McDonald Observatory trip to Chile

October 15, 2009. I caught the flight to Dallas and met Grant and Sherry Roane at the Gate where we went to Champs for a bite and a drink. Dale and Roy Truitt joined us just before boarding. Met the rest of the people at the gate including the rest of the family. The flight was uneventful and I slept most of the way. Other people joining us are Shirley Wozencraft and Charles Goodwin and Rhett Butler and Maria and Josephine Krause.

Oct 16. Took the bus to the Hotel Plaza El Bosque in Santiago. Went walking around with Steve. Had lunch with Steve at the Melba Café and caught up with Shane and Waltraut who had met Nestor, a co worker of Shane's who is working in Santiago to bid on Chile to bid on tunnels here. We went to the museum of natural history in town and looked at the Meso American artifacts. We had a short stop for Lapis at one of the stores and went back to the hotel for a formal dinner. Steve snored!

October 17. It was an EARLY flight to Calama. The wake up call was at 3:30 am and the bus was at 4:30. The flight to Calama was interesting, the sky seemed to merge with the sea with a myriad of colors.

The whole coast was extremely arid with virtually no one living there. Flew over some copper mines shortly before we landed. The bus to San Pedro in the Atacama had some magnificent views of the salt pans and the eroded geography. The Atacama desert is due to two distinct subduction events resulting in two mountain ranges. One of the ranges on

the coast (older) and the Andes about 200 kilometers in scrape the sky clear of any moisture leaving the desert one of the driest places in the world with two rains in the last 70? years. The Salt Mountain Range We arrived at the Hotel Tierra Atacama, our home for the next three nights.

The hotel is quite impressive with beautiful rooms and a nice bar! We went into San Pedro and went to La Estaka for a lunch of salad, steak and Tres Leches for lunch.

The interior decorating and architecture was interesting. Steve, Shane, Waltrout, and Mom and I wandered around town. Steve found some swim trunks and he and I stopped for a draft beer. Draft beer around here seems to be the second class stuff and the bottled stuff is the better quality. The church was established in 1557 and seems to be a refuge for some of the local dogs.

The town economy seems to be mainly based on tourism with travel guides, tourist shops and restaurants being the mainstay of the main street in town. Headed back to the hotel and took a dip in the indoor pool, the outdoor one was freezing. Tried the indoor pool which was warm with nice jets and then went to the outdoor hot tub which needed some work on the decking where carriage bolts were coming up. Went back the room for

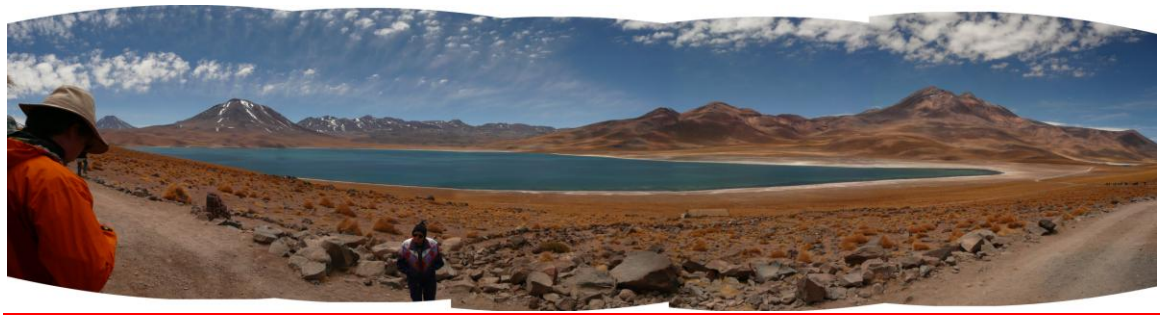
showers in the outdoor shower, very nice! 5:30 departure for the Valley of the Moon to see the sunset. Stopped a couple of times on the way to take in the view of the salt flats and the statue of the three Marys of which one had accidently gotten pushed over awhile ago by an over zealous tourist who wanted his picture taken with it up close. Went to the sunset viewing area along with a lot of other people to see the sun go down. You actually look at the landscape to the East and not the sunset to enjoy the color and lighting changes to landscape.

We didn't go to the main viewing area because it was too crowded, but went to a smaller hill that worked just as well. Took lots of pictures and enjoyed the great view! The exposed formations let you see strata and the faulting in the rock. We went back to San Pedro afterwards to eat dinner at Blanco. Starting with oriental soup, a salmon dish and crème brulee for dessert. The Chilean wine was very good. Montez Alpha Chardonnay. Steve said the merlot was good too. A little walking around with a stop by the church again. The sign indicates that the first mass was held in 1557. The church in San Pedro is the second oldest in Chile. Caught the bus home and had a good night's sleep after a quick look at the stars.

October 18, 2009. After a leisurely breakfast that included strawberry juice, eggs and pancakes we climbed on the bus and headed out to go see the flamingos. We stopped in the town of Tocanao over the river that comes into town.

