THE TELESCOPE

1. The Mission.

I wanted to explore the deep sky too far south for central California sites. So I decided to build an airline-transportable telescope of respectable size, and do some voyaging.

2. Performance Goals.

The telescope needed to be optimized for deep-sky work -- I wasn't going south to see planets. Lots of aperture and good light baffling were important, but obstruction size and tube currents were less so.

3. Airline Portability.

I planned to transport the telescope on scheduled airline flights. I could put a larger telescope in checked baggage, than in carry-on luggage, even with enough padding to protect it from baggage handlers. I was thinking of Hawaii to begin with, so I worked to the widespread US baggage limits, for which the largest luggage piece shall not exceed 62 inches (157 cm) length plus width plus height, nor weigh over 70 pounds (32 Kg). Airlines generally allow a smaller piece of checked luggage, just as heavy but with 55 inch (140 cm) sum of dimensions.

One consideration was, what is "luggage"? Some airlines are reluctant to check stuff packed in cardboard boxes, for example. A web article suggested a problem with things with no handles for carrying, or too oddly shaped to stack well, or too flimsy. Web-surfing led to Atlas Case, at http://www.atlascase.com, who stock several lines of tough air transport shipping containers with padding. I ended up buying one.

4. Two-Stage Set-Up.

Most transportable telescopes are stored in pieces at home, driven to an observing site, and assembled there for use. My operations would be more elaborate: As baggage, my telescope would be in more pieces, and smaller ones, than the average instrument in the garage. The plan was to unpack it in a motel room, assemble it there at least partly, then drive it to the site. Thus the fastenings and assembly procedures to join the packed pieces could be more complicated and more time-consuming than those used, say, for field assembly of a Dobson.

5. Early Design Thoughts.

Over the years, I have played with such designs, via pencil sketches and dimension and weight estimates. I know of two approaches to a compact portable telescope, distinguished by whether the transportation

case is part of the instrument, or not. I decided on a separate case, because I was not sure I could construct an assembly stout enough to protect the contents, and light enough for part of a telescope. Yet the case-as-component approach seems viable. For an example, though perhaps too light to survive baggage handlers, see Tom Noe's "TelePort" design, at "http://www.annexstudios.com/Design/D-pdf/TpManual.pdf". Another design I considered used a short, stubby telescope tube as kind of a solid-wall duffle bag, full of parts, accessories, and components. One might even have two sections of tubing that, er, telescoped together.

6. Final Design.

My design became final when sketches convinced me I could construct a truss-tube Dobson so that except for truss poles, the parts would pack into a cube about four inches (10 cm) larger than the clear aperture. The 62-inch baggage limit gives a cube a bit over 20 inches (50 cm) on a side, so after allowing for case wall thickness and padding, a 10-inch (25 cm) telescope would be a good fit, and a 12-inch (30 cm) telescope a tough one. I had a full-thickness 10-inch f/5 Pyrex mirror -- bought from Nova for a more conventional project I later abandoned -- so I picked the smaller size. One technical risk remained:

7. Shrinking the Truss Poles.

Truss poles are the wrong shape for baggage. Those for a 10-inch f/5 are about 40 inches (100 cm) long, so a case for them that fits baggage size limits will have no room for much else -- and I do travel with more than a telescope: I need charts and eyepieces, and maybe even extra socks. I needed a way to cut the truss poles in half, and reassemble them in a motel room with a stiff, light, vibration-free joint. I didn't want a symmetrical truss, with twice the number of shorter poles, because the extra weight near the tube's midsection would bring the center of gravity skyward and lead to a larger, bulkier rocker, perhaps too large to transport.

I played with designs for wooden clamps, like those Kriege and Berry (1997) describe for attaching truss poles to the box. I came up with several, but they were too heavy for half-way up the poles of a small telescope. Using telescoping tubing as poles seemed asking for trouble from vibration and slop. I thought of using a piece of oversize tubing as a joint, with O-rings between it and the poles, and that might have worked, but I while I was testing it, I came up with a better way, using an old telescope-maker's friend -- beeswax!

I found that a section of hollow, square aluminum extrusion could rigidly join two lengths of truss pole, if I used beeswax to take up slop and damp vibration. I cut a short length of extrusion, inserted a piece of truss-pole stock part way into it, and epoxyed it in place,

making a socket into which another piece of truss pole would fit. Beeswax made the slip fit into a stiff joint that was entirely satisfactory for the telescope.

It is not necessary to fill the space between pole and extrusion with beeswax. What I do is dip each "male" end of the cut pole into melted beeswax before I travel, to get a thin, uniform coat of beeswax on the portion that goes into the extrusion. A little will do, and once there is some there, you don't necessarily need to keep adding more every time you assemble the poles. I do this part of assembly and dissembly in a motel room. Beeswax softens enough under a hot water faucet to make the task easy.

I carry a little plastic bottle of spare beeswax, that I can melt entirely by putting it in a glass filled with boiling water from my portable coffee heater. That way I can add more beeswax if necessary.

I didn't think a whole lot of this idea when I thought it up -- I was just glad to have a scheme that would make my project possible. Yet nearly all the amateur astronomers and amateur telescope makers who have seen the finished instrument have thought the "beeswax trick" to be a considerable technical innovation in the construction of Dobson telescopes. So in case they are right, I have been describing it at length, in case others should find it useful.

With that trick in mind, I went ahead with my project. I had built several telescopes before, including Newtonians to 12.5-inch (32 cm) aperture, but none as complicated mechanically as a truss-tube Dobson, so I was looking forward to a challenge.

8. Materials and Fastenings.

I have some experience working in wood, so I used it extensively. I got a moderately good grade of half-inch plywood from a lumber yard, and for the small quantities of thinner plywood I needed, a hobby shop had plenty of variety in good-quality stock. Local hardware stores provided small pieces of "project" wood -- poplar or oak, finished on four sides, in handy sizes. I used 5/8-inch hardwood dowels for truss poles. I had to pick through a whole bin of dowels to find enough straight ones.

I have had occasion to use good cements, so I made permanent assemblies with glue alone -- no fasteners. The hobby shop had clear epoxies with pot lives of 30 and 120 minutes, in four-ounce bottles. The 30-minute stuff penetrates far better than the usual quick-setting, "5-minute" kind. The 120-minute version flows nearly like water, easily fills cracks and voids, and makes nice fillets. I selected Weldwood phenolic/formaldehyde wood glue for large areas with no end grains, and used contact cement to wrap Ebony Star around the side bearings. Contact

cement works best when you follow the directions: Let it dry smooth and hard before joining the pieces. Don't ask me how I know.

After a few experiments and some visits to hardware stores, I picked threaded inserts and T-nuts for joining pieces that come apart for transportation. I was able to put all of them in places where they would not pull out when the machine screws that went through them were torqued down.

I used stainless fittings and fasteners whenever I could find them. Marine hardware stores offered a particularly large assortment, and also supplied the rubber grommets used to attach bungee cords to the shroud.

9. Construction -- A Few Details.

I won't bore you with conventional details of a truss-tube Dobson -- Kriege and Berry is a wonderful source for those -- but there are a few places where I did things differently, and it may be noteworthy that the construction is very light. Let's take it top-down.

The telescope does not have a sky-end "cage" as such -- the focuser attaches between two truss poles, four inches below an octagonal wooden "ring" at the upper end of the truss. I built the octagon by gluing four strips of 3/16-inch plywood, 1.5 inches wide, into a square whose width was a bit less than the inside dimension of the mirror box. This piece looked like a square cake pan with the bottom cut out. Then I glued braces of 3/4 by 1.5 inch oak, with ends mitered to 45 degrees, inside the corners of the square, with dimensions such that the inside of the glued assembly was a regular octagon. Finally, I cut off the corners, outside the braces, creating an octagonal structure whose wall thickness alternated between 3/16 and 3/4 inch. This part nests inside the box for transport, but when I rotate it 45 degrees from the nested position, the 3/4 oak sides provide a surface for attaching the upper ends of the truss poles.

With careful use of a spade bit, I could drill a 5/8-inch hole half an inch or more into the end of 3/4-inch square stock without breaking through. Thus I made square cross-section "rod ends" for my 5/8-inch truss poles, and epoxied them in place. The ends are drilled through 7/32, for 10-32 machine screws that hold the truss poles to threaded inserts embedded in the top-end octagon or in the structure of the mirror box. I made two sets of poles, one cut for the beeswax trick and one not. If the beeswax joints had worked poorly, I would have made a case for the long poles and traveled with them as excess baggage. The cut poles fit into a small suitcase or duffle with plenty of room left.

I was very careful to make the truss poles interchangeable -- I worked hard to make sure that the spacing between attach points at the

opposite ends of the pole was the same for each one. When I cut the poles for the beeswax trick, I was also careful to make the cuts at the same distance from the attach points, for each pole; thus any upper pole piece can be used with any lower pole piece.

The focuser is mounted on a thin piece of plywood that presses against two truss poles from within. The focus tube protrudes between the poles. Wooden strips glued to the edges of the plywood help located it precisely. A piece of thin brass with a hole for the focus tube fits outside, and machine screws with spacers go through plywood and brass alike, to hold all in place. The focuser thus extends minimally out from the tube. The focuser is far enough down from the octagon ring that there is no need for an additional light baffle that extends skyward from the ring.

A friend did me a huge favor by doing nearly all of the fabrication of a beautiful shroud from black rip-stop nylon. She has worked professionally creating women's lingerie -- we thought about trimming the shroud with black lace, but decided not to. She modestly demanded that I not show the shroud to anyone with fashion or costuming experience, but telescope owners ogle it no end -- even without lace. It has an edged hole for the focus tube. The bottom bungees go all the way around the mirror box -- the rod-ends on the truss poles are a bit small for a bungee to get a grip on.

