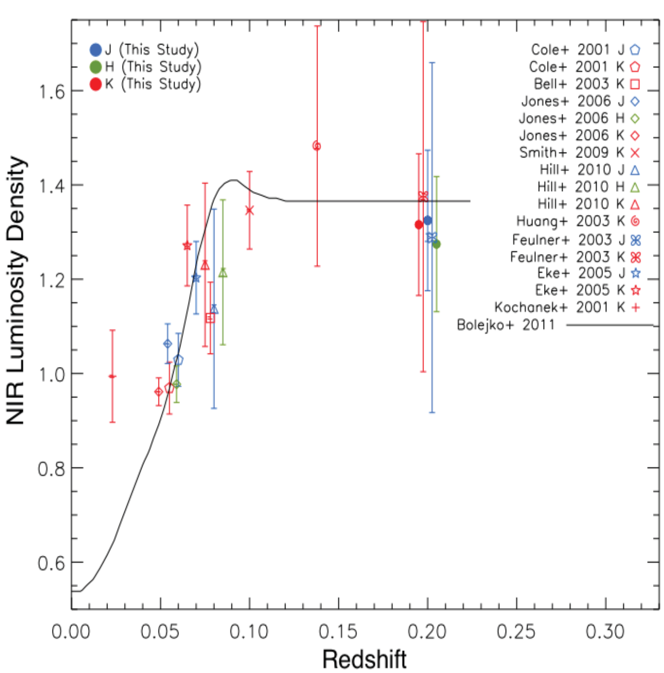

Figure 4: Luminosity density at z ~ 0.2 are some 30% higher than locally measured values.

PPA Development

Dick Shaw

After passing a Critical Design Review at the end of February, the pODI Pipeline, Portal, and Archive (PPA) development team has been feverishly translating design specs into a working system. The system is coming together well, and the team is about to begin the second in a series of system build and integration tests. Much of the calibration pipeline functionality has already been tested on simulated pODI (Sims) data, and the algorithms are now being tuned with real data from the newly installed instrument. The Sims data have also been used to test the data transfer part of the system (DTS). Raw image files can now be moved from the telescope on Kitt Peak to the archive in Bloomington, Indiana in half a minute. Development of DTS monitoring and error recovery procedures is underway, and the team is preparing to connect the live instrument data stream. This last phase of DTS testing will allow us to tune the DTS performance, measure reliability, and be ready to archive pODI Science Verification data.

Key pieces of hardware and other infrastructure are now in place to support the Archive; data ingest, safe-store, and retrieval are being tested with raw, reduced, and ancillary data products. The Portal is the web-based user interface for data discovery, analysis, and retrieval for pODI users. A set of basic Portal functionality already is in place, including browsing metadata, searches, simple image visualization, enforcement of data ownership rules, and data retrieval. Testing even this level of functionality on a variety of user machines with various browsers is complex, and we are fortunate to have some volunteers from the WIYN science community to help us. Our loyal testers also provide valuable feedback on the utility and ergonomics of the interface.

Up to now the PPA development team has focused on the basics: data transfer, safe-store, simple search and metadata display, rudimentary data visualization, and data retrieval. In the next few months the team will build upon these capabilities: porting the pipeline to the XSEDE (Grid-based) computing environment, routine data reduction, tuning the pipeline instrument

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Science Highlights

Jayadev Rajagopal

Leo P - A Newly Discovered Local Group Candidate

John Salzer & Katherine Rhode

John Salzer, Katherine Rhode, and their students at Indiana University, used WIYN and the KPNO 4-m and 2.1-m telescopes to carry out the first optical observations of a new nearby dwarf galaxy, designated by the discovery team as Leo P, with P meaning `pristine.'

Leo P was first discovered as a low-velocity HI source in the ongoing ALFALFA Survey being carried out with the Arecibo 305-m radio telescope (Giovanelli et al. 2012). Cross-matching of the HI detection with imaging data from the Sloan Digital Sky Survey (SDSS) showed an extended, faint blue source located close to the HI coordinates.