The river has some of the best water in the area and the Spaniards planted a variety of trees up the river. A celebration in Tocanao honoring St. Lucas caused a colorful diversion. We stopped and watched three marching bands and the accompanying dancers.

The delay caused a change in plans and we headed south passing through a planted grove of trees and several small towns on the way to Lago Miniques. On the way we had fun at an optical illusion that made an uphill slope seem like a downhill one. The high point of the drive was Cerro Miscanti with a short slope down to the lake.



The water was very clear with a few flamingos. We walked to a second lake where we could see the ducks clearer. Another bus ride took us to lunch in Socaire. An interesting salad had some kind of black potato, carrots, potatoes and some other starchy tuber, a main course of chicken and rice and a fruit cocktail dessert. After lunch we went to see the flamingos as well as seeing avocets and Wilsons phalaropes. The flamingos flew overhead like low level fighters.

A 45 minute hop took us back to the hotel. We were running late so no shopping in Tocanao. A short break for everyone and off to a traditional meal at the Xport Café. Empanadas, beef soup, a corn meal dish that was very tasty, desert was a rehydrated peach in a wine glass. The cloudy skies canceled the star party that night, but the skies had cleared and we had a few constellations pointed out by Tom and Hernan.

October 19, 2009. The morning came EARLY at 3:30. Several people were smart enough to sleep in and take it easy skipping the trip so we were without the full

contingent on the bus. While waiting for the bus we saw the Southern Cross, the Pleiades and Orion was still in the sky. The bus ride to the Geisers of El Tatio was adventure itself with the bus dying three or four times on the very rough roads. We went over a high pass before dropping into the valley with the geysers just before sunrise. The steam rising made the place seem a little surreal.

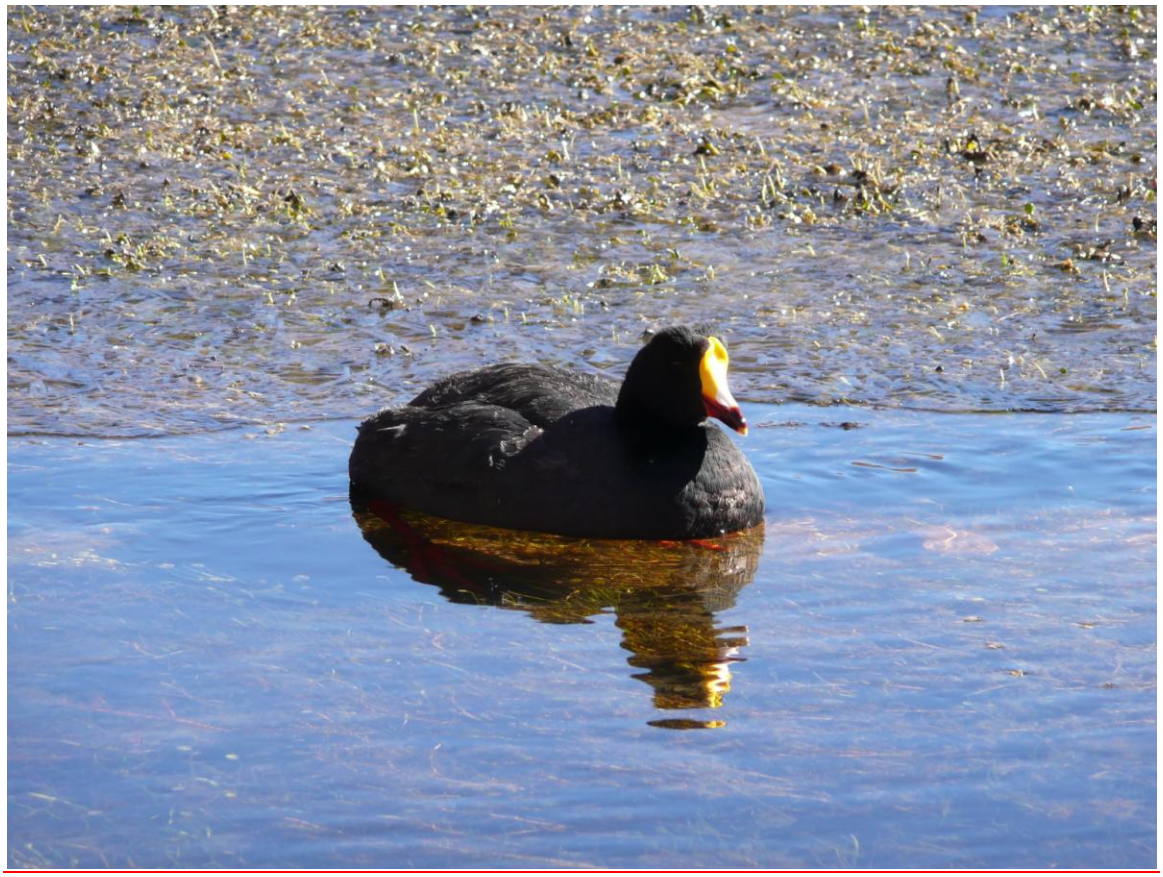
The geysers steam steadily without the typical eruptions one thinks of at Yellowstone.