The mirror box is five sides of a cube. There is no detachable cell; the mirror side of the box is glued in place. It is half an inch thick; the other sides are quarter-inch. I glued long pieces of "2x2" (actual dimensions, 1 3/8 by 1 3/8 inch) inside the corners, where the quarter-inch sides join together, as braces. The truss poles attach to the outside of the box.

I didn't happen to have any half-inch plywood when I was ready to make the mirror box, but I had extra quarter-inch, so I laminated two pieces of quarter-inch together for the mirror side. It was rainy that day, so I could not use the usual trick of weighting the glued assembly by jacking up my car and setting it down with one wheel on the plywood. I glued it indoors, with 90 pounds of GEM counterweights and 75 pounds of unused, bagged cat litter as weights. I had about 10 pounds of used cat litter standing by just in case, but I am not convinced I could have kept the cat away from it long enough for the glue to set.

The mirror sits on three nylon collimation bolts inserted through the bottom via T-nuts. I also installed extra T-nuts at the right place for 9-point support pivots, in case I need them. After the mirror is in place, I attach two wood assemblies inside the box to keep it there. Each assembly has two nylon furniture glides, to define the mirror's position laterally: It sits touching two glides; the others don't let it

slide more than a quarter inch if I should tip the tube backward. The assemblies also have cork-tipped fingers that protrude a little way in front of the edges of the mirror, so it can't fall out if the tube gets upside down. The cork clears the mirror by a quarter or half an inch, depending on how far in I turn the nylon bolts. Each assembly is a piece of oak, 2.5 by 6 inches, with one face against the inside of the box and the 6-inch length running crosswise; it has two wooden wedges glued on, at the right place and angle to hold the furniture glides, and two wooden fingers glued on, carrying the cork pads.

The side bearings are semicircles of 5/8-inch plywood, with "piece-of-pie" sectors for bracing across the clearance cuts for the truss poles. They detach from the mirror box for transportation. The threaded inserts that hold them in place are embedded in either the "2x2" corner braces, or in extra pieces of half-inch oak that I glued to the inside of the box, just to carry the inserts. I put washers between the threaded inserts and the box sides as I was gluing everything together: Thus the inserts are kept from pulling out through the thin plywood. I could not find any 10-32 T-nuts; they would have worked better than threaded inserts and washers.

Rocker and ground board are conventional, of half-inch stock, with Ebony Star and DuPont Teflon for bearing surfaces. There was a thread on sci.astro.amateur when I was building the rocker, about how difficult it is to cut Ebony Star. Don't believe everything you read on sci.astro.amateur: I scored it with a hobbyist knife and then cut it with scissors, all just fine.

I had some 1/16-inch sheet Teflon for bearings: I made convex surfaces wherever I needed Teflon, bent strips of the slippery plastic over them, and fastened the ends with wide-head screws whose heads were thin enough to clear the bearing surface, given the convexity. The curved surfaces were the top edges of the rocker, for side bearings, and convex blocks of wood epoxyed to the ground board, for the bottom bearing. Several telescope makers have seemed delighted by such a quick and easy way to attach Teflon. I have made bearings of thicker Teflon with countersunk screws, but this way was simpler, because Teflon tends to deform when you torque down the countersunk heads, and that can be a pain to deal with. It was also more compact, and used less material.

10. Tools and Jigs.

My only power tool for this project was an electric drill. (My seamstress friend used a sewing machine.) Several special tools and jigs helped. I bought a thin saw with fine teeth set to cut on the "pull" stroke. It derives from Japanese carpentry, and was a joy to use. I could split a pencil line when sawing, and my cuts required only a few finish strokes with sandpaper, and I am by no means an experienced

carpenter. I also used a drawknife -- a very old tool for shaping wood -- and a good set of wood chisels. I kept chisels and drawknife razor sharp, and took great care that they cut only wood, not flesh.

I had a simple drill stand so I could use my electric drill as a drill press -- that was extremely useful. Also useful was a good hand miter-box saw assembly -- a fancy metal unit, with clamps and guides, adjustable to many angles, with a high-quality backsaw.

I had a variety of store-bought clamps for gluing. The project would not have succeeded without them. I built several special jigs. Useful ones included some simple wooden "V"s, to support a 90-degree angle edge down, so I could weigh down a glued joint while the glue dried, and a strip of metal with holes pre-drilled at the design separation of the fastener holes in opposite ends of my truss poles.

11. Packing for Portability.

Except for the truss poles, the telescope packs into roughly a 14-inch (36 cm) cube for transport. With side bearings removed, the box nests into the rocker, and the octagon fits into the top of the box. I found a Rubbermaid refrigerator container about 11 inches (33 cm) diameter and 4 inches (10 cm) deep, just right to hold the primary with plenty of padding. It also fits into the box, under the octagon. There is lots more room in the box for small parts, accessories, and tools, or for clothing and non-telescope stuff, either as padding or to distribute weight more evenly among pieces of luggage. The ground board and side bearings fit around the rocker, to make up the rest of the cube.

Even though all the parts mentioned do indeed fit into the cube, I actually packed for traveling by putting as many small, heavy parts as possible into my other piece of luggage, and filling gaps in the telescope case with clothing and other light items. All the fasteners used for motel-room assembly traveled this way. Without doing so, the case would have been very heavy and awkward to handle.

12. Other Case Features.

The container I bought from Atlas Cases has an interior that is approximately an 18-inch (46 cm) cube. It came with two inches of foam lining, which I trimmed with a bread knife for a snug fit. It has handles and latches; I drilled holes for a long, bicycle-lock style padlock, which seems enough to deter casual pilferage. Anyone who steals the entire case can take it somewhere private and open it with power tools, so a fancier lock won't help. But the case is stout enough that I can dance on it.

I added threaded inserts to the case bottom, for simple rubber feet,

sized to sit on Celestron vibration-damping support pads. Thus I can sit the telescope atop the case when I am working near the horizon, to raise the eyepiece from a rather awkward 40 cm to nearly a meter. That's steady enough for deep-sky work at 106x -- the magnification I found myself using most often -- and surprisingly so, since the case flexes easily. The explanation seems to be that the light finger pressure required to steer a well-balanced Dobson isn't enought to distort the case noticeably.

The vibration damping-pads worked well. I noticed no jiggles when I was observing. Wind-induced vibration is sometimes a problem with telescopes, but when sitting on its case, the 10-inch showed no wind-induced vibration at the eyepiece, even at wind speeds sufficiently high that I had to keep a hand on the telescope to keep it from turning like a weather vane.

13. Spare Parts and Supplies.

When I am putting something together away from home base, I can count on finding a crack in the earth that goes clear to the antipodes, because I am certain to drop into it some fastener the whole project depends on. So my rule about spare small parts is, take 50 percent extra, but never less than two. If the gadget needs one 1/4-20 by two-inch Allen head machine screw, I take that one, plus two spares. If it needs six, I take nine. And so on.

I bring enough tools to get by if I lose one. A "Leatherman" or similar pocket gizmo is a handy backup, but do put it in checked baggage to keep airline security happy. I take stuff like Epoxy and grease, for repairs and maintenance. I have a spare truss pole. And don't forget duct tape, so if the universe breaks down, you can fix it, too.

14. Shake-Down.

I lucked out. The 10-inch Dobson came up smoothly. Everything fit together. The pieces all fit in the case. The focal point was where I intended. The balance was a little tail-heavy with the solid truss poles, but the extra weight of the joints for the cut poles put it dead on. I worked hard to get the telescope ready weeks before traveling, so there would be time for modifications, but none were required.

Yet I learned a lot from the use I had of the telescope, before my first trip. Some of it was relearning the habits of Newtonians: I have made thousands of observations with them, but it has been a long time since I used one extensively. Some of it was familiarization with this particular telescope -- it went together a lot quicker the second time than the first. And some things were useful new ideas, suggested by experience -- the bit about putting feet and vibration dampers under the

case, to use as a stand for working near the horizon, was one such.

Anyhow, after five nights' experience and over a hundred objects logged, I was ready for my first trip south -- to Hawaii.

Reference:

Kriege, David, and Richard Berry, 1997. _The_Dobsonian_Telescope:_ _A_Practical_Manual_for_Building_Large_Aperture_Telescopes_, Willmann-Bell.

THE SADDLE ROAD

The big island of Hawaii is dominated by two massive, 4 Km high volcanos, the long ridge of Mauna Loa to the south and the rounder summit of Mauna Kea to the north. Hawaii state route 200, the "Saddle Road", traverses the broad, 2 Km high saddle between the two great peaks, from Hilo, on the eastern part of the island, to state route 190, near the northwest coast. At milepost 28, 45 Km west of Hilo, begins the side road that leads north and up to the Onizuka Visitor Center, at an elevation of 2.7 Km, and then beyond, to the Mauna Kea summit itself. These are the routes that astronomically minded visitors to the facilities at Mauna Kea must travel on, and there are things that such visitors should know.

These roads are widely reported to be extremely dangerous. Most car rental companies don't want their vehicles up there -- not even on the Saddle Road, much less at higher places -- and will not honor insurance or provide towing for those locations. I rented from what seemed to be the only agency with no such restrictions -- Harper Truck Rental -- and made the round trip from Hilo to the Visitor Center six times. I hope my report will be useful to other travelers, through I hasten to add that I am by no means an expert on any aspect of vehicles, roads, or driving, and that I did *not* travel on the saddle road west of milepost 28, or on the summit-access road above the Visitor Center.

