Timeline of Astronomy in Hawai'i

-A Brief History of Astronomy in Hawai'i since 1940
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1940s:
Grote Reber places a radio antenna atop the 10,025-foot high Haleakala on the island of Maui, hoping to build an interferometer capable of simultaneously catching direct radiation from an astronomical source, and its reflection from the ocean. The results were poor because of the unevenness of the ocean surface and difficulties with the equipment. Grote Reber left for Tasmania in the mid 1950s. This clever technique did later achieve some success at Dover Heights with the Radio Physics group at the University of Sydney.

1953:
Walter Steiger joins the small Physics Department at the University of Hawai`i (UH) in Manoa, and looks for research opportunities.

1955:
Site testing for a Solar Observatory, with Steiger and graduate student John Little. Haleakala is selected on Maui because of logistical difficulties with the high mountains on the Big Island: Mauna Loa (13,680 ft) is active, and Mauna Kea (13,786 ft) has no access road.

1956:
Fred Whipple of the Smithsonian Astrophysical Observatory (SAO) writes a letter to Dr. Kenneth Mees (retired vice-president of the Eastman Kodak Co.) in Hawai`i, asking if he knows some way to

locate a satellite tracking station in Hawai`i. Mees contacts Steiger and agrees to fund with Eastman Stock valued at about $15,000 some developments on Haleakala for this and a solar observatory. The University of Hawai`i obtains a use permit, the State of Hawai`i sets aside 18 acres as a science preserve, and a small cinder-block building with sliding roof is constructed by July 1957. A Schmidt camera from SAO and eventually a Baker-Nunn Super Schmidt camera are installed, and the facilities developed and enlarged over the years, to include laboratory and dormitory space.

1956:

During the IGY the US Weather Bureau/National Bureau of Standards decides to build the **Mauna Loa Observatory** (MLO) at the 11,134-ft elevation on the Big Island, taking advantage of a road **built in 1948 to provide for a weather station**. The MLO is intended primarily for long-term monitoring of atmospheric qualities, including ozone and CO2 content. The first researchers in June 1956 are C.C. Kiess and C.H. Corless, who also make spectroscopic observations of Mars on its close approach to Earth.

1957-58:

The International Geophysical Year (IGY) enables Steiger to obtain funding for the first solar flare telescope in the mid-pacific, at Makapu`u point on Oahu.

Back to top

1960:

May 22. Hilo is struck by devastating tsunamis generated by 7.5 and 8.5 magnitude earthquakes in Chile. The first waves are relatively minor, so many local people ignore the later warnings and are caught in the maelstrom that strikes with a 30-foot wave just after midnight. The downtown area is literally flattened. Over the next few years, the Hawai`i Island Chamber of Commerce looks around for new opportunities to rebuild the economy. The executive secretary of the HICC is Mitsuo Akiyama. Despite frequent evening rain in Hilo, he hears from his friend **Howard Ellis**, then head of the MLO Weather Observatory, how clear Mauna Kea looks when seen in the evenings from Mauna Loa.

1961:

The National Science Foundation (NSF) approves a proposal from UH to create the Hawai`i Institute of Geophysics (HIG) and to build a solar observatory in the science reserve on Haleakala. The facility is named after the (now deceased) photographic scientist and benefactor of astronomy in Hawai`i, the "C.E. **Kenneth Mees Solar** Laboratory" and is dedicated in January 1964.

1963:

Gerard Kuiper, Director of the Lunar and Planetary Laboratory at the University of Arizona (UA), comes to Hawai`i to look for sites for a new observatory. He is particularly interested in high altitude sites suitable for measuring the newly opened region of infrared radiation, which is the dominant emission from cooler bodies like planets, but which is heavily affected by passage through the earth's atmosphere. Steiger shows Kuiper and his assistant, Alika Herring, around Haleakala, and they measure the nighttime "seeing" or image quality, and find it to be "excellent". However Haleakala is barely above the inversion layer, sometimes in clouds, and can be affected by fog blowing out of the caldera.

June 1963:

Akiyama writes a letter to all large universities in the US and Tokyo, asking if they might be interested in Mauna Kea as a potential observatory site. The only reply he gets is from Kuiper, who is definitely interested.