Sunrise is the best time to view the geysers since that is when the air is the coldest and the steam rises the highest. The rising sun finally lights up the plumes of steam

dramatically as you walk down the paths between the geysers. The high altitude allows the water to boil at 87 degrees instead of 100 and one pool was cool enough to hold about eight bathers. Breakfast was set out by the time we got back to the bus and we were ready for it. Ronaldo had warmed the chocolate milk in one of the steaming pools of water to mix up with some Nescafe for some instant Café Mocha which really hit the spot.

Back in the bus we were headed to the Baños Puritama, a series of small pools fed from a thermal spring. On the way we saw many vicuña which Ron said were rare in the area as well as birds that were spotted both on the high areas and by a small marsh.

The birds were unafraid of us and allowed us to approach within a few yards before moving off.



Arriving at the pools a long walk took us from the bus parking to the bathing areas and change rooms. A series of little pools cooled as you went downstream with a starting temp of about 33 degrees centigrade. The Explora Hotel had built the support facilities and turned them over to the local village to run and maintain so the first pool was reserved for them.

There was quite a flow of water through the pools and several of us made our way upstream from one of the pools to a small waterfall which offered a pounding massage of both water and the pebbles it carried with it. On the way out we passed the Explora group laying out a wine lunch, not enough extra for us though! Driving back to San Pedro we also saw the Andean version of a Saguaro cactus. Back in San Pedro we met up with the rest of the group for lunch at Café Adobe. The grilled chicken was tasty with a marinated pear for dessert. Our local guide Ron had come down with a stomach bug and had to leave us. We will hopefully see him again later in the trip.

The afternoon was free and we wandered around doing some shopping before heading back to the hotel for a dip in the pool and the hot tub. A short siesta and we were ready for MORE food. Dinner was at La Ixtaka for a tomato salad, salmon dinner and a pastry dessert. We went to the Chilean version of a star party hosted by a Frenchman Alain Maury and his wife. Most of the telescopes were made by him. The sky was perfectly clear and we looked at many of the things we've seen in West Texas and many constellations we have not.

October 20, 2009. Up for breakfast at a reasonable hour and off to the Atacama Large Millimeter/sub-millimeter Array (ALMA). We were met by Dr. Richard Hills, the Project Scientist. ALMA had been closed to visitors so people could get their work done, the intervention of McDonald Observatory allowed us to visit. Dr. Hills gave us a tour of the base of operations and what ALMA is all about. When completed ALMA will consist of 66 high-precision antennas, with the option to expand in the future. There will

be an array of fifty 12-metre antennas, acting together as a single giant telescope, and a compact array composed of 7-metre and 12-metre diameter antennas.

The antennas can be arranged in different configurations that will allow resolution of smaller areas more clearly or larger areas with less detail. The dishes will be installed on a plain at an altitude of approximately 5000 meters. When the installation is complete

over 2 X 10^{16} operations per second will be processed by the correlator which will combine the information from the 66 antennas to give usable data. [See http://74.125.155.132/search?q=cache:wqPPYDYoxscJ:accelconf.web.cern.ch/AccelConf/ica05/proceedings/pdf/P3_067.pdf+ALMA+correlator&cd=4&hl=en&ct=clnk&gl=us&client=firefox-a]The array will be so sensitive it was estimated that it would collect enough energy in 30 years of observing to let a gnat take off. One of the objectives of ALMA is to determine what happened during the "Dark Ages" of the universe between the Big Bang and the formation of the first galaxies. During the tour we were able to watch them calibrating one of the dishes. The individual panel misalignments were mapped on computer and the corrections would be programmed into a special tool that will turn the adjuster screws by as little as a single micron. The overall spec for the mirror is 25 microns and adjustments have been averaging 10 microns! The dish should not require realignment for 5 years. 25 dishes are to be made by the US, 25 by the ESO, and 16 by Taiwan and Japan. We were able to visit the final assembly building of the US dishes which was quite an operation. The contractor is Vertex, based in Kilgore, Texas with the frame constructed in Mexia, TX. Carbon fiber components are made in Germany at an old fighter aircraft factory that has an autoclave of sufficient size. The dish pedestal is shipped complete from the US. The dish is shipped in parts for assembly at the site. The dish is made of 264 carbon fiber panels with aluminum panels above it. Behind the assembly building were the two transporters named Otto and Lore that pick up the assembled dishes for transport to the configurable array at the high plateau at a top sped of 5 kph.

The transporter was originally designed for transporting boats. The 32wheeled transporter can turn on its own length and place the dish with millimeter precision.