The good news is, that these roads have been improved recently. A local contact reported that as late as 1999, the eastern Saddle Road was in such sad shape as to be virtually a one-lane road; that is, the pavement edges were so worn that drivers tended to straddle the middle. That is not so any longer. In my opinion, as of mid 2000, the entire route from Hilo to milepost 28, and then to the Visitor Center, had paving, condition, and markings that most Americans would call good to excellent. Shoulders were wide and generous between the periphery of Hilo and milepost 19, but narrower thereafter. The asphalt was new and well maintained. The roads had a yellow centerline of reflective paint,

with reflective raised dots, for all their length, and had edge markings of similar quality for most of the way. Sharp and unexpected curves and dips, and other hazards, were well marked.

The bad news is, that the road is twisty and in places very steep, it goes quite high, and it is subject to occasional hazardous weather conditions. Persons from areas where two-lane roads are generally straight, or flat, or at low elevation, may find themselves in difficulty. It is good two-lane blacktop, but it is first and foremost a twisty mountain road. Specifically, the hazards include:

1) Portions of the grade between milepost 28 and the Visitor Center are as steep as seventeen percent. Wimpy cars may have trouble going up such slopes at high elevation. Drivers not familiar with engine braking may burn their brakes out and kill themselves on the way down.

2) The Saddle Road follows the lay of the land closely, in the manner of a country road built generations ago, with little budget for straightening kinks and dips. Much of the road might appear safe at speeds above the posted 35 and 45 mph, but there are many places where the line of sight suddenly becomes very short, as the road approaches a dip in the landscape or the top of a hill. If you cross the crest at speed and find livestock or a vehicle in the way, you are in difficulty. Similarly, there are many places where a long, straight stretch, that tempts one to high speed, terminates suddenly, in a bend that requires a speed reduction of 20 miles per hour or more. These changes are often unexpected, for the road crosses country that is generally very open and is in great part treeless.

3) Portions of the road from milepost 28 to the Visitor Center have what mountain drivers euphemistically call "low shoulders". If you somehow find yourself beyond the guard rail, your vehicle may bounce and roll the next thousand feet downward, crumpling all the way.

4) Portions of the Saddle Road run through lava fields whose upper surface is rough and jagged on a scale from tens of centimeters to several meters, and in general, these portions have no shoulders at all. If you stray even a meter from the edge of the road, your vehicle may suffer immediate and enormous damage to tires and undercarriage.

5) Many local drivers travel these roads at breakneck speeds.

6) The Saddle Road is subject to frequent cloud, rain, drizzle, and upslope fog, particularly at night. What is happening is that the trade winds, blowing from the east, lift the hot, wet, oceanic air mass up the shallow slopes of the saddle, and moisture condenses out of it as it rises and cools. The effect strengthens as the night wears on and the compensating heat of the day diminishes.

7) Higher portions of these roads are subject to snow, ice, and strong winds in winter. I didn't encounter any, but there were plenty of images at the Visitor Center.

8) Portions of the road travel through open range. Livestock gets on the road occasionally, and some local cattle are uniformly dark in color. The reflective paint and reflective dots give the impression that you can see the road far ahead at night, but a black animal against black asphalt might be very difficult to spot until you were almost on top of it, the more so in fog or rain. Signs at the Visitor Center warn of invisible cows -- that's what they are talking about.

9) The roads are lonely. A breakdown at night might leave you ten miles from the nearest 'phone and an hour from the next passing car.

West-coast American amateur astronomers may find some comparisons useful: The roads described are generally comparable to, or a little better than, the main road through Lassen National Park (though some portions have narrower shoulders or are steeper than the road through Lassen). The roads described are much wider and lots less twisty than the upper half of the access road from San Juan Bautista, California, to Fremont Peak State Park, or the upper half of the road from Morgan Hill, California, to Henry Coe State Park.

Harper would not rent any lesser conveyance than a four-wheel-drive sport-utility vehicle for access to the mountains. That was overkill: On the basis of experience in the Sierra Nevada, I am sure I could have gotten up and back in my 1989 Geo Metro safely. Yet I would have had to be careful and cautious in the Geo, and would have had to take my time ascending and descending the steeper slopes. Their vehicle was also expensive -- Harper charged $100 a day for a 1999 Isuzu Rodeo, and that did not include gasoline or insurance.

Anyhow, I did not have any trouble with vehicle access to the Visitor Center. I hope my remarks help you have the same experience, but remember -- as I said before -- my remarks do not apply to the Saddle Road west of milepost 28, or to the summit access road above the Visitor Center.

THE OBSERVATORY PELE BUILT

I won't say much about the aesthetics of the big island of Hawaii, because this is supposed to be an astronomical report. However, a few impressions forced their way into my one-track mind.

First, the geology is gorgeous, and it is dominated by volcanic processes -- Pele, the Hawaiian goddess of volcanos makes her home in Kilauea crater, and modern geology tells us that she not only lives there but also built the entire island chain, all the way to Midway and the seamounts beyond. My first view of Hawaii, inbound on an Aloha Boeing 737, reminded me that the island volcanos have vast areas and shallow slopes; they are not the steep, conical peaks that one finds elsewhere in the world. On one late afternoon drive up the Saddle Road, I passed out from under the trade wind clouds at about 1.5 Km elevation, to find the sky above completely clear. The dark loom of Mauna Loa lay to the south, like some giant rorqual sculpted in lava, gently lifting its broad back above an ocean of cloud. Ruddy Mauna Kea, to the north, was a little more symmetrically rounded in shape, though flanked by many cinder cones. The road seemed gently cradled between the vast swell of these two mammoth mountains. Both appeared very near, because of the clear air and smooth, treeless plain that sloped up to their sides.

The drive up took me through a wide variety of biomes and climatic zones. Hilo is one of the rainiest cities in the United States, with over three meters of precipitation a year, mostly at night. Where unmodified by humans, the lowlands accordingly tend toward dense forest, not quite jungle, but certainly lush and green. The daytime temperature is hot, and the humidity is high. Further up, the trees thin out, not only because of declining temperature and humidity, but also because the Saddle Road passes over successive lava flows, recent enough in terms of the lifetime of a forest so that there has not been time to break the rock down uniformly into soil and to establish climax vegetation. Nearing the crest of the saddle, the flows are so fresh that there is little vegetation at all, just the rough-surfaced lava that the Hawaiians call a'a, with jagged lumps and protrusions in all sizes from boulders on down. If we ever terraform Mars or the Moon, parts of it will look like this during the process.

Near the start of the side road to the Mauna Kea summit, the young lava flows end, and suddenly it's the wild, wild west, with free-roaming cattle cropping scraggly grass from an open, rolling countryside that reminded me of the Dakotas. Most people don't think of Hawaii when they think of cowboys, but this is a land of vast ranches and large herds of livestock. Cattle guards in the road confine the animals below the steep part of the summit, but I don't know why a cow would want to go there anyway, for the pickings on this increasingly rocky and alpine habitat become rapidly slimmer with height. By the altitude of the Visitor's Center, the vegetation looks like chaparral that is just a little too dry and too cold to be making it. On the higher slopes above, the only living things I could see were astronomers, and you find them so regularly in so many odd habitats that I am not sure they count.

The view back across the saddle from the Visitor Center is an even

grander vista than that from lower elevation, for the eye can begin to see down the side of the mountains toward where the ocean would be, if it were not for the sea of cloud. The shadows of the mountains stretch visibly across the haze as the sun sets. The site of the active eruption of Kilauea crater is within line of sight. It is not obvious, but at night, binoculars reveal a flicker of its orangy-white light.

Some of the very small things impressed me as well. The taxiways at Hilo's airport are lined with closely-spaced floral bushes -- I think they were hibiscus -- in a vast variety of colors. What fun it was to see all the familiar ecological niches for birds, filled with birds that were totally unfamiliar! There were birds that acted like robins, and that showed up in habitats where you would expect a robin, but they were not robins, and similarly for rock doves (common "pigeons").

For all the experience I have star-hopping, I surprised myself one day when I went out looking for lunch and couldn't find the Sun. It wasn't very cloudy, and I wanted to orient myself by determining directions in a general sort of way, from the time of day and the position of the Sun. Yet there were no shadows to be seen. The problem was simple: Hawaii is indeed in the tropics, and at the time of year of my visit, the noonday sun was just about straight up.

THE VISITOR CENTER

Yet it was not for terrestrial aesthetics that I came to Hawaii. What prompted my expedition was the chance discovery, through conversation with friends, that there is well supported site high on the southern slope of Mauna Kea where amateur astronomers may set up at will for as long as they like. That is the Onizuka Center for International Astronomy Visitor Information Station, or the Visitor Center, for short. They have a web site, at http://www.ifa.hawaii.edu/info/vis/. This facility, at about the 2.7 Km level on the road up to the summit observatories, provides tourists with programs, interpretive and hands-on science, and rest and comfort facilities seven days a week, with a strong emphasis on astronomy. The small, newly-constructed building has static displays, videos, and computer-controlled sequences of images. Its tiny gift shop is well-stocked with souvenirs and beginning astronomy stuff. Even the goodies have an astronomical theme -- there are Mars bars, three kinds of Milky Way, packages of Starburst candies, and astronaut-style freeze-dried ice cream. And for *real* astronomers, there are big pots of piping hot water, with instant coffee and hot chocolate right at hand.