Within a month of the initial discovery, ALFALFA team members at IU used scheduled time on three Kitt Peak telescopes to observe the new source. Salzer and IU graduate student Angela Van Sistine obtained narrowband Hα images with the 2.1-m and detected an HII region in Leo P. Salzer, IU graduate student Nathalie Haurberg, and John Cannon used the KPNO Mayall 4-m telescope to obtain a spectrum of the HII region, which reveals the very metal-poor nature of this dwarf system. The current issue of the NOAO Newsletter carries the highlights of each of these observations. Here we focus on the WIYN effort.

Rhode and IU student Michael Young imaged Leo P with the Mini-Mosaic camera on the WIYN 3.5-m through optical broadband (BVR) filters. Excellent image quality (0.6 - 0.8 arcsec PSF FWHM) resolved the galaxy into stars. Figure 5 shows the color composite image of Leo P. The light from this galaxy is dominated by young, blue stars, particularly in its southern (lower) half. The single HII region is the brightest object in the clump of blue stars. The brightest individual stars are V ~ 22; PSF-fitting recovers photometry for stars as faint as V ~ 25. A color-magnitude diagram (CMD) for the brighter stars in Leo P is shown in Figure 7. The CMD reveals a well-defined upper main sequence, but a weak or under-populated red giant branch.

The combination of the upper main-sequence photometry and the presence of a single HII region constrains the distance to between roughly 400 - 700 kpc, suggesting that Leo P is an outlying member of Local Group. Applying the tip of the red giant branch (TRGB) distance method to the CMD results in a distance estimate of 1.0 - 1.5 Mpc (depending on which stars are used to represent the TRGB). The current situation regarding the distance is rather enigmatic: the nearer distance requires that Leo P have a very unusual star-formation history to account for an under-populated RGB, while the greater distance, with just the single HII region, appears to violate basic stellar and nebular astrophysics. This distance ambiguity might be resolved via deeper photometric observations.

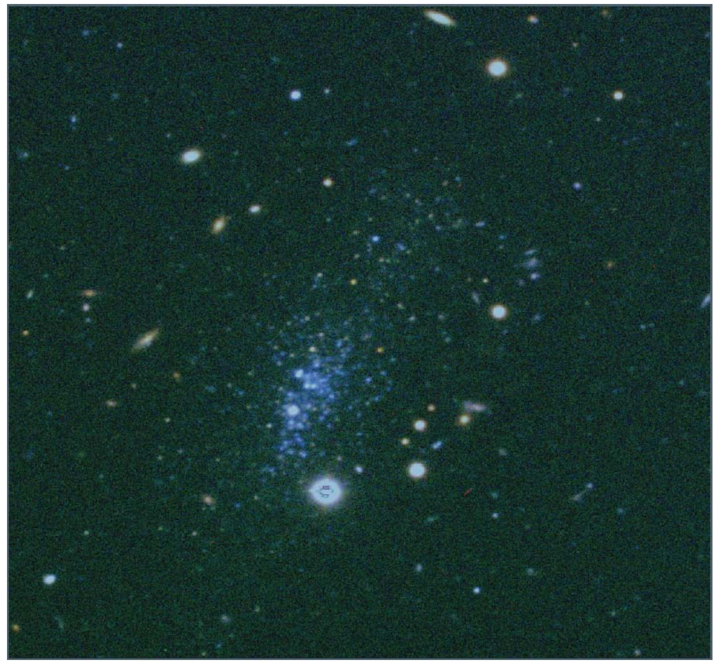

Figure 5: BVR color composite image of Leo P obtained with the WIYN telescope. The FOV of this image is 2.4 by 2.5 arcmin and the orientation is N-up, E-left. The lower (southern) portion of Leo P is dominated by a clump of blue main-sequence stars, indicating very recent star formation has occurred. The brightest object in Leo P (located within the clump of blue stars) is an HII region that appears to be photo-ionized by a single B-type star. The upper portion of the galaxy is very low surface brightness but includes a number of redder stars, presumably RGB members in Leo P. The total size of the galaxy at this sensitivity level is ~90 arcsec.