Back to Top

1964:

Kuiper arrives on the Big Island in January to talk to local officials in Hilo, and tours around the mountain in a small plane. Kuiper then takes a jeep ride to a ranger station at the 9500-foot elevation called Hale Pohaku (HP). The difficulty is the lack of any access road above HP. Akiyama arranges a visit to Honolulu, where Kuiper meets Governor Burns. Burns wants an economic boost for the Big Island and offers $25,000 in State funds to build a road, later adding another $17,000. The first road to the summit is bulldozed by April 1964. NASA has provided funds for a 12.5-inch site-testing telescope, and Kuiper makes plans to install it on Pu`u Poliahu, avoiding the sacred summit peak itself. Alika Herring, who is part Hawaiian, is a careful and precise observer, with experience at many astronomical sites around the world. When he starts observations in June, he realizes that Mauna Kea is the best site he has ever experienced. He classifies nights on a scale of 1 to 10, with 10 being perfect. Many nights on Mauna Kea are classified 9 or better. Later Bill Hartmann, a graduate student from UA, also goes to Mauna Kea to help with the site testing.

1965:

Jefferies of UH asks NASA for $3 million for the design and construction of an 84-inch telescope on EITHER Haleakala or Mauna Kea (depending on site test results). The State of Hawai`i, through the University, commits to paying $2.5 million for the dome, associated buildings, and power line. This proposal is in competition with a proposal for a 60-inch telescope from Kuiper of UA, and another proposal for a 60-inch telescope from Harvard University. Politics become important at this stage, with competition between two experienced and well established universities, and one upstart which has however done its homework well and is better placed to work in Hawai`i. Local politics also come to the fore, with competition between interests on Maui and on the Big Island for the eventual site. NASA selects the proposal from UH, for an 84-inch (which became an 88-inch or **2.2-meter**) telescope on Mauna Kea.

Late 1960s:

Kuiper assures UH officials that he has money for a 60-inch telescope, although NASA has not yet granted approval. In fact NASA is concerned that Kuiper has too many projects underway, and they actively encourage other universities to propose to build a large telescope on Mauna Kea. By this time John Jefferies has succeeded Walt Steiger as director of Haleakala Observatory. Although the small UH astronomy department has no experience in nighttime stellar observations, Jefferies decides to research the possibilities, submit a proposal to NASA, and build up the department if they are successful.

Back to Top

1968:

With road access and construction starting, other groups become interested in Mauna Kea. The Air Force builds a 24-inch telescope at its present site to the south of the summit ridge in 1968, primarily for satellite tracking. Later they give the telescope to UH, and move to Haleakala. Lowell Observatory also builds a 24-inch telescope on the summit ridge in 1970, mainly for planetary observations. This telescope is donated to Leeward College on Oahu in the late 1990s, and the Fred Gillett Gemini North telescope is built on the site.

1970:

The UH 88-inch telescope is dedicated as the seventh largest optical/infrared telescope in the world. It is the first major construction on Mauna Kea, and is delayed by storms, ice and difficulties of working at altitude with lowered Oxygen levels. There are considerable initial problems with the telescope gears, and especially the computer control system, but this telescope and the site development associated with it eventually establish Mauna Kea as the pre-eminent site for ground based astronomy. Science results from this telescope remain much better than expected for comparably sized telescopes around the world, because of its site advantage, and instrumentation developed by UH and its partners. About 100 UH students have obtained their PhDs in astronomy with this telescope.

1973:

An agreement between Canada, France and UH is signed to build a 3.6 meter **CFH** telescope on Mauna Kea, at a cost of $30 million. Canada and France did look at various sites for this premier telescope, but are persuaded by John Jefferies when on sabbatical in France to choose Mauna Kea. This is a coup for Jefferies, UH and its new **Institute for Astronomy** (IfA). UH/IfA initially expect CFH to establish their headquarters on the Manoa campus on Oahu, but CFH wants to be on the Big Island, closer to the telescope. The local council expect them to establish in Hilo, the seat of government, but instead they accept an offer from the Waimea Chamber of Commerce, and establish their base facility in Waimea. The CFHT is dedicated in 1979. For many years CFHT is the best optical telescope on Mauna Kea, and remains one of its most powerful with its newly refurbished prime focus megacam.

