History of the Catalina Sky Survey

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12 January 2022

The Catalina Sky Survey[2] (CSS) is a NASA funded project supported by the Near-Earth Object Observation Program (NEOO) under the Planetary Defense Coordination Office[3] (PDCO). We are based at the University of Arizona's Lunar and Planetary Laboratory[4] in Tucson, Arizona. Our telescopes are managed by Steward Observatory.[5] Our mission at CSS is fully dedicated to the discovery and tracking of near-Earth objects (NEOs) in an effort to meet the U.S. Congressional mandate[6] to catalogue at least 90 percent of the estimated population of NEOs larger than 140 meters, some of which can be classified as potentially hazardous asteroids (PHAs) which pose a potential impact threat to Earth. Longstanding success of the project is attributable to our comprehensive sky coverage, continued development and application of innovative software and our NEO detection pipeline, and the inclusion of near real-time human attention to the NEO discovery and follow-up process.

The first telescope in the Catalina Mountains was built in 1962 for polarimetry and photometry at the site of the current 0.7-m Schmidt telescope adjacent to Mount Bigelow. The telescope that would become the Catalina Sky Survey 1.5-m was built at the direction of University of Arizona planetary scientist Gerard Kuiper in 1967. At the time, it was slewed by hand. IBM punch cards and star charts were used to locate targets. Data was recorded on paper tape. The 1.0-m telescope was built in 1968 to test if a center-supported glass mirror would produce quality images.

Figure 1 – Historical Mount Bigelow Station. Left: A wide array of instruments dotted Mt Bigelow in 1968. Right: Approach road to the 61-inch and 21-inch telescopes under construction. All photographs, S. Larson.

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[2] https://catalina.lpl.arizona.edu
[3] https://www.nasa.gov/planetarydefense
[4] https://www.lpl.arizona.edu
[5] https://www.as.arizona.edu
[6] https://www.congress.gov/congressional-report/109th-congress/house-report/158/1

In 1970 the U. S. Air Force closed their radar station at the summit of Mt. Lemmon and Kuiper petitioned the U. S. Forest Service to take over the site for a new observatory. This would become the future home of the 1.5-m and 1.0-m Catalina Sky Survey telescopes which were moved there in 1971.

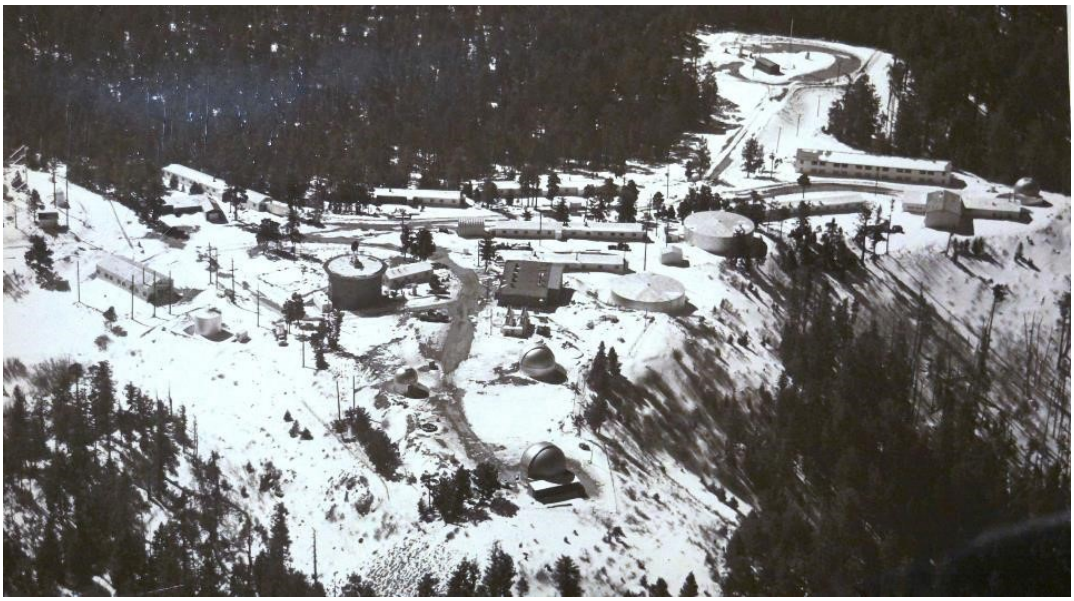

Figure 2 – Mount Lemmon Station in 1971. What is now the CSS 1.5m telescope is located at bottom center. S. Larson.

