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Earth's Sky: Photographing the Night Sky

Capturing the Cosmos

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Conclusion

This free sample contains the Introduction and Chapter 1. The complete book contains the full contents above.

Introduction

Photographing the night sky is the art and science of recording what the eye alone cannot hold: the faint smear of a distant galaxy, the rise of a comet, the slow wink of a variable star. A photographic plate or a modern sensor can integrate light for minutes, hours, or across successive nights, accumulating signal until objects invisible to the unaided eye stand out in detail. The practice is old enough to have its own archaeology, and its products are not only pictures but data: records of how the sky looked on a particular night, in a particular year, that no future observer can ever take again.

Night, or nighttime, is the period of darkness when the Sun is below the horizon. Daylight illuminates one side of Earth, leaving the other in darkness; Earth's rotation causes the appearance of sunrise and sunset. Faint sources, from moonlight and airglow to the scatter of distant streetlights, leave some glow in even the darkest darkness, and the length of true night swings with season and latitude. That variation is the photographer's calendar: it sets when and how long the sky can be recorded at all, and how much of the darkness itself is worth photographing.

The oldest continuously important body of night-sky photography is a library of glass. Created over more than a century by the Harvard College Observatory, the Harvard Plate Stacks are widely described as the largest collection of astronomical glass plates in the world. The collection includes more than 550,000 glass plate negatives dating from the 1870s to the late 1990s, as well as early photographic data from as early as 1849, and the logbooks, notebooks, and photographic prints associated with astronomical work of every kind. The collection is best known for its widefield imagery and represents roughly a fifth of all the astronomical plates ever taken, with the typical patch of sky recorded hundreds of times across a century.

Many of the astronomers, assistants, and computers who worked with the collection were women, including members of the group now commonly known as the Women Astronomical Computers, whose measurements of the plates underpinned much of modern stellar astronomy. The negatives alone weigh over 165 tons, and they are stored on Observatory Hill in Cambridge, Massachusetts, in a purpose-built building whose three floors were designed around the archive they hold.

Astrophotography today spans every scale of ambition. A phone on a tripod can frame the Milky Way; a dedicated camera on a tracked mount can resolve spiral arms in galaxies fifty million light-years away; and a survey observatory in Chile can image the whole sky nightly for a decade. The practices at these

scales share the same physics, the same vocabulary, and the same archive obligations, and this book treats them as one subject, because that is what they are.

This book follows the subject from the first daguerreotypes of the Moon to the cloud-hosted plate archives and dedicated astronomy cameras of the present day. It is a story of chemistry and patience, of women who measured starlight on glass, of amateurs who built observatories in their backyards, and of a craft that keeps turning invisible physics into images that anyone can see.

The dry plate also industrialized the sky. Once factories could coat plates in quantity and guarantee their speed, an observatory could plan a photographic program the way a railroad plans a timetable: standard emulsions, standard holders, standard development. That shift, more than any single invention, is what turned astrophotography from a virtuoso stunt into a survey practice, and it is why the closing decades of the nineteenth century fill so quickly with firsts made simultaneously by people who never met.

Chapter 1: The Discovery of Photographing the Night Sky

The night sky was the first hard photographic subject. The collection at Harvard starts at the dawn of photography with some of the earliest images ever created of objects in space, including an early collection of daguerreotypes made by photographer John Adams Whipple collaborating with the father-and-son astronomers William Cranch Bond and George Bond. The oldest dated image in the collection is a multiple-exposure daguerreotype of the Moon made in 1849. This is the second oldest extant photograph of the Moon known to survive, surpassed only by John William Draper's photograph of the Moon, now held at the New York University Libraries Special Collections. The photographic firsts contained in the collection include the first photograph of an eclipse, a partial one, created by Whipple on 28 July 1851, and the first photograph showing the "diamond ring" effect of a total solar eclipse.