The Visitor Center is well equipped for public astronomy. They have at least four telescopes -- a Meade 16-inch LX200 on its stock mounting,

a Celestron 14 on an Astro-Physics 1200, a Celestron C-11 on a Losmandy G-11, and a commercial six-inch Dobson. The three larger instruments are all set up for wheel-out on castered feet or platforms, and when they reach their pre-marked positions on the concrete patio, a quick turn of jackscrews with an electric drill fixes them more rigidly in place for an evening's observing. These instruments are set up for public observing every night to 10 PM, weather permitting, and knowledgeable staff and volunteers put on a fine show. The patio is well located and well designed, on the lee (west) side of the building, with a superb view of the south horizon.

It was interesting to hear comments about how such familiar telescopes performed in heavy-duty service. The Meade was said to have serious optical problems -- astigmatism on axis, that could not be traced to diagonal or eyepieces -- and to be given to electronic glitches as well. The placard on this instrument indicates that it is in part a donation from Meade. I hope the manufacturer has sense enough to see that it gets fixed, considering that thousands of people a year encounter the problems. The Celestrons were more highly regarded, and I heard considerable praise for the Astro-Physics mount.

There are also two sturdy piers bolted to the patio, bearing permanent wedges set for polar alignment, each drilled with bolt patterns for the drive bases of all the popular small to medium Schmidt-Cassegrains. I believe that Celestrons through at least 9.25-inch will fit these piers, and Meades through at least 10-inch. Any other telescope with a flat plate extending beyond its drive base could probably be made to work with a couple of stout C-clamps.

After the end of the public show, the building is often open for an hour or more, to put the telescopes to bed and wrap up the administrivia of the day. Stragglers can duck inside to get warm or refill their hot beverage cups. When the staff finally locks the doors, they don't lock all of them -- the bathrooms stay open 24 hours. They have red internal lighting, and electrical power sockets where you may plug in your portable coffee heater, if you have had the foresight to bring it. The heat is off in the building at night, but the structure has considerable thermal mass, so it stays warm for a long, long time, and besides, the bathrooms are out of the wind.

If you should encounter a real emergency, there are other humans at hand. The dormitory for technicians and users of the summit observatories is only a few hundred meters away. Casual visitors are not allowed, but I am sure they would not turn away anyone who was sick or injured. That building's lights are well shielded, but if those lights, or the red glow from the bathrooms, are too much for you, there are stubby side roads a few tens of meters down the access road where you may set up outside the line of sight to any light except the stars.

There are external power plugs on the side of the building facing the set-up patio. Bring your extension cord, and don't forget a DC adaptor, if your telescope cannot accept line voltage directly. If there are a lot of you, you may need some octopus-outlet fittings as well. The patio has a telephone, and also an external switch to the parking lot lights, which of course were off for the public viewing. The staff will ask you to turn them back on when you leave, assuming it isn't dawn already. The parking lot holds some twenty cars, and portions of it are also well suited for setting up telescopes, in case you would like to peer far to the south, beyond the hip-high retaining wall at the edge of the patio. Using both patio and parking lot, the facility could probably accommodate twelve to fifteen fair-sized amateur telescopes, plus the cars of the folks who brought them. (I am not saying that it would be a good thing to cram it full, just trying to describe its size.)

The sky is as dark as you would expect at 2.7 Km in the middle of an ocean. I could not see any light domes from anything, anywhere. Horizons are good except to the north, where Polaris barely clears the summit of Mauna Kea, and with the caveat that you may wish to choose which side of the building to set up on, depending on how cold your blood is and how interested you are in the southeastern sky: The easterly trade winds are cold by the time they reach the mountain side. The seeing is said to be good, as well, though I did not use more than 106x on my 10-inch Dobson anyway, so the fact that it didn't bother me doesn't say much.

Those horizons are something else. The Visitor Center lies between 19 and 20 degrees north latitude, which means that in the absence of atmospheric refraction, the sea-level horizon would allow objects at 70 or 71 degrees south declination just barely to rise. Refraction and elevation work in your favor, but Mauna Loa blocks the oceans. Anyway, I was working serious deep-sky objects at 65 south declination, and could see alpha Musca, more than 69 degrees south, with the naked eye. The latitude, darkness, and transparency allow viewing of the entire southern Milky Way -- eta Carina, Crux, the Coal Sack, the Jewel Box, and all the other galactic clusters and nebulosity that you have heard about. The Clouds of Magellan are too far south, though perhaps the northern extremity of the Large Cloud could barely be detected in the absolute best of circumstances. Unfortunately for me, late spring is the wrong season to do so.

Local amateur astronomers know of this site and use it well. During each of the six nights I was there, there was at least one Hawaiian observer present. Yet this location seems little heard of on the mainland. It ought to be much better known. The ancient Greeks thought that the Muse of Astronomy was Urania. Yet I think that a better

candidate for our patron diety is Pele. The summit facilities on Mauna Kea are widely regarded as the best professional observatory in the world, and the Onizuka Visitor Center may well be the best site for doing amateur astronomy on Earth.

PREPARING TO TRAVEL

It would be sad to be on Mauna Kea and not know what to look at, so I made an observing plan. For years, my deep-sky program drew from Burnham's _Celestial_Handbook_, but I had found all the listed galaxies, star clusters, and nebulae to 45 degrees south declination, and a few beyond. This trip allowed extending that survey almost twenty degrees in declination, for over half way around the sky. So I copied the Burnham deep-sky lists for southern constellations, and marked what I had not seen. I added other objects of interest, such as Proxima Centauri, and made lists for facing pages of _Millennium_Star_Atlas_, showing which objects were on which charts.

There are not many Burnham objects in that strip of sky, so I added NGC and IC objects from _Millennium_. I cross-checked other sources, such as the lists of open and globular clusters in volume II of _Sky_Catalogue_2000.0_, to be sure I had not omitted any bright object.

In case I had spare time, I made a similar series of chart-by-chart lists for fainter objects -- mostly ESO galaxies -- drawn from selected areas that had many. That series extended north of 45 degrees south declination, because I cannot work faint objects as close to the horizon as the brighter stuff in Burnham, so I have seen few of these targets from California. When all was done, my lists included about 700 objects, which I deliberately intended to be more than I could look at.

Millennium is my favorite observing atlas, but it's awfully heavy. With trepidation only partly relieved by the prospect of more travels in the future, I cut mine up with a hobbyist knife, so I could take just the charts I needed. I would have needed two _Millennium_ volumes otherwise. The hack job saved eight pounds of weight, and nearly the whole bulk of those two volumes. I had visions of the wind blowing my loose charts to Japan, so I added a few "Bulldog" clips to my kit, to keep them under control. And I ordered a replacement _Millennium_.

I brought all the Email I had exchanged with Hawaiian amateurs, and also pages printed from the U. S. Naval Observatory web site, showing times of Sun and Moon rise and set for when I would be there.

To these materials, I added most of my regular observing kit -- a medium-thick attache case with an old Norton's _Star_Atlas_, a copy of

_NGC_2000.0_, the current Royal Astronomical Society of Canada _Observer's_Handbook_, my current logbook, red flashlights, and a handful of gadgets and doodads. I also took a full set of Brandon 1.25-inch eyepieces. All this went in one carry-on bag -- the one I use for my observing kit on the mainland. The only thing I brought that I didn't need was all those eyepieces. I had six -- my Brandon kit includes a very old 6 mm -- but I only used the 12 mm.

I knew I would need heavy clothes. I hand carried a down vest and wide-brimmed hat, and stuffed my luggage with sweat shirt, windbreaker, down gloves, ushanka, and a stack of one-shot catalytic hand warmers. These are non-flammable, non-toxic, non-corrosive, and non-oxidizing, and they only get about as hot as a cup of coffee, so they are not a concern aboard airliners.

Did I mention coffee? I took one of the tiny 120V hot water heaters that can heat water in a hotel drinking glass, plus a twelve-volt hot pot about the size of a medium thermos bottle, for boiling water in a car. If I had known that the Onizuka Visitor Center had 120V available 24 hours a day, I could have skipped the hot pot, but it was handy even so -- the 10-inch's diagonal assembly traveled inside it, wrapped in tissue and bubble-wrap. And I took a large supply of good instant coffee. I let someone at the Visitor Center borrow it to make some, but said I would come looking for him if he didn't bring it back. Jeeze, I can remember when "Columbian" meant marijuana...

My second piece of hand-carry luggage was an Orion 14x70 binocular in its case. The rest of my travel kit was the usual clothes, toilet articles, and so on. I swapped heavy parts and fasteners from the telescope case with lighter stuff from my second checked suitcase, to reduce the weight of the loaded telescope case.

I packed everything a week early, so I would have time to notice or remember things I should have packed. I only found a few, and nothing turned up forgotten when I was in Hawaii.

I bought a few things in Hilo, such as snacks and instant foods to eat on the mountain, and note cards for indexing my observations. With hindsight, I would have bought coffee on location, too -- Hawaii's excellent Kona was widely available. I also sent a box of stuff home by postal service before I returned. It might have been cheaper as excess luggage, but at the cost of more hassle at the airport. I sent dirty clothes, souvenirs, Hawaii travel books, and such heavy telescope stuff as I could easily replace from hardware stores. (I took the 10-inch apart the day before I left, and used the 14x70 the last evening.)

Early on May 28, I drove to San Francisco Airport, heaved my luggage onto the long-term parking shuttle bus, and manhandled it into the

United terminal area. United had no problem with the size or weight of my telescope case. In fact, it provided a benefit: United staff waved me around the line of passengers waiting to check in, to a special station with a sign for odd-sized baggage. Behind the counter they had a big door and conveyor belt for things like surf boards and bicycles. My baggage was not oversize, but it sure was odd. The 747 didn't seem too heavy on takeoff, so I guess it was okay. I dozed on the flight to Honolulu, but spent the shorter leg to Hilo peering out the window of the Aloha 737, trying to decide whether the scud left over from a recent low was going to dissipate by evening.