A short trip took us back to the Café Adobe in San Pedro for a lunch of salad, an enchilada and home made ice cream. We went to the cultural museum for a guided tour that was very informative. We then boarded the bus to Calama and the Park Calama Hotel by way of an Incan fortress.

Once again the bus had some troubles, but it finally made it to Calama. A buffet dinner with lots of interesting conversation with Charles, Tom and Hernan ended the night except for doing some catching up on notes.

October 21, 2009. Woke up at a reasonable hour and was showered, packed and at breakfast by 6:45. A breakfast buffet once again filled us up for our drive to Cerro Paranal and the Very Large Telescope (VLT). This time we had a first class tour bus. This leg of the journey was through a section of the Atacama that was even drier than before, virtually nothing grows there. We arrived at the VLT which is located about one and a half hours south of Antofagasta only 12 km in from the coast at an altitude of about 9,500 feet.

We were met by Dr. Massimo Tarenghi , the former Director for ESO. The telescope was his dream and brainchild that was always on his mind through his life. He worked on and built a series of smaller facilities before his plans for the VLT came to fruition. He began the tour by showing us the creature comforts of the place starting with the "Residencia" which was featured in the last James Bond movie Quantum of Solace. The facility is almost entirely underground with a dome over a huge central atrium.

The facility was built for 12 million Euros (about 1% of the whole project) and houses not only rooms, but a huge atrium, game room, music theatre, library, cafeteria, and movie facilities.

A short hop over to the rec center containing workout, Pilates, squash and indoor soccer facilities. We then went through the facility that strips the old aluminum coating off the mirrors, and places them in a vacuum chamber and recoats them with a fresh layer of aluminum about 80 microns thick +- 10 microns through a sputtering process. Each mirror is recoated every 2 years. The process is extremely automated requiring a minimum of personnel. One of the reasons for this is the possibility of an earthquake occurring during the handling of the mirror that could cause it to fall. The buildings are heavily reinforced and have handled an earthquake with the strength of 8.2 on the Richter scale. We had a break for lunch, the food is in keeping with the rest of the facilities, first class all the way! The bus brought us to the top where we had a look firsthand at the array of telescopes.

There are four 8.2 meter telescopes that are equipped with mirrors that are 17.8 cm thick. The mirrors are adaptive meaning they can be shaped using hydraulics on the back to curve the mirror as needed. The secondary mirrors are also adaptive, but the mirror is made of beryllium. The whole structure rides on maglev bearings. The light can either go to an instrument at that point or be sent to the tertiary mirror where it can be reflected

into another system. When the telescopes are used for interferometry, the light from the various telescopes can be bounced through a series of mirrors in an underground chamber to equalize the length of travel so the wavelengths are in phase and the data can be used. There are also four 1.8 meter mobile telescopes that are moved around and used in filling out the array when used for interferometry. No one is in the telescope while it is operating, the two people necessary are in the control room below. The control room has room to grow allowing control of the VISTA wide field telescope that was just completed nearby as well as the four small ones and potentially the E-ELT telescope should it be built nearby. The operating budget for the facility is approximately $180,000,000 annually, about 30 times that of McDonald! Our tour was all too short for the amount of things to see there, but Dr. Tarenghi had given us the royal treatment during our visit. We hopped on the bus and headed back to Antofagasta around 5:00. We checked into the Radisson and down to the bar for our Pisco sours. We noticed a lot of security at the hotel. Evidently there were some kind of war games going on and military personnel were staying at the hotel.

Steve and I headed out for a walk along the shore. The wind blowing off the Pacific was colder than expected. There is a military post of some sort across the street and there was a guard on the church next to the hotel. We walked west to the park where a cargo crane was placed as a monument, passing a radio controlled car racing track, and an area preparing for what looked to be a Greekfest. There were lots of couples in the cars overlooking the water, kids in the skateboard park and evening

strollers and soccer players in the park. Made it back to the hotel for dinner where we joined by Doctor Tarenghi . Masimo told us several stories of his experiences as an astronomer that filled up the evening.

October 22, 2009. We took the bus to the airport with a side trip to La Portada, a natural sandstone arch standing out in the bay.

We were lucky enough to hop on a flight directly to La Serena instead of having to fly all the way to Santiago and then back. We checked into the Hotel Costa Real. Steve and I went for a walk to the square and saw part of the market area. We had lunch at the hotel with a guacamole/scallop salad, corvine, and a light dessert. We took the bus to the AURA facility over looking La Serena and met Chris Smith, director of CTIO. Chris gave us a tour through part of the facility and handed us of to Francois Roddier, of the Gemini Observatory, who showed us what they had been developing in adaptive optics. In this case a 50 watt sodium laser is shot into the atmosphere and excites sodium atoms in a layer about 90 km above the Earth's surface. This "artificial star" is analyzed using a series of mirrors and a wave analyzer to determine how the atmosphere has distorted the beam and the mirrors in this instrument are reshaped to correct for the distortion. The laser is split into five beams and each area analyzed so a larger area can be compensated for. This is quite a different approach than the corrections cranked in to the primary mirrors at Cerro Paranal. We took a very short hop to see the Las Campanas base facility where we were met by Miguel Roth, the director for the Magellan Telescope facility. Miguel kindly took us through his administration facility at El Pino.