Regardless of the final distance, Leo P is an amazing object. The HI-to-stellar mass ratio is 2.6, making Leo P one of the most gas-rich galaxies in the nearby universe. It is the lowest mass system known that is actively making stars at the current time. Its ultra-low metal abundance indicates that it is relatively unevolved chemically. The location of Leo P in the periphery (or just outside) the Local Group, coupled with its high gas content, suggests that it has not yet traveled inside the virial radius of either the Milky Way or Andromeda. The emerging evolutionary scenario is one in which Leo P has lived on the outskirts for most or all of its existence. Perhaps a recent encounter is responsible for the current round of star formation? Leo P may represent a prototype system for a category of low-mass dark matter

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Director's News

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So let's talk about all the exciting things that have been going on. First and foremost, of course, is that pODI has achieved first light! It's hard to describe how impressive this instrument is when seen on the telescope, and the reports of its progress are even more impressive. I've been involved in quite a few instrument projects over the years, and I have never seen an instrument finished, installed, and deployed with so few "gotchas." Meanwhile, the collaboration between WIYN, NOAO's Science Data Management (SDM) group, and Indiana's Pervasive Technology Institute (PTI) is well along in the development of the data system that will transport pODI data, pipeline process it, serve it to the user community through a web portal, and archive it. They are on-track to be able to support our shared-risk observing time when it begins in March 2013. This all is a real testament to the talent and professionalism of the ODI team, and I want to congratulate them on their achievement, and look forward to more to come!

The installment of pODI required the transfer of the Instrument Adaptor Subsystem (IAS) and its affiliated instruments, electronics, cables, etc. to the Hydra port. This enormous effort was skillfully orchestrated by Charles Corson and everything is undergoing final testing to ensure that things like the headers are correctly populated given the new port, etc. Now when you go up on the dome floor, you'll see that WHIRC, MiniMo, and SparsePak, live on the "other side of the telescope," sharing the port with Hydra. As I think most of you are aware, this now means that we can have Hydra on the port, or the IAS with WHIRC+MiniMo, WHIRC+SparsePak, or potentially visitor instruments. The change between Hydra and the IAS needs two full days, so we will only be doing that 1-2 times per semester. Furthermore, assuming things continue to go well with pODI, we are proposing not to offer MiniMo in 2013A, which will simplify our operational support, while still providing our community with a solid suite of instruments.

Another activity undertaken in preparation for the arrival of pODI was to re-aluminize both the primary and tertiary mirrors of the telescope. So, again, if you're on the dome floor and the mirror covers are open, you can see our very shiny mirrors! The secondary mirror will be re-aluminized next summer. And speaking of the dome floor…we're in the process of installing a new one. The Kitt Peak facilities staff has undertaken the removal of the old (chipped, cracked) tiles, and will be installing new tiles as a daytime activity. We all look forward to the completion of that long-desired project.

New instrument, new mirror coatings, new dome floor…but wait, there's more! As you may recall, the WIYN dome was damaged during an unusually strong storm in January 2010. Dome panels were lost, and some of the structural integrity of the dome was compromised. In addition, there have long been areas of the dome that leak. We shut the facility down early this summer, and a new standing seam roof was applied over the flat roof panels, the lost shutter was replaced, and other repairs were undertaken to return the dome to its original specifications.

And let's not forget the 0.9m. They also aluminized their primary this summer – for the first time in five years! And we're delighted to note that a contract has been signed with the Institute for Astrophysics at the University of Hawaii to provide the 0.9m with a Half Degree Imager (HDI). We anticipate its delivery to the 0.9m in early 2013. WIYN is definitely a busy place, so on your next visit take a look around at all the changes.

Finally, as always happens with time, there have been changes in the personnel who support WIYN. Hillary Mathis will begin a new job as Kitt Peak Telescope Operations Manager on October 1. Dan Eklund of KPNO, who helped provide support of planning and monitoring WIYN's finances, retired at the end of April. Lead Mechanical Engineer for ODI, Gary Muller, left in mid-August to pursue other opportunities, and ODI Systems Engineer Mark Hunten will be departing at the end of September. I'd like to take this opportunity to thank them all for their key contributions to WIYN, and wish them well in their future endeavors.

And while there have been departures, there have also been arrivals! Dr. Dick Shaw of NOAO became the

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0.9m Telescope News

Hillary Mathis

The 0.9m primary mirror was removed in July of 2012 for a realuminization. After stripping the existing coating off of the mirror a small crack was discovered in the glass (see Figure 6).