It also includes the first photograph made of a comet, taken by William Usherwood of Comet Donati on 27 September 1858, and subsequent exposures made by George Bond on 28 September 1858. While scientifically, photographically, and artistically significant, these earliest photographs were not created consistently. The media of the day, daguerreotypes, ambrotypes, wet plate collodion, and salt prints, are photographic processes that require more light, through longer exposure times, than these media could easily supply, and they could capture all but the brightest objects in the night sky. Early astrophotography was therefore less a matter of sensitivity than of endurance: exposures ran long, plates were prepared on the spot, and failure was the ordinary outcome.

The instrument makers rose to the new medium. Refractors of unprecedented aperture were ordered for photographic duty, and the great refractors of the late nineteenth century were prized as much for their flat, color-corrected fields as for their light grasp, since a photographic lens must hold its focus across a plate, not merely at the visual center. Exposure times fell from hours to minutes on the brighter objects as emulsions improved, and the exposure log, which had been a heroic record of endurance, began to look like a schedule.

The decisive technical break was the dry plate. It was not until the invention of dry plate negatives as a commercially available medium that the exposure times became practical for systematic work, because a dry plate kept its sensitivity for months, could be bought by the box, and could be exposed at the telescope and developed later at leisure. Following the American Civil War,

advances in photography and astronomy allowed multiple pioneers to advance the burgeoning art and science of astrophotography. The British couple Margaret Lindsay Huggins and William Huggins were credited with being the first to experiment using dry plate photography to capture astronomical objects in 1876. At the same time, the American couple Henry Draper and Anna Palmer Draper were pursuing parallel work with their own instruments.

The Drapers would be the first to successfully photograph the spectrum of a star, Vega, in 1872, and the first to capture the Orion Nebula on September 30, 1880, all with collodion photography. In Massachusetts, William H. Pickering and his brother would experiment with lenses and start systematically photographing the night sky by 1877. These three pairs of collaborators exchanged correspondence and results, building a scattered but real international community of practice: the subject was being discovered not once but by a network of experimenters comparing notes on emulsions, drives, and exposure times.

On November 20, 1882, Henry Draper died of pleurisy after returning home to New York from a hunting trip in Colorado. In a letter from Edward Pickering to Anna Palmer Draper dated 13 January 1883, he wrote: "My dear Mrs. Draper, Mr. Clark tells me that you are preparing to complete the work in which Dr. Draper was engaged, and my interest in this matter must be my excuse for addressing you regarding it. I need not state my satisfaction that you are taking this step, since it must be obvious that in no other way could you erect so lasting a monument to his memory." This would be the beginning of Anna Draper being the single largest benefactor to the Harvard College Observatory for the next three decades.

Her funds and future endowment would back the creation, preservation, and housing of nearly 600,000 glass plates and the core of the Harvard Plate Stacks collection, which would amount to a century of photographing the night sky. Her gift would include not only funds but also her own and her husband's personal telescope. She would establish the Henry Draper Memorial, which would include both the creation of a physical photographic plate collection and the study and publication of what is known as the Henry Draper Catalogue. Over 44 women would partake in the study, writing, and creation of the catalogue from 1886 until the final publication of the Henry Draper Extension

Charts in 1941.

This would be part of the group of women known as the Harvard Computers or, more recently, the Women Astronomical Computers at Harvard. Nearly 200 women would work at the Harvard Plate Stacks during the century of the use of glass plate negatives, 1875-1975. Their individual and collective legacies

shaped the way we understand the Universe, and their impacts on the institution and the field are still being documented. In the words of Dorrit Hoffleit, "there is hardly any branch of astronomy that has not benefited from the results of the Henry Draper Memorial. Without Mrs. Draper's vision and generosity, one wonders how preeminent Harvard would have become."

Draper would also provide funds for the observatory to build three different buildings to house the Plate Stacks, including its current home built in 1931. She would separately establish the Henry Draper Medal, become a founder of the Mount Wilson Observatory, and establish the Draper Collection of Cuneiform at the New York Public Library. This individual support would be compounded by other donations, including the estate of Uriah A. Boyden to establish a Southern Hemisphere Observatory, first called Boyden Station and later Boyden Observatory.