We took the bus back to the hotel and people headed to their rooms for a much needed siesta. Steve and I headed for the markets where, to my dismay, I found out that no pocket knives are made in Chile. After stops for pictures and beers we headed back to clean up for dinner. At dinner we saw Chris and Miguel as well as meeting Mark Phillips, Frederik Rontakyro, Elaine MacAuliffe with AURA, and Enrique Figureoa with the NOAO Strategic Development office. Good conversation was had on subjects ranging from cherimoya to mirror casting.

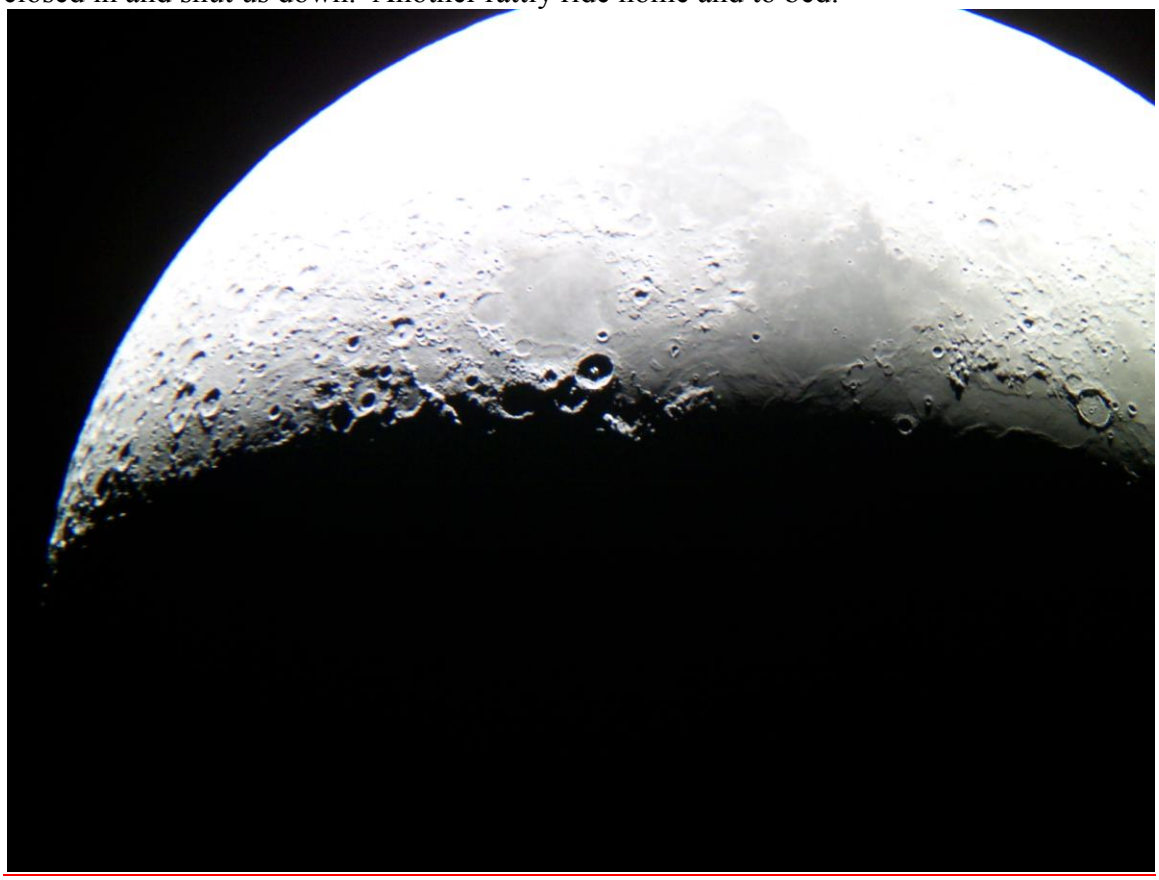
October 23, 2009. We left for Las Campanas at 9:15 and were slowed up by traffic getting to the site a little late. Miguel and Paula were there to greet us. The support area was very nice with great views and of course a cafeteria with great food.

We then walked over to take a look at one of the two Magellan 6.5 meter twin telescopes. Miguel spoke of how he decided to clear off a space for a second telescope while doing the first one. When the foundation for the first one went in it was only a little more to pour the second one and put a tunnel between the two. After that, he was turning away groups interested in funding the second telescope. The two telescopes are identical except for instrumentation, but it doubles the observation time.