After an evaluation by the NOAO optics expert, Gary Poczulp, it was determined that the crack was repairable. The repair method would require the fracture to be ground away by following along its extent using a ball end diamond tool attached to a high speed Dremel motor. After all traces of the fracture were removed, the ground area would be treated with a glass etchant – either dilute hydrofluoric acid (HF) or a commercially available ammonium bi-fluoride paste (Armour Etch).

The 0.9m Executive Committee agreed that this was the path they wanted to follow. Gary spent two days repairing the mirror at which time the mirror was aluminized and replaced back into the telescope ready for science use. The new coating is 1,050Å thick. The reflectivity and scattering numbers will be posted on the 0.9m web site once the information in available in mid-September, see http://www.noao.edu/0.9m/ .

The 0.9m Executive Committee is happy to announce that the 0.9m Consortium has come to an agreement on a contract with Institute for Astrophysics (IfA) at the University of Hawaii for a Half Degree Imager (HDI). The camera will be a turnkey system featuring a 4K x 4K e2v detector, a Cryotiger cooling system and a STARGRASP controller. While the schedule is still being finalized, the instrument delivery is expected to be during the 2013A semester, hopefully in the early part of the semester. After commissioning the imager will be available the rest of the 2013A semester for shared risk use among the 0.9m consortium members. Starting in 2013B HDI will be available to the public through the NOAO TAC.

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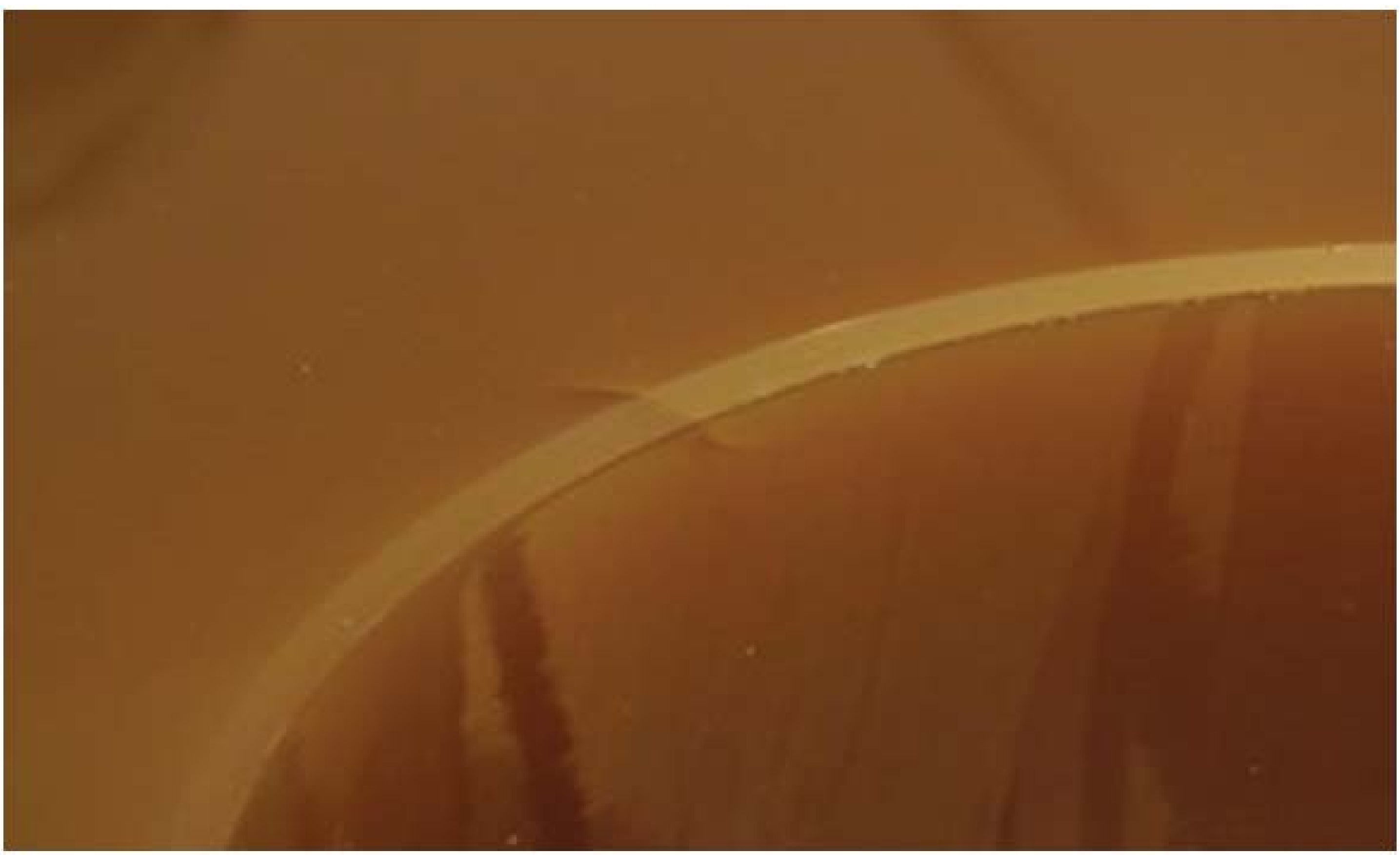