Back to Top

1973:

The **United Kingdom Infrared Telescope** (UKIRT) is designed as a 3.8-meter dedicated infrared telescope. Money is in short supply in the UK; the telescope is awarded only half the estimated construction funds, and built on a shoestring. UKIRT is installed in a very modest dome on Mauna Kea, and dedicated in 1979. It has been a tremendous success ever since, far exceeding its initial goals. It now provides excellent image quality with a variety of sophisticated infrared instruments, and a new wide-field infrared imager under development. The UK builds the first **"Joint Astronomy Centre"** (JAC) base facility in what is to become the University Park off Komohana St. in Hilo.

1974:

NASA awards a contract to UH to build and operate a 3 meter **Infrared Telescope Facility** (IRTF) on Mauna Kea, in competition against the UA and their preferred site on Mount Lemmon in Arizona. The IRTF is dedicated in 1979, pioneers many infrared observing techniques, and provides dedicated support to NASA space missions. UH and its partners continue to develop new infrared instrumentation for this facility, and to build a strong reputation in astronomical research. The UH and IRTF telescopes are operated out of a garage on the Hilo Community College campus. Several pioneers from UH move on to astronomy centers on the mainland and national representative boards.

1975:

The United Kingdom submits a proposal to build a 15-meter sub-millimeter antenna, which can look at the short radio wavelengths emitted by vibrating molecules in space, and hence open up a new window on space. Submillimeter wavelengths are even more affected by the atmosphere than infrared, so a high, dry site is most desirable. The UK looks at sites in the Canary Islands in Spain, and avoids Mauna Kea because of opposition to further development of Mauna Kea at this time, principally from the Audobon Society. However no agreement with Spain is signed.

Back to Top

1982:

Opposition to further development on Mauna Kea subsides. The UK cuts funds to the project, but the Netherlands joins and together they sign an agreement with UH to build the 15-meter "**James Clerk Maxwell Telescope**", named after the Scottish Physicist and discoverer of " Maxwell's equations" describing the propagation of electromagnetic radiation. The JCMT is dedicated in 1987, and has become one of the world's leading observatories at submillimeter wavelengths, again with many new developments in instrumentation.

1984:

The Keck Foundation donates $70 million to the University of California (UC) and Caltech to build a new, large telescope. Thirteen sites are considered, including sites in California, Spain and Mauna Kea. By this time Mauna Kea has established itself as the world's best site for ground based astronomy, and it is selected - the largest coup to date for the developing astronomy program in Hawai`i, and its new Director Don Hall. The 10-meter **Keck I** uses novel lightweight technology, multiple mirrors, and automated control mechanisms to support a segmented mirror 4 times larger than anything before it.

1986:

The 10.4-meter **Caltech Submillimeter Observatory** (CSO) is dedicated on Mauna Kea. Designed by Caltech Physicist Robert Leighton (and now named after him), it is a marvel of compact and futuristic design for such a large antenna. Walter Steiger, who started astronomy in the UH physics department and Haleakala observatory, and who brought in John Jefferies to start Mauna Kea Observatory, now moves to Hilo and takes on a management role running the CSO.

Back to Top

1989:

A proposal is delivered to NSF for the funding of two large US National telescopes, one in the Northern Hemisphere, and one in the South. The total cost is estimated at $176 million, of which NSF agrees to fund half. International partners are found to contribute the other half: the UK, Canada, Argentina, Chile, Brazil and later Australia. Two competing mirror designs are investigated. One is the thick but lightweight honeycomb mirror design developed by Roger Angel in Arizona and now used in the MMT in Arizona and the Carnegie Magellan telescopes in Chile, and the other is the thin meniscus design using Ultra Low Expansion (ULE) glass developed by Corning. Gemini selects the thin meniscus design, which is also favored by Subaru and the European Observatory. Gemini goes one step further in designing a fully active telescope, with controls on the mirror surfaces and all telescope parts that can be adjusted to maintain position and curvature as the telescope structure moves under gravity. The **Gemini North** 8-meter Telescope is built on the site of the Lowell Observatory 24-inch telescope on Mauna Kea and dedicated in 1999. In 2002 it is named the Frederick C. Gillett Gemini North Telescope after one of its main architects and a pioneer of infrared astronomy. The Gemini South 8-m telescope is dedicated in January 2002, in Chile.