In 1998 Steve Larson and two astronomy undergraduate students Tim Spahr and Carl Hergenrother founded the Catalina Sky Survey. The team obtained exclusive use of the unused 0.7-m Schmidt telescope on Mount Bigelow and began a photographic survey of high ecliptic latitudes as the "Bigelow Sky Survey". The survey expanded in 1999 with the development of specialized hardware and software dedicated to the search for NEOs. Additional grants from NASA allowed the founding of the Siding Spring Survey in New South Wales, Australia, long making it the only full-time NEO survey in the southern hemisphere.

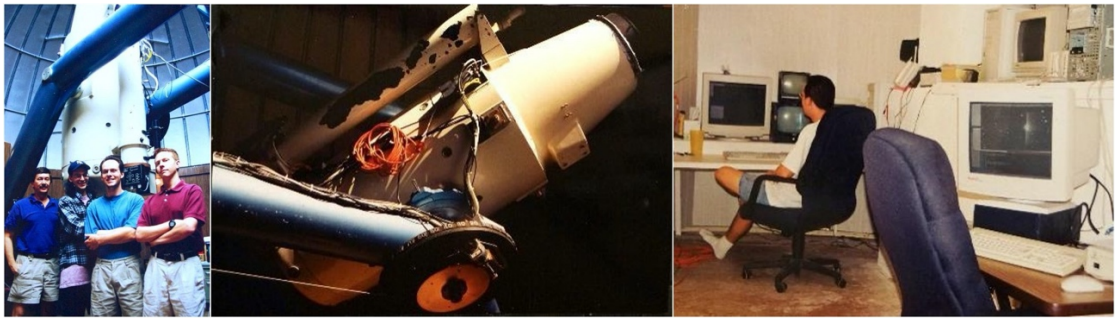

Figure 3 – Start of CSS, (formerly the Bigelow Sky Survey). At Left: the founders, Steve Larson, Carl Hergenrother, Tim Spahr, and John Brownlee. Note, too, the auto guider controls at the bottom of the 8" guide scope where the Periodic Error Correction was trained. Center: the 16"/27" Schmidt (w/16" corrector plate). Note the cone-shaped top supporting the 16" Schmidt corrector; and the relative lack of cables going to the camera because it was thermoelectrically cooled (yellow tube for chilled water). The CCD was a single channel, thick 4K x 4K. Right: Tim Spahr operating in the then refurbished warm room. S. Larson.

After numerous upgrades, the Catalina Sky Survey became the most productive NEO survey in 2004 and has found more NEOs than any other survey in the world. As of 2020, the Catalina Sky

Survey operates two survey telescopes full-time, given Minor Planet Center (MPC) site codes G96 and 703, plus one remotely operated telescope dedicated to follow-up observations, MPC code I52. CSS also has part-time access to another follow-up telescope, MPC code V06, and collaborates with SPACEWATCH® and the University of Minnesota to operate a part-time survey on the 90" Bok telescope on Kitt Peak.

Summary

The success of the Catalina Sky Survey for near-earth asteroids is due in large part to the availability of little used telescopes built by Gerard Kuiper in the Catalina mountains north of Tucson. In 1996, Steve Larson and two astronomy undergraduate NASA Space Grant students Tim Spahr and Carl Hergenrother started the precursor to the Catalina Sky Survey using film in the 0.4/0.7-m Schmidt and a home-built stereo comparator that led to the discovery of 1996JA1, an Apollo that approached within 0.003AU of the earth on May19 1996. This very part-time photographic survey became the "Bigelow Sky Survey" to distinguish it from the later CCD-based "Catalina Sky Survey".

After Kuiper's death in 1973, the LPL telescopes were transferred to the Steward Observatory by 1978. Since the Schmidt had not been used for 15 years, the Steward Observatory director allowed Larson to modify and use it for NEO surveying. Through initial small NASA grants, Larson replaced the plate holder with a thick 4K CCD to demonstrate the potential for survey purposes. Based on initial tests, CSS obtained a larger NASA grant that allowed increasing the Schmidt field, modifying a little used 1.5-m lightweight-primary telescope with a 4K x 4K CCD and to start developing software for routine imaging and analysis.

Additional grants from NASA allowed the founding of the Siding Spring Survey in New South Wales, Australia, using the 0.5-m Uppsala Schmidt making it the only full-time NEO survey in the southern hemisphere for ten years.

A damaged 1-m telescope on Mt. Lemmon was repaired and used to make follow-up observations resulting from discoveries made by the 1.5-m and 0.7-m survey telescopes. These telescopes were then outfitted with monolithic 10.5K CCDs for increased fields. CSS relies on experienced observers to validate and report in real-time new discoveries to the Minor Planet Center. Such rapid reporting resulted in discovering 2008 TC3 prior to entry over the Nubian desert and recovery of the resulting meteorites.