Figure 6: After stripping the existing coating off the 0.9m primary, a small crack was discovered.

Director's News
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new ODI-PPA Program Manager in February 2012. Sabrina Pakzad, a data analyst at NOAO, is helping with the multitude of pODI commissioning data, and Erik Timmermann of NOAO's Science Data Management group (SDM) is assisting Andrey Yeatts in developing the user interface for pODI.

Let's look forward to facing future!

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PPA Development
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signature removal, providing secure log-in for users, advanced data visualization, and more flexible data download options. We expect the PPA system to be ready for initial deployment to the community by the start of shared-risk observing in early 2013.

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Leo P - A Newly Discovered Local Group Candidate
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halos with small baryon fraction. The existence of such objects could help reduce the discrepancy between theory and observation that is commonly referred to as the "missing satellite" problem.

A paper detailing the optical imaging observations described above has been submitted to the Astrophysical Journal (Rhode et al. 2012). In addition to the Indiana University astronomers mentioned herein, collaborators on this project include Riccardo Giovanelli, Martha Haynes & Elizabeth Adams (Cornell University), Evan Skillman & Kristen McQuinn (University of Minnesota), and John Cannon & Elijah Bernstein-Cooper (Macalester College).

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Giovanelli, R., Haynes, M.P., Kent, B.R. & Adams, E.A.K. 2010, ApJ, 708, L22
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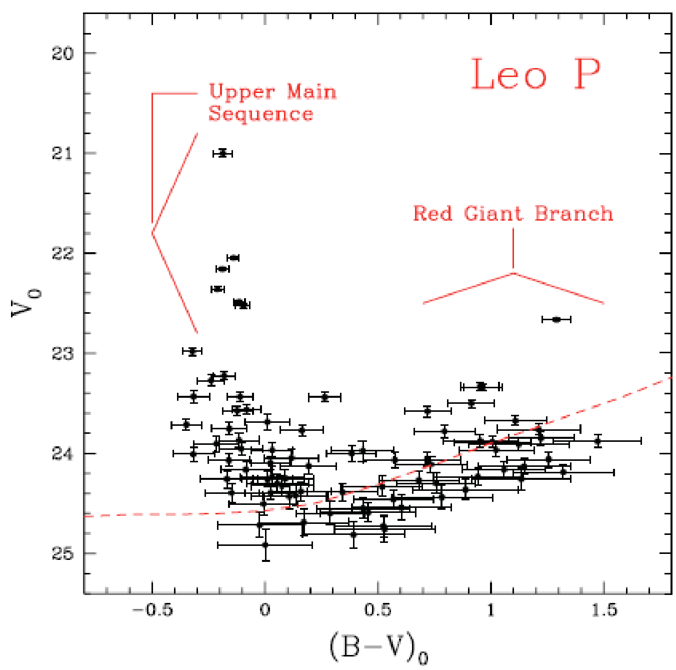

Figure 7: Color-magnitude diagram (CMD) constructed from PSF photometry of the stars in Leo P measured in the WIYN telescope images (see Figure 5). The plot includes all objects within the galaxy that have photometric uncertainties in B-V less than 0.25 mag. The upper main sequence and red giant branch stars are indicated. The dashed line indicates the 50% completeness limit for the data. Note the well-defined upper main sequence and the under-populated red giant branch.