OBSERVING -- MAY 28/29, 2000

I picked up my rental car, found the hotel, and checked in. I unpacked the 10-inch Dobson and assembled it, all quickly and uneventfully. I rested a bit, then loaded the car, found the lower end of the Saddle Road, and started the long climb to the observing site.

I arrived at the Onizuka Visitor Center to find that I had brought the curse of the new telescope with me: Broken cloud crossed the sky, and not the whole sky, either, just the far southern part, that I had not already seen from California. It wasn't actually that bad, and it was a very long way home, so I set up anyway. The sky darkened as I fussed with collimation. All done, I rose, stretched, and turned around -- and there was the Southern Cross, clearly visible through gaps in the clouds, straight up and down over Mauna Loa, beyond the far horizon. I should have brought Crosby, Stills, and Nash for background music. To its right, a vast glow marked the eta Carina nebula. I took a few steps to the side, so I could look to the east, past the windbreak of the Visitor Center building, and there were alpha and beta Centauri, shining brilliantly and unmistakably. Yeehah!! Here I am! I made it!

The clouds did not not render observing impossible, but trying to find objects through sucker holes with an undriven telescope is sometimes slow, so I didn't get a whole lot done that evening. Notwithstanding, just that one night would have been astronomically memorable, for good views of several of the showpiece objects of the southern Milky Way, as well as of the Milky Way itself.

The Visitor Center's Meade 16-inch LX200 was working well -- it did not do so always -- and I had a nice view of the eta Carina complex though it at about 160x. This vast nebular region, made disturbed and fluorescent by the incredible powerhouse of a star that provides its name, is richly detailed and fascinating, with numerous dark streamers and variations in brightness everywhere. It is larger and brighter than the Orion Nebula. I wish I had had enough artistic skill to make a

drawing. I kept coming back to it again and again, during my visit.

The 16-inch was also directed to NGC 6543 at one point. I took a look at this northerly object, again at 160x. It showed an elongated blue ring, with a central star and hints of more detail. It would have been interesting to increase magnification, but there was a line of visitors, and the optics of the big LX200 were said to be faulty.

The Center's Celestron 14 had omega Centauri in a 71x field. This enormous globular -- or is it the nucleus of a galaxy long since devoured by the Milky Way? -- is visible from central California sites with good southern horizons. Even from there it is a naked-eye object and the best globular in the sky, so viewing it was not so much seeing something new as discovering how much better it was when high in the sky. It was in fact noticeably better than I had previously seen it, but not vastly so -- a tribute to the fact that our coastal California sites sometimes have very clear air when the flow is off the Pacific and conditions are warm enough to deter condensation. Notwithstanding, you who are too far north to see this mammoth cluster are missing something. Omega Centauri makes M13 in Hercules look puny and pitiable.

In my own 10-inch, I viewed and resolved the wide double stars alpha Centauri and alpha Crucis, and spent a while staring at NGC 4755, better known as kappa Crucis or the Jewel Box. This open cluster is neither as large nor as bright as the Pleiades or the Beehive -- it is about as bright as either member of the Double Cluster -- but it is remarkable for several reasons. First, it is very sharply defined, seeming much more to have "edges" than do many of its kin; that is, the density of stars visible in an amateur-sized telescope falls rapidly at the boundaries of the cluster, rather than slowly. Second, it is densely packed with relatively bright stars. Third, many of its stars show colors. These qualities make the Jewel Box very dramatic -- its visual impact is similar to that of a bright, colorful binary, such as Albireo or Izar, but with dozens or scores of noteworthy stars, instead of just a few.

Increasing clouds made the southern sky more and more difficult to view -- sucker holes are hard to use when you are looking through them obliquely. So after an hour or two of chasing less magnificent objects, that lay higher in the sky, I called it a night with only nineteen things viewed. At least I had a chance to get caught up on my rest for the remainder of the week to come.

On the bright side for the evening, the 10-inch worked well. I had hoped it might, as it had had several night's shakedown on the mainland, but there is always the nagging worry about missed problems with a new telescope. Furthermore, notwithstanding the recent low passage, temperatures and wind chill were bearable. They were nicer than, say,

the Bumpas Hell parking lot at Lassen National Park in mid summer, which is almost as high but much farther north. And the people, Visitor Center Staff and local amateurs alike, were all friendly and helpful. I shall keep my internet habit, of not naming folks with thousands of dollars worth of telescopes in their living rooms and garages, but _mahalo_ and _aloha_ to you all -- and you know who you are.

On the next day I slept late, explored Hilo a bit, then rendezvoused with some amateur astronomers I had met over the internet for a meal. In late afternoon, as we started up the Saddle Road once again, rain began to fall with increasing ferocity.

OBSERVING -- MAY 29/30, 2000

The heavy tropical rainfall was dismaying, but our determined little convoy climbed the Saddle Road, windshield wipers flicking boldly. We eventually reached cloud base, and though enough daytime heat remained in the lava to keep visibility up at the surface, large drops falling from close, gray sky suggested a poor evening for astronomy. Yet as the terrain leveled off, we scooted out from under the clouds, and what do you know? The sky was and clear, and the sun was shining. Bits of cloud spilling onto the saddle from the east tickled the two mammoth volcanos, but most of the heavens were a deep, pellucid blue.

Weather on the east side of the big island resembles the marine layer of the central California coast, with two differences. First, the prevailing trade winds in Hawaii are out of the east. Second, the vertical scale is about five times as great. The top of the layer is nearly 2 Km above sea level, which makes the clouds thick enough to deliver considerable precipitation. Hilo averages over three meters of rain a year, most of it from late afternoon till dawn. At that time, the heat of the day has diminished, and no longer counteracts condensation as the wet air mass flows upslope between the volcanos.

A strong temperature inversion defines the top of the layer. Clouds above are extremely rare. They occur for the most part only when there is a weather system in the area. But trade-wind showers are the daily fare of eastern Hawaii -- there was always at least some rain on the drive up the Saddle Road in late afternoon or early evening, and lots more coming down in the small hours of the morn. Yet for the rest of my visit, the night sky at the Visitor Center remained clear, dark, and dry. The lower clouds even helped: Hilo generally uses full cutoff outdoor lighting, but a mile of wet stuff reduced the light still further. I saw no light domes from Mauna Kea.

My friends' elderly Toyota subcompact slowed to nearly a crawl on

the seventeen-percent grades of the last few miles before the Visitor Center, but we finally made it. The first task was a photo session. I had bought a tacky plastic lei, made in China, with colors carefully selected to match nothing else in my possession. We got several photos of me standing beside my 10-inch Dobson, wearing lei, sunglasses, many disorganized layers of warm clothes, down-filled gloves, and my decrepit furry Russian infantryman's hat with its ear flaps turned haphazardly down. The definitive images have trash and recycling barrels in the background -- they were out of the wind, so I used them as chart tables.

My lists of objects started far west of Crux, in Carina and Vela, including many targets setting in twilight. Thus the night's observing followed a pattern familiar to Messier marathon fans and other deep-sky die-hards: Manic observing early, as I chased stuff in the southwest before it went away, followed by a more relaxing time of it later on. My lists were intentionally optimistic as to how far west I could work, since I wasn't sure when twilight ended, or how low the southwest horizon was. Even for areas I could get to, there was more stuff than I could see in an evening, so the mania persisted for several nights.

My planning and list-making paid off, though. Even in sky I had never seen before, star-hopping was easy. I would scan naked-eye to identify some bright star that was on the _Millennium_Star_Atlas_ chart of the moment, get it in the finder and then in the main telescope, and star hop from there. I worked one facing pair of _Millennium_ charts from west to east, then turned a page over and continued eastward. It was rare that I had to use the finder, though some times it was faster and easier to do so, than to star-hop a long distance with an actual field of view, in my 12 mm Brandon at 106x, of less than half a degree. That Brandon was the only eyepiece I used with the 10-inch during the entire trip. If I omit to mention magnification again, assume 106x.

Most objects I was seeking in that part of the sky were open clusters, with a few planetaries or other nebulae for variety. Central Vela is as far from the bearing of the center of our galaxy as is central Cygnus, only in the opposite direction, so it would not be surprising to find the Milky Way from Vela through Carina, Crux, and Centaurus approximately as rich as the sweep from Deneb down through the Aquila, which is more familiar to northern observers.

In fact, as far as galactic clusters go, southern observers have rather the advantage, for this part of the Milky way seems to contain more bright clusters -- things that look like M6 and M7 -- than does the opposite, northern sector. I am reluctant to write a shopping-list observing report -- you can get dimensions, magnitudes, and star counts from any number of atlases and catalogs, and my exclamations of awe and wonder will not have the nearly the impact of your own, when you see these objects first-hand. Nevertheless, let me mention a few

highlights, though by no means all of them.

NGC 3532 is a large open cluster a few degrees east and a little north of the eta Carina complex. At a glance in the 10-inch's 6x30 finder, or with the naked eye, it was possible to confuse the two for a moment. _NGC_2000.0_ gives it a magnitude of 3 and a diameter of nearly a degree. Its scattering of stars seems homogeneously distributed across its width, and does not contain any that seem anomalously bright. NGC 7789 might look like this if it were three or four times closer, with each of its individual stars ten or twenty times greater in apparent brightness. The stars were bright enough that the cluster was well resolved in my 14x70 binocular, as well as in the telescope.