After our walk through the telescope we took a short hop over to the site of the proposed Giant Magellan Telescope. While there Miguel demonstrated the singing rocks after which the site is named (Las Campanas). There are certain basalts whose crystal structure allows them to ring like a bell and everyone had a whack. Miguel did admit that he would probably clear space for TWO telescopes… Back to the hotel for a break before dinner.

Some of our hosts sent us a basket of Churimoya or custard apples, a tasty white fleshy fruit with lots of seeds. Steve and I went walking around some more before heading back for dinner. Some of us were then crazy enough to go on a late night road trip out to a small private observatory named El Pangue, for some night viewing. Those smart enough to stay home avoided an hour long ride over washboard dirt roads with steep drop offs. We arrived after a long ride (being tired to start with) to the observatory. The observatory was powered by solar cells. Unfortunately twelve days of cloudy weather interfered with the battery charging and all the automatic tracking systems were out of juice. We started out by viewing the moon and Jupiter and also looked at a spiral galaxy (NGC 253) edge on as well as a globular cluster and a Messier object until the clouds

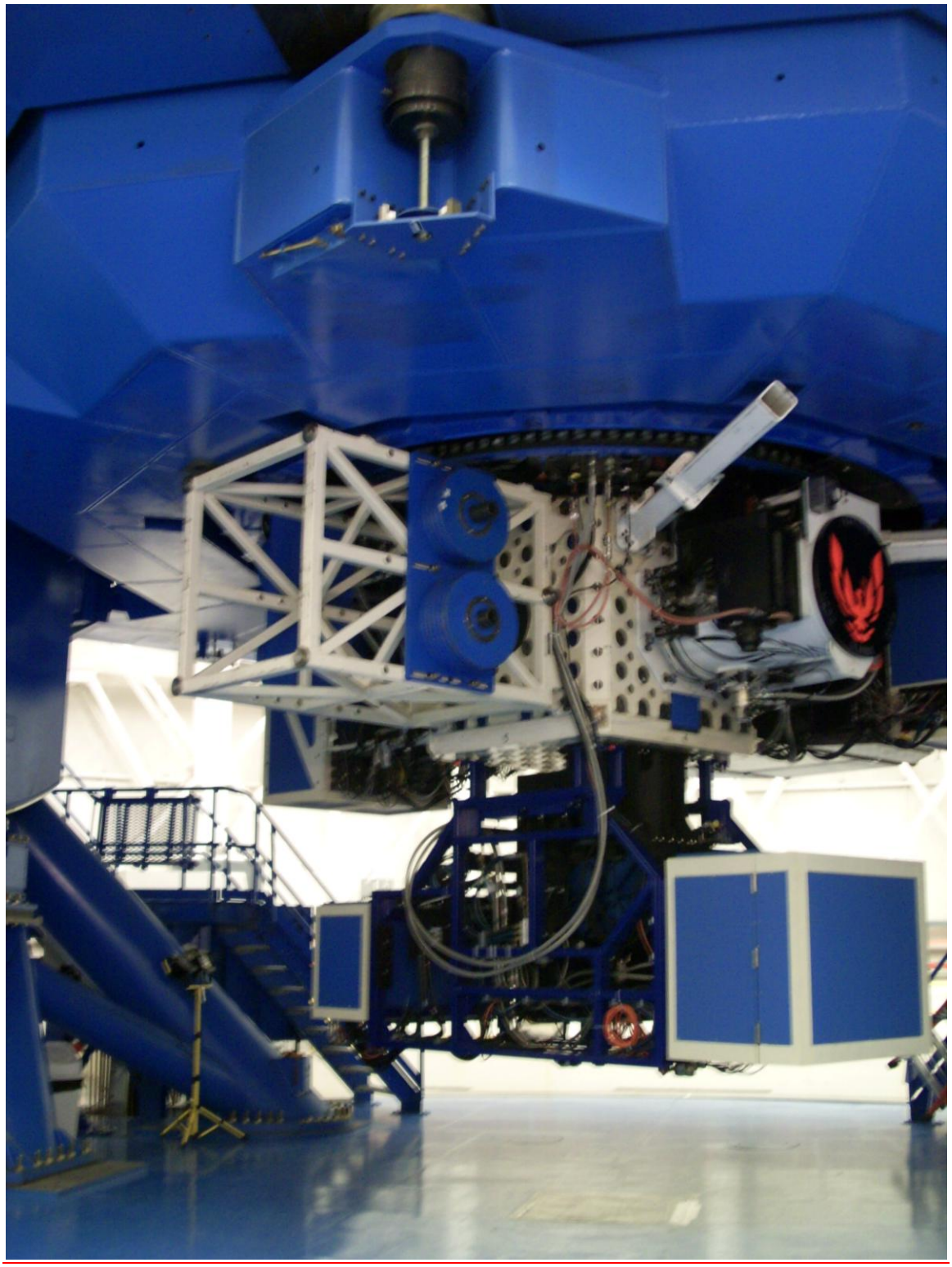
closed in and shut us down. Another rattly ride home and to bed.