1991:

Keck I is dedicated in November, and transforms optical and infrared astronomy worldwide. Observations that previously were impossible in a whole night of observing, become possible in an hour or so, enabling many observations and real statistics to be obtained for the first time on critical faint objects like quasars and faint galaxies. For the first time Astronomers can make reliable measurements of the density of the Universe, and cosmology moves from guesswork to measurement. The Keck foundation donates funds for a second telescope, to be built adjacent to Keck I. Keck II is built using many of the original techniques and assemblies, but also new approaches to solve problems that had arisen with Keck I. Keck II is dedicated in 1996. Keck also builds its base facility in Waimea.

1992:

The **Very Long Baseline Array** (VLBA) consists of 10 identical 25-meter radio dishes, spread across the United States from Hawai`i to the U.S. Virgin Islands. All these dishes are operated remotely from Socorro in New Mexico, and the data transported there for subsequent combination and analysis. When looked at from space, the 10 VLBA dishes effectively form a single "synthesis" telescope with an effective aperture of 8500 km, although there are many gaps within this aperture.

Back to Top

1992:

Site work begins for the 8.3-meter Japanese National Large Telescope (JNLT), now called **Subaru** after the Japanese word for the star cluster Pleiades. This is the first large Japanese national project located outside of Japan, and has become their premier astronomical facility since dedication in 1999. It is the largest of the 8-meter class "monolithic" mirror telescopes, representing the current state-of-the-art in large mirror fabrication. Many new instruments have been built for Subaru, including some developed in collaboration with UH.

2000:

The Astronomy and Astrophysics Survey Committee recommends, as its highest priority ground-based initiative for this decade, construction of a 30-meter aperture **Giant Segmented Aperture Telescope** (GSMT). Such telescopes are necessary to detect the faintest infrared objects, and resolve planetary environments around other stars. Designs and plans for this concept are now underway, and possible sites are being investigated. Caltech and the Europeans are also studying designs and sites for larger telescopes.

Back to Top

2001:

The twin Keck telescopes normally work independently, each with its own suite of instrumentation. They can also work together, directing their two light beams down into a sophisticated beam combination room below the workshops. Keck were the first large observatory to achieve this goal in 2001; the European Observatory in Chile also achieved this goal in 2003. Interferometry exploits a basic physical quality of light and telescopes that the resolution obtained for a particular wavelength of light depends on the maximum linear dimension of the telescope. The 10-meter aperture of a single Keck telescope provides a maximum theoretical resolution of about 50 milliarcsec at infrared wavelengths. This is equivalent to resolving a dime about 25 miles away and is the kind of fine resolution necessary to examine many astronomical sources including star formation in great detail. With both Keck beams combined, the maximum aperture increases to about 100 meters, for a 10-fold increase in resolution, and permits observations at the finest resolution possible from the ground, including observations of other planetary systems around nearby stars. Many such observations need large separations and sophisticated detection capability, but do not need the large collecting apertures of the individual Keck telescopes. Keck and NASA now propose to add several 2-meter class telescopes around their parking lot to feed light into the beam combination room, and allow the large telescopes to look independently at the faintest objects.

2003:

The **Submillimeter Array** (SMA) is a collaborative project between the Smithsonian Astrophysical Observatory (SAO) and the Institute of Astronomy and Astrophysics in Taiwan. This array of eight 6-meter dishes exploits the synthesis and interferometry aspects of physics to form a versatile telescope for observations in the submillimeter region. The SMA is dedicated in November 2003.

A single submillimeter dish has relatively poor resolution of about 15-20 arcsec, the same as a dime 100 yards away and only as good as the human eye. By combining several dishes together with larger baselines, this can be improved by factors of 10-100. The individual dishes can be moved around with a large forklift to provide a compact array which maximises sensitivity at moderate resolution, or the dishes can be spread out to almost 1 km baseline to achieve maximum resolution but reduced sensitivity to faint sources. Both JCMT and CSO can be added into these configurations occasionally to improve resolution and sensitivity. New facilities like the SMA, now in its commissioning phase, enable us to look in considerable detail at the coolest, densest regions of star formation, from which no optical or infrared light escapes, and will be an exciting new field in astronomy over the next decade or so. SMA is building a new base facility in the University Park in Hilo, joining facilities now there for JAC, CSO, Gemini, Subaru and **UH/IfA**. The University Park has become a center for science and technology in Hawai`i.