About five degrees south of eta Carina lies IC 2602, the Southern Pleiades, an even brighter cluster -- magnitude 1.9 -- with a very different character. It doesn't look like its namesake in detail, but bears a resemblance in number and distribution of members. Grouped around theta Carinae are a coarse handful of fairly bright stars, with additional fainter ones as background, but not in such quantity as to dominate the cluster. The northern Pleiades might well look this way if they were a little farther off, and were viewed from an unfamiliar angle. At 64d 20' south declination, IC 2602 was one of the most southerly deep-sky objects I observed, so far south that I could not easily see it from any of the locations where I set up my telescope. My observation was with my 14x70, for which it is a fine object.

NGC 3114, in Carina, is a bit more than five degrees west of eta. It is interim in character between the last two clusters mentioned, though not as large or as bright. The 10-inch resolved it, and I suspect the binocular would have as well, though I did not get around to using the 14x70 on this object

NGC 3766 is a cluster in Centaurus, about a degree and a half north of lambda. It contains a quite dense knot of stars about ten arc minutes across. The 10-inch resolved it.

NGC 5662, in eastern Centaurus, is not as southerly. It is five degrees north of Beta Centauri, and a bit west. At magnitude 5.5, it is no doubt a naked-eye object, and my failure to notice it, as well as many others, follows from the fact that I am nearsighted, and spend most of my time at star parties with my glasses safely squirreled in the car, while I experience the restricted limiting magnitude that comes from having all the stars greatly out of focus. This fairly loose small cluster was pretty in the 10-inch, and was granular to resolved in the big binocular later in the week.

After a few hours' observing, I found that there was nothing I wanted to look at that was about to set on me, so I lowered my telescope

from its carrying-case stand and took a break from sweeping the southern horizons. I decided to look at some Messier objects, not only because a Messier survey is something I do with most telescopes and binoculars I possess, but also as a way of evaluating both site and southern objects against a familiar yardstick.

These views confirmed what I already knew about Mauna Kea -- it is a wonderful place. The Trifid Nebula shown resplendent in clear nursery colors, pale pastel pink in the ionized-gas "trifid" part, and soft baby blue in the reflection nebula, looking much like the images in many astronomical coffee-table picture books. M17 showed feathery detail on the body of the swan, and revealed portions of the vast loop of gas that lies beneath. On a later night, M27 appeared as a fat, stubby, blunt-pointed spindle, that might have been a cartoonist's caricature of a cigar -- but the bright cigar band was the familiar apple-core shape, that is all most observers see at lesser sites.

As the heavens rotated, I continued my southern-sky survey eastward, into Norma, Ara, and a corner of Pavo, picking off objects as they cleared the south horizon. Perhaps the best showpiece object for the remainder of the evening was the beautiful globular cluster NGC 6752, a hair shy of 60 degrees south, in northern Pavo. This cluster is larger and a half magnitude brighter than M13, though it is nowhere near as fine an object as omega Centauri. NGC 6752 appeared granular to resolved in the 10-inch, at 106x.

By 2:30 AM I was beginning to be very tired. My biological clock was only just unsetting from a place where dawn was breaking -- so I packed the telescope and drove back to Hilo. I had looked at 148 objects that night, 123 of which I had never seen before. Not bad, and four nights still to go.

OBSERVING -- MAY 30/31, 2000

Many northern amateurs do not know where the southern constellations are and how they fit together. Crux is about the size of Corvus, and lies south of it by a bit more than the width of two handspans, with fingers stretched apart, at arm's length. Huge Centaurus envelopes Crux to the west, east, and north: Maps with pictures for the constellations show the Southern Cross as road kill under the Centaur's great hooves.

With Crux on the meridian, Carina and Vela are off to its right. The eta Carina complex sits a handspan out. Brilliant alpha and beta Centauri lie a handspan left of Crux, and dominate the sky there.

Above left of Centaurus is the motley strew of bright stars that

define Lupus, the wolf. A sliver of Circinus fits just east of Alpha Centauri. East of that lies nondescript Norma, well south of Antares. Then comes Ara -- beta, gamma, and zeta Arae form a prominent, long, narrow triangle, pointing west, below the fishhook of Scorpius by about the width of a fist at arm's length. The whole constellation is much larger.

Telescopium is next, with few bright stars. It begins below Corona Australis, which in turn lies below the teapot of Sagittarius, and ends south of the west end of Capricornus. Beside its southeastern corner shines bright alpha Pavonis, the Peacock Star, drawing emphasis and dramatic enhancement from its solitude, like Fomalhaut. Pavo extends far south from Telescopium.

Indus is east of Telescopium. Alpha Indi is fairly bright, a third of the way from alpha Pavonis to southern Capricornus, south of Microscopium. East of Indus lies southern Grus, and that is as far as my survey went.

A few more southerly constellations peeped over Mauna Loa during my evenings in Hawaii. I saw objects in Musca, south and east of Crux, and in Triangulum Australe, south of Norma. But on the third night of my expedition, I observed many objects that were comfortably above the south horizon; I had logged enough of those that were about to set, that I did not have to spend all my time scrambling after them.

I reviewed omega Centauri in the ten-inch. It was just as wonderful as it had been in the Visitor Center's C-14, showing many resolved stars against a granular background. Further north, I checked NGC 5128, the Centaurus A radio source. This mysterious galaxy well showed the broad, dark band that crosses it. I could begin to see feathery detail or scalloping at the band's edges. But my best views of this object had been with larger telescopes at mainland sites, so I moved on.

NGC 4945 lies about four degrees west of omega Centauri, in the middle of a triangle formed by xi-1, xi-2, and f Centauri. It is just a bit too far south to observe conveniently from central California. This galaxy is luminous and large -- some 20 by 4 arc-minutes in size, with a photographic magnitude in the mid 9s. At 106x it appeared essentially featureless, just a smooth smear of low surface brightness across the eyepiece field. I had hoped for something as rich in detail as NGC 3109 in Hydra, but no such luck. The same page of _Millennium_Star_Atlas_ shows many field galaxies, from the NGC, IC, and ESO catalogs, and since I was in the neighborhood, I spent a while chasing them. Particularly challenging were NGC 4945A and ESO 219-14, both small, and both hiding in the glare of closely adjacent 9th magnitude stars. The 10-inch seemed almost as capable with faint fuzzies as Harvey, my Celestron 14. Some of its ability no doubt stemmed from the dark and transparent sky

of Mauna Kea, but perhaps it is time to have my C-14 recoated.

Omega Centauri itself has many field galaxies nearby. They were easy to find: When I got lost, it was the work of a moment to sweep back to the giant globular and resume star hopping from it. One of these galaxies, ESO 270-17, is a high aspect-ratio edge-on, which is also called the Fourcade-Figueroa Object. A ragged line of tenth-magnitude foreground stars is superimposed on its long streak.

About seven degrees east of omega Centauri is a pretty small open cluster, NGC 5460, which contains two clumps of stars separated north/south. A degree and a half beyond it, almost to the Lupus border, is a small but relatively high surface-brightness NGC galaxy, NGC 5516, nearly superimposed upon ESO 221-34A, a larger galaxy with much lower surface brightness. I doubt I would have noticed the second galaxy if it had not been marked on my charts.

I looked at a few planetary nebulae in Centaurus, as well. NGC 3918, the Blue Planetary, was indeed blue. Notes in Burnham suggest it is rather like Uranus, but I might have said Neptune on grounds of color, and a bloated Neptune at that, for this object is much larger in angular size than either planet. I didn't see any detail at 106x.

PK 290+7.1 was oval, with a brightening at the center which made me note "central star suspected". Yet Steven Hynes's excellent book, _Planetary_Nebula_ (Willmann-Bell, 1991) does not list one, so I was presumably seeing a structural feature of the nebulosity itself. I should have put on some more magnification, but I was lazy.

I took a break from observing southerly targets to view a few more Messier objects, then resumed my program, starting to working eastward as the night progressed. But I was beginning to think about strategy for the rest of the week. I had a good many things to look at that would not be well placed until shortly before dawn, and to stay wide awake and efficient for an all-nighter might require catching up on sleep in advance. So I quit early, not long after midnight, with only 110 objects logged for the evening. Tomorrow would be a busy night.

OBSERVING -- MAY 31 / JUNE 1, 2000

Jet lag and an hour's drive to my hotel room made the prospect of an all-nighter daunting, but I got as much sleep as possible, ate a good meal, and drove to the Visitor Center. I had nearly finished my primary target list for objects visible in early evening, so I worked on my secondary list a while, chasing more ESO galaxies in Centaurus. I also chatted with staff and regulars -- I intended to return, and wanted to

learn how operations and weather varied from season to season.

I took the opportunity to push the southerly limit of my main list, as well. As Musca crossed the meridian, I logged three of its open clusters as granular to resolved -- NGC 4463, NGC 4815, and Ru 107.

I reviewed some southerly objects I had already seen. Kappa Crucis -- the Jewel Box -- was just as pretty as on nights before. Alpha Centauri split neatly; it is comparable in visual impact to Mizar, but much brighter.

The lion's share of the night's program began in Norma and continued east. After the Visitor Center staff had closed down and gone home, I moved my telescope to the north side of the parking lot, where I could see the southeastern horizon to the left of the building, so I could find objects not long after they had risen. That position left both me and the telescope exposed to wind. Fortunately, it was warmer than on previous nights, but there was enough breeze at times to swing the Dobson's tube. So I moved the car, parking it just east of the instrument, as a windbreak. The staff had kindly let me borrow a folding metal chair for the night, so I was quite comfortable in my improvised observing station.