October 24, 2009. This morning we left after not enough sleep to go to the Gemini and SOAR facility at Cerro Pachon. A bus ride up the fertile Elqui Valley got us near the entrance of the road that goes up to the AURA facilities. The facility on Cerro Tololo is open to the public on Saturdays so there was a line of cars waiting to be escorted up. Hernan used a little magic (and an AURAvehicle) to get us past the waiting cars and on our way up the mountain. The views were as spectacular as we have seen on this trip and we could see both facilities on the way up. The 8.1 meter Gemini telescope is one of two telescopes, the other is based on Mauna Kea in Hawaii.

In theory either one of these telescopes can be operated from either location. Director Steve Heathcote met us as we arrived along with Melissa and some old hands. Steve explained how the Gemini administration prioritized the projects that have received observation time in a very modern control room. Priorities are judged by Gemini's board and grouped by instrument and observing conditions required. Observations are performed by the telescope's operator and astronomer and the data are then made available to the project initiator. This may sometimes mean that not all projects get done during a semester.

The telescope has an instrument mount that can hold several instruments at one time and the instruments can be changed fairly rapidly depending on what is needed.

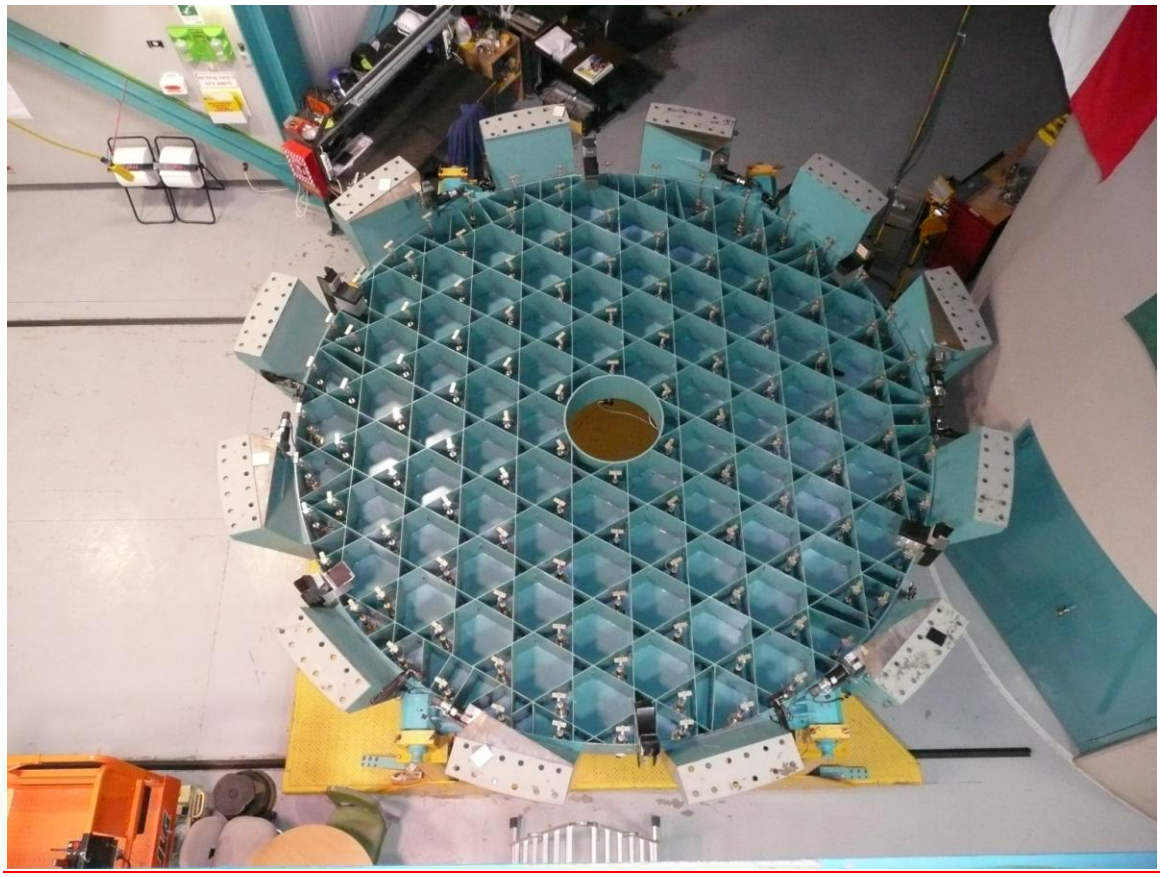


If a new instrument needs to be switched out for another on the mount though, more time is required. We went to take a look at the telescope and the operator opened the side vents to the dome, which open like a curtain around the waist of the enclosure, while rotating the dome and the telescope in opposite directions and changing the azimuth so we could see the mirror. The feeling was a little disorienting as it felt we were moving

instead of actually standing still. It was quite a show. We were also able to observe the multiple instrument mount as well as the mount for the adaptive optics module we were shown back at their base of operations in La Serena.

Steve also explained what type of mirror maintenance is performed, a combination of cleaning with dry ice snow with occasional soap and water cleanings using natural sponges that have been specially prepared and horse soap! After reflectivity gets bad enough the mirror will be removed for recoating. All the facilities have some type of recoating capability. All involve cleaning the mirror, stripping the original coating off it using acid and Potassium hydroxide. At this point the mirror is translucent. It is then placed in a vacuum chamber for coating. Gemini has pioneered the use of a silver coating with several protective coatings atop that to prevent oxidation. This works well for the kind of science being done by the telescope. Other telescopes typically use an aluminum (or should I say aluminium in deference to the British astronomers?) coating that is about 80 angstroms thick with no surface coating. The coating is typically applied by either allowing the metal to condense on the mirror's surface or by sputtering it onto the mirror surface. The Gemini telescope has not yet required recoating since its commission however, the adjacent 4.1 meter Southern Observatory for Astronomical Research or SOAR telescope was in the process of being recoated. We were able to see the mirror on the working floor of the recoating area. It had been stripped of its coating and was hiding under plywood in preparation for its new aluminum skin it is to receive next week. The secondary and tertiary mirrors had already been recoated.

A short hop over to the SOAR telescope let us see a rare sight to outside eyes, a telescope in pieces. The cell was sitting on a frame next to the telescope exposing a myriad of push pull motors that are used to shape the thin mirror to compensate for deformation of both the mirror and the cell due to gravity when the telescope is in different positions.



This is not considered adaptive or active optics, more a method of keeping the mirror true. This telescope does have active correction that is applied to the tertiary mirror. This is when correction is applied (in this case) to the tertiary mirror in two axes (tip and

tilt) to correct the image jittering that is caused by the atmosphere.

Due to time constraints we went to have lunch and visit a Pisco distillery in the nearby town of Vicuña instead of the one up the valley as originally planned. On the way to the distillery we passed vineyards, orchards, and crops of all types. At the Capel distillery we saw where the five types of grapes (mostly Muscatel) are cleaned, crushed, fermented, distilled and bottled.

[This was in Antofagata I think]We caught the flight back to Santiago with a little time to spare. When we got to Santiago everyone wanted to head directly to the hotel instead of stopping for dinner. We checked in, cleaned up and met Shane's friend Nestor and his wife Marianna for dinner. Nestor took us to Bella Vista where there were numerous clubs and restaurants as well as art displays and live music. We ate at a Peruvian restaurant which was very good. The steaks were rare and the beer cold. Nestor dropped us off around midnight, but it seemed like the party in that area was just getting started.

October 25, 2009. We slept in, at least if you call sleeping till 7:00 sleeping in. Breakfast was on the 17th floor with great views. Rhett and Maria had to catch a flight home and Shane and Waltrout went to visit Nestor and Marianna. The bus felt a little empty as it took us to the Central Valley to visit the Santa Rita Winery. On the way past the vines the tour guide pointed out the rose bushes that were planted at the end of every other row of vines. The bushes are kind of like the canary in the coal mine being more sensitive to certain diseases that may hurt the vines and acting as an early warning system.

Since we got there a little early we were able to visit the Museo Andea that exhibits the collection the owner of the winery, Mr. Claro, had amassed. The museum was very modern with the Pre-Colombian artifacts well exhibited. It turns out that the only gold artifacts that remain from Pre-Colombian times are those that were removed from tombs as the Spaniards had melted down the rest to ship back to Spain.

The winery was huge with grapes from their many vineyards being processed at that location. The oldest part of the winery was an aging area with barrel vaulted ceilings constructed with native stone cemented with a mix of limestone, sand and egg white.

Lunch was at the winery and consisted of a smoked salmon appetizer followed by swordfish and a dessert of a pastry coil topped with cherimoya ice cream resting in a sea of caramel sauce that everyone made disappear.

The return trip took us back through the fertile Central Valley and to the hotel where we had a chance to clean up and head to the airport. Charles and Shirley headed to their Delta flight to head back to Texas while the rest of us did some last minute shopping

along with a break in the Admirals Club before climbing on AA flight 940 for home.

Final thoughts. Chile is a country of contrasts, cutting edge science is allowing astronomers to look into secrets of the past and Mapuche natives are working in their fields, volcanoes steam overlooking an arid desert while valleys have rich farmland. We had a tremendous trip that let us look at wide range of approaches to observing the sky. From the Rolls Royce approach of ESO at Cerro Paranal to Alain Maury with his home made telescopes, they all add to human knowledge whether it is discovering something new to astronomers and science or something new to someone who has never looked through a telescope before. All these things make us grow. When can I do it again?