Norma and Ara are Milky Way constellations, so most of my targets there were objects in our own galaxy. One showpiece in this area is the complex of emission nebula NGC 6188 and open cluster NGC 6193 in Ara, not far from its corner with Scorpius and Norma. The nebulosity showed well in the 10-inch at 106x, and the cluster has one star that is fifth magnitude. Ara also has some bright globular clusters. NGC 6362 was too far south. NGC 6352, a degree and a half northwest of alpha Arae, was not even granular at 106x, but NGC 6397, four degrees north of the northwest corner of Pavo, was granular to resolved. A pleasant, loose open cluster, IC 4651, lies a degree west of alpha.

Norma has several areas of interest. A very rich star cloud lies at about 16 hours 12 minutes, south 54 degrees. Rich open cluster NGC 6067 is near its center, and a handful of stars that are naked eye, or nearly so, are within a degree or two, and contribute to the brightness of the area. Small globular cluster NGC 5946, just across the border from Lupus, did not even show granularity.

A basic rule for all my observing sessions is, keep warm! When I get cold, my efficiency and enthusiasm rapidly deteriorate. It takes a long time to recover, even if warmth is available. I had plenty of heavy clothing. My layers included sweat shirt, down-filled vest, lined windbreaker, down-filled gloves, and a thick Russian ushanka hat, with broad ear and neck flaps. Early each evening I would open a packet of one-shot catalytic hand-warmers and stuff one into each glove. They

stayed toasty all night. Occasionally I put them temporarily under my hat, or in my pockets. I had enough that I could have tucked warmers into the insteps of my shoes, if my feet had gotten cold.

The Visitor Center bathrooms were red-lit, out of the wind, and always open. The building is well constructed for nocturnal use in cold weather. It has lots of thermal mass, so the interior stayed much warmer than the outside for a long time, even with the heat off. (The building does have heat, it just wasn't working when I was there.)

There were AC sockets in the bathrooms and on the patio, but I kept forgetting to bring up my portable AC water heater, from my hotel room. I did have a 12-volt thermos-sized hot pot, with a similar heating element, that would boil a cup of tap water from the car's 12 volt supply in about fifteen minutes. I stopped observing several times each night, to make instant coffee, instant soup, or something similar. I used the excuse of not draining the battery to run the engine while using the hot pot, and sat in the car with the heater running full blast. What a terrible shame I forgot the AC water heater... (The battery would likely have stood several such uses -- the hot pot draws only about ten amps.) I also had granola and breakfast bars to munch.

Beyond Ara lie Telescopium, Pavo, Indus, and Grus. This is for the most part galaxy country, not as rich as Virgo or Coma Bernices, but with plenty of lumpy darkness for fans of such things. I previously mentioned the great globular cluster NGC 6752 in Pavo, but beyond that I have no truly spectacular objects to report for these constellations. My operations for the rest of the night consisted of sessions at the telescope, observing what had just risen, interrupted by snacks, coffee breaks, and intervals of warming up.

Getting out of the car after one of the latter, I noticed the eastern sky lightening, and panicked for a few minutes, thinking dawn was sneaking up. But it was merely morning zodiacal light. There were still a couple of hours to go. The eastern horizon was lower and clearer than in most sites I use, and I was wonderfully dark adapted, so the apparition truly and deceptively lived up to its occasional common name, "false dawn".

I kept observing. As galaxies lifted above the far horizon I pushed onward, even when there were a few in the current sector of sky that I had not yet seen. This plan worked well, for when I reached the eastern limit of my survey, true dawn was beginning, and though there were objects on my list that I had not yet spotted, they all lay farther west. I would not have to stay up quite so late on the following evening, to see them.

It scarcely seemed necessary to turn the parking lot lights back on

before I left, but that was the rule, so I did. As I drove down the Saddle Road, into the layer of puffy trade-wind cloud, the sky turned slowly blue. Finally, the rims of the stratocumulus ahead suddenly brightened with the first rays of direct sun. I had logged 128 objects, and my main observing program was almost finished.

OBSERVING -- JUNE 1/2, 2000

I slept as late as I could. After I got going, I bought dinner for the friends who had done the same for me earlier in the week. My list of early-evening objects was cleaned out, so we had time for a leisurely meal. I arrived at the Onizuka Visitor Center late in twilight. For a few hours, I had nothing much to do but chat and look at the sky. Several staff members expressed opinions about the most impressive and spectacular celestial sight visible from Mauna Kea. There was general consensus what that was, and I agreed. The most spectacular cosmic view from Mauna Kea, and the finest deep-sky target I have ever looked at, is our own galaxy, not piecemeal, through telescopes, but as a single object, seen with the naked eye.

I was primed to ponder the view of the Milky Way from southern locations, by the experience of a fellow graduate student years ago. He came home from an observing run on a Chilean mountaintop, where Sagittarius culminates straight up, and couldn't rave enough about the spectacle. I could see what he was talking about from central California, knowing where to look and what to expect. Yet the view from far enough south to see well beyond Scorpius is unmatched: The Milky Way is a classic edge-on spiral, with central bulge and dark lane. In visible wavelengths, it looks rather like M104, but from our close-up, insider's viewpoint here on Earth, it spans the sky, horizon to horizon, and then some.

There are many decent photographs, montages, or synthesized images that show the entire Milky Way, or at least the central portions. My web search turned up several nice ones, including

> http://www.astropix.com/HTML/D_SUM_S/MILKYWAY.HTM
> http://www.nofs.navy.mil/projects/pmm/universe.html
> http://adc.gsfc.nasa.gov/mw/milkyway.html.

There are lots more. Look at one to understand what I saw.

The vast star clouds that obscure the heart of the galaxy are bisected by a straight dark lane, that passes north of the teapot and north of the Greater Sagittarius Star Cloud, then crosses the southern portion of the fishhook of Scorpius. That dark lane bifurcates on both

sides of the galactic center; offshoots extend north of the plane. They begin far to either side, and widen out as they get closer to Scorpius and Ophiuchus. Thus the star clouds there appear framed by two long, moderately narrow "V"s of darkness, whose points lie in northern Aquila and in eastern Centaurus.

Stardust is visible on the galactic north side of the offshoots for much of their length. It defines their northerly boundaries. The northern dark offshoot, the Cygnus Rift, is well-known to northern amateurs. Some of us are car-crazed California kooks disguised as amateur astronomers: We refer to the long, curved streak of Milky Way at its northern boundary as the "Off Ramp". The wide end of the southern offshoot is visible from mid-northern latitudes, west of Scorpius, enough so that some native Americans described the combined complex of all these bright and dark areas as "the hands of Father Sky", but the full symmetry of the pattern is not apparent unless you can see all the way to alpha and beta Centauri.

From a site as dark as Mauna Kea, the vast amounts of dark matter in or near the galactic plane stand out readily against the glow of stars beyond. Most of the naked-eye star clouds located close to the line of sight to the center of the galaxy are relatively nearby. The actual galactic center is highly obscured. One web page I cited shows views in several wavelengths, including some that make it past the dust: They give an entirely different picture, one that is in some sense more realistic. Yet it is dark clouds that provide the specific character of the naked-eye view of our galaxy. The dark lanes themselves are the largest such areas that are clearly defined. The Coal Sack, a big blot at the southeast border of Crux, is probably the most famous cloud, but northern observers should not miss the Pipe Nebula, in southern Ophiuchus. It resembles a conventional smoker's pipe, with the bowl at the east and the stem running east-west. This nebula is about as long as the lid of the teapot of Sagittarius is wide, and is clearly visible to the naked eye from a dark site.

Bright star clouds that lie at least a little away from the direction to the center, are related to the large-scale structure of the galaxy. Most of these clouds appear where our line of sight passes along the axis of a major spiral arm, so that we see many of the bright stars within it. Stand close to a curving hedge row and you can understand this phenomenon. When you look at right angles to the shrubbery, you can perhaps see through it, but the view along the row, looking into it as it bends, is dense with leaves. So it is with stars in the arms. The eye of the knowing observer can ferret out the spiral structure of our home galaxy, even from deep within it.

Other physical features of the galaxy are detectable in the sky, if you know what to look for. The area from Scorpius through Centaurus

contains many blazing suns of early spectral type. These young blue-white giants comprise one, or perhaps several, physically associated groups, located in places where substantial star formation has taken place in relatively recent times. My doctoral thesis research obtained a point measurement of the temperature, density, and velocity vector of the interstellar gas, close to the solar system, but before beginning to experience the local effects of the Sun. When I corrected the observed velocity vector for the motion of the Sun through the local group of stars, the interstellar gas appeared to be flowing outward from that vast collection of young giants. Perhaps past supernovae among them had caused the gas to expand outward, as within a swelling balloon or a growing bubble. How strange to find the placid tidewaters of the solar system subtly lapped by long swells from distant, powerful disturbances, hundreds of light years away, storms beyond the far horizon of the outstretched sea of space. As a kid, I dreamed of travel to the stars, yet it seemed perhaps that they had come to me, instead.

Presently alpha Indi rose, and then the Peacock Star, so I placed my telescope for a good view of the southeast horizon and picked up the last few objects on my primary lists. Yet these were generally nondescript. I logged them all, double-checked and re-checked that I hadn't forgotten any, then drove down the mountain. It had been a rather light session -- only 58 objects viewed -- but I was glad for the chance to relax under the night sky. Back in Hilo, I moved the telescope inside. On the next afternoon, I disassembled and packed it for return to the mainland, and mailed myself a box of dirty laundry and heavy telescope hardware, to lighten my baggage for the trip home. Yet there was one night's observing yet to come: I had planned to spend the final evening of my vacation with my 14x70 binocular.

OBSERVING -- JUNE 2/3, 2000

For me, astronomical binoculars are special-purpose instruments, for quick and easy wide-field views, so I almost always use them hand-held. My Orion "Giant" 14x70 -- one of the last before the current, lighter, 15x70 was introduced -- is perhaps the best of the half-dozen or so that I have owned. It is almost too large and too powerful to hold, which means it has almost exactly as much performance as I can handle. (By the way, be warned: The edge at which a hand-held binocular becomes unwieldy is sometimes very sharp, and varies from person to person.) I know several tricks for holding it unbraced, but when circumstances permit, I like to lean either myself or the binocular against something solid when I am using it, or prop my arms on a rigid surface, or something like that.

My rented Isuzu Rodeo had a two-piece back door. The rear window

tilted up, and the lower door panel was hinged at the side. I parked it facing north -- toward the summit of Mauna Kea -- and sat on the rear threshold with the door pulled toward me, half closed. Thus I could brace arms and binocular on the top of the door for observing, and also get some shelter from the wind. From this position, I surveyed the part of the heavens that I had swept with the 10-inch. Sometimes I would look to see how a specific object appeared in the binocular. Sometimes I would notice something, and have to check my charts to see what it was. I also paid attention to large features, like star clouds, rifts, and dark nebulae, that were too big for the field of the Dobson.

I have been mentioning binocular observations of southern objects along with descriptions of them in the larger telescope, so I don't have a great deal to add that is new. Yet there is certainly plenty to do with a binocular in these skys. I logged more than fifty observations of southern objects with the 14x70, plenty to warrant having it along. The large, bright, and famous stuff -- the eta Carina complex, omega Centauri, the Jewel Box, and numerous of the open clusters that I have already mentioned -- all showed interesting detail. Alpha Centauri was resolved. And the prime object for binocular astronomy was the galaxy itself, as a whole.

If I had had no telescope, I would have been disappointed, but a night or two with a large binocular would have been very satisfying. You northerners who have an opportunity to travel south, but who do not have a portable large telescope, or are limited in budget or baggage allowance, by all means bring a binocular, and be prepared to enjoy yourself. A smaller one would do. For real saving in space and weight, consider a large-aperture monocular, if you can find one, and if you can't, you might get a suitably sized binocular with individually focusing eyepieces, and take it apart at the hinge. One of the popular small f/5 refractors, which come in 80, 90, and 100 mm aperture, might make an even more versatile package, but I suspect you would need a tripod for it. A monopod with a simple tilt head might make a good, compact support, for a binocular or for a low-magnification telescope.

Again wishing to use a familiar yardstick to evaluate both site and southern celestial wonders, I decided to review some Messier objects. I got carried away. In an hour or so cumulatively, spaced over the night, I went through eighty-three of them, from the Beehive and M67 all the way around to M2, M15, M30, and M39. That was easier than it sounds -- I have been through the Messier catalog more than twenty times, and can find most of them without charts, and a 70 mm binocular of modest magnification is probably the easiest instrument for a Messier survey: It is capable enough to show them all without difficulty, and has a wide enough field to make finding them a cinch.

The southern objects fared very well in comparison. Except for the

Beehive, and for the Messier objects in the Scorpius, Sagittarius, and Scutum Milky Way, the patch of heavens that was new to me had more stuff with interesting detail for the binocular, than that part of the Messier catalog that I could see.

The Messier objects also fared very well. As I cross-indexed my observations onto file cards, back at home, I noted that the cryptic notes I append to each such reference often indicated less detail seen in previous views of these objects with the 14x70, when I was doing a Messier survey with it not long after I bought it, than I could see from the Visitor Center. What's more, many of the observations for the 14x70 Messier survey were made from very dark sites in the southern Cascade Mountains, near Lassen Peak, at altitudes of 1.5 to 2.5 Km. I may have said it before, but let me say it again: The Onizuka Visitor Center on the side of Mauna Kea is a wonderful place for visual amateur astronomy.

Two hints of detail were particularly interesting. Both M83 and M51 showed what I would call anisotropic structure, whose nature I could not quite determine. That is, in binoculars of similar size, I regularly see these objects as diffuse patches whose brightness varies radially, and I can routinely see the companion to M51, NGC 5195, as well. But on this night, both galaxies showed hints of structure -- something like filaments in the fuzz -- that I had not noticed before with similar instruments. Clearly, the spiral arms were on the verge of resolution. Yet even knowing that these galaxies are spirals, I could not say that I saw spiral structure with the 14x70, only that there was structure present, just beyond my ability to detect precisely what it was.

I also used the binocular to push on the southerly limits of my main survey. As I said before, the Southern Pleiades, surrounding theta Carinae, was blocked from my big telescope by the wall of the Visitor Center observing patio. I had a nice view of it in the 14x70. I also saw a few other, more difficult, southerly objects. Peering south of Crux, I found several stars in Musca, and then noticed that alpha Musca, at beyond 69 degrees south declination, was visible to the naked eye -- did I say that Mauna Kea was a good site? A bit more than half a degree north of alpha, I detected the barest hint of open cluster Harvard 6 in the binocular's field. I think that was the most southerly deep-sky object I observed during the entire trip.

I usually have a binocular handy when I observe, but only rarely use one much. This night was an exception. I logged 155 observations with the 14x70, more than on all the previous ones with it, put together.

As I drove down the access road from the Visitor Center, I noticed Alpha Centauri setting toward the summit of Mauna Loa. Shortly before I reached the Saddle Road, it winked out, and I knew that my astronomical vacation had truly ended. But the next day had one more pleasant

surprise. As I staggered to the departure gate at Hilo's airport, wondering why I had made a reservation for the absurdly early hour of 9:28 in the morning, two of the friends I had met on the island stepped forward to greet me. They presented me with a lei -- a real one, made with real flowers, in the finest Hawaiian tradition! How wonderful!

They say _aloha_ can mean both "farewell" and "greetings". As my flight winged across the broad Pacific, away from Hawaii's frigid temperatures, thin air, and inky darkness, home to the soft sunshine and warm breezes of central California, that seemed appropriate. For I was already planning to return.

FULL CIRCLE

My observing vacation on the big island of Hawaii was a complete success. I pushed my long-term survey of the deep-sky objects in Burnham's _Celestial_Handbook_ to 60 degrees south declination, and a little beyond, in the range of right ascension from about 09:30 to about 23:30. I logged over 600 observations, of which over 400 were first-time observations of southern objects I had never seen before. The others were two-thirds Messier objects, and beyond that mostly repeat looks at some of the new, southern stuff.

Besides the obvious advantage of Mauna Kea's clear, dark, southerly location, and the excellent support for amateurs provided by the Onizuka Visitor Center, several things contributed to my good fortune:

(1) The telescope worked. Taking a brand new, home-built telescope on an expedition that depended on it was worrying, even though I had had time for some shakedown at home. My biggest fear was that the "beeswax trick", which allowed cutting the truss poles in half for transport, would somehow prove faulty, but the waxed joints not only proved stiff in use, but also even held collimation from night to night, notwithstanding transporting the whole telescope down and up the Saddle Road in the back of my rented vehicle.

(2) I had done enough advance planning to be able to conduct an observing program, rather than just sit around wondering what to look at next.

(3) I anticipated cold observing conditions, and was prepared to deal with them, via clothing, catalytic heaters, coffee, and calories.

(4) I did not try to do regular tourist stuff as well. It would have messed up my sleep schedule for observing, even if I had had

extra time. The only view I got of volcanic activity was through a binocular from the Visitor Center. I think my hotel was on the beach, but I never actually went out on the side away from the street to check. I ate mostly in fast-food joints, or in my room, from supplies bought at the local Safeway. I hulaed no hulas and luaued no luaus.

(5) I planned for plenty of rest, both on the trip and before and after it. I did not set out the day after a work day, or return the day before I had to return to my job. I slept a lot.

(6) I spent enough money to be sure of getting all the things I needed to make my trip a success. My air fare was economy, and the hotel was relatively inexpensive, but both United Airlines and Uncle Billy's Hilo are established players that provide plenty of service. I bit the bullet and rented a four-wheel drive vehicle for the Saddle Road -- that was probably the expense that seemed least necessary. I fussed with my telescope design and bought a special carrying case, so I could transport it as standard checked airline baggage without great fear of damage. I did not keep detailed records, but the entire cost of my six-day trip was about $2000, which does not include the telescope. The 10-inch would probably cost about $1300 if I had to build it again, and that includes commercial optics (but no eyepieces) and the special carrying case.

I have been trying to think of some philosophical way of summing up the entire voyage. It occurred to me more than once, that most normal people would think me crazy to spend a vacation the way I did, especially in Hawaii. I joked before leaving, about returning bleached pale from lack of sun, with a touch of frostbite, but that humor was very nearly the truth. I am tolerably traveled in the lower forty-eight states, but the only other nation I have ever visited is Canada. Many people with that history would have set their travel priorities differently. It used to be common to do some kind of grand tour, seeing those parts of what was considered to be the civilized world, that you hadn't already visited.

I did do a grand tour, but not of the civilized world. I toured something much grander. The northern Milky Way has been familiar since childhood, but now I have seen the full circle, from where it vanishes beyond the California horizon in Puppis and Vela, to where it emerges again, climbing out of Ara into Scorpius. I have been a science fiction fan since I could read, so I cannot help but think of the title of one Heinlein juvenile, _Citizen_of_the_Galaxy_. My voyage was vicarious, while that of Heinlein's character was not. Nevertheless, that title suggests how I feel about my experience.

The only other words I offer those of you who are contemplating a similar project are, "Do it!" I will close by once again giving

thanks to the staff and volunteers at the Onizuka Visitor Center, and to several astronomically oriented friends in the Hawaiian islands, for making my travels easier, more interesting, and more pleasant. I hope to see you all again some time soon.

-- Jay Reynolds Freeman
Palo Alto, California
June 13, 2000.