Originally established in Arequipa, Peru in 1889, the Observatory would be moved to Maselspoort near Bloemfontein, South Africa, where it still exists and operates under the Physics Department of the University of the

Free State since 1976. Over 60% of the Plate Stacks collection would be made at these two locations. Uniquely among astronomical glass plate collections, the Harvard Plate Stacks has an equal-length history and even use of the same instruments to create plates of the northern and southern celestial hemispheres: a single century-long eye on the whole sky, held in one archive.

The wider world was discovering the same method at the same moment.

Andrew Ainslie Common's photograph of the Orion Nebula in 1883, taken with a common reflector in the garden of his London home, first showed that amateur-scale instruments could record faint nebulae, and Isaac Roberts' 1888 three-hour exposure of the Andromeda "nebula" revealed its spiral structure, overturning a century of telescopic impressions. In 1891, Max Wolf demonstrated in Germany that asteroids could be found as trails on long exposures, since a moving body draws a short line while the stars stay points; his method made sky patrols productive in a way visual sweeps never were. And in 1887, a congress of observatories convened the Carte du Ciel, the first international sky-survey project, assigning each station its zone of the sky and a common telescope and plate standard. Its catalog part limped along for decades, but the project fixed the idea that the sky could be photographed as a shared, systematic task.

The ambition of the collection was planetary in scale from early on. The first sets were offered around 1905 along with the "First Supplement to Catalogue of Variable Stars." According to Williamina Fleming's own published account,

by October 1890, Harvard had photographed both the northern and southern hemispheres, from Cambridge, Massachusetts and from an earlier predecessor of the Boyden Observatory established on Mount Harvard near Chosica, Peru. This would lead to the creation of the "Harvard Map of the Sky" in 1917, the first photographic atlas of the entire visible sky: printed on glass plate negatives from original plates deemed the best of each quadrant of the night sky, 55 glass plate negatives, later expanded to 74 plates, were copied using an interpositive process to create multiple copies of the glass plates for distribution to observatories around the world. The Harvard Plate Stacks thus contain the first photographic atlas of the visible universe, predating the much more well-known international collaboration and multidecade publication of the Carte du Ciel.

The scale and volume of creating photographic plates would go largely unchanged, with only minor pauses or lower production during the two world wars. Other major donations funded further instruments, of which the most productive was the gift of Catherine Wolfe Bruce, who would fund the creation of a 24-inch doublet telescope honoring her husband. This telescope would first be installed in Massachusetts to capture the northernmost stars, then moved to a purpose-built building at Boyden in Arequipa as its centerpiece. The Bruce telescope was the largest astrograph of its time and would be used to create 30,000 glass plates. These plates, known as the A series, are the largest in the collection, measuring 14x17 inches, and are some of the farthest-seeing plates in the archive.

The collection's later history carries its own lessons. The Boyden Observatory was moved to South Africa, enabled by a grant of $200,000 from the Rockefeller Foundation, with Abby Aldrich Rockefeller funding the creation of a 60-inch telescope. In 1952, Donald Howard Menzel was appointed the director of the Harvard College Observatory, and according to Dorrit Hoffleit, one of the first things he undertook in his new appointment was the systematic shuttering of the photographic plate program in favor of newer techniques. The consequence was a hole in the record: because of Harvard's outsized role in creating astronomical glass plates, the resulting gap in astronomical data from the 1950s to the 1960s is referred to as the "Menzel Gap" by modern astrophysicists, and it included the culling of thousands of plates from 1960 to

1965 through a Plate Stacks committee that excluded the voices of the curator of the collection and of those employed at the time as computers.

The committee would meet and vote to destroy whole series of plates, including experimental plates and early spectra plates. What had been built over seven decades as a continuous record of the sky was, in one decade,

partly dismantled: the discovery of the value of continuous sky photography is, in part, the discovery of what happens when it stops.

Spectroscopy had its own plate tradition with its own characteristics. An objective prism, a thin wedge of glass mounted before a telescope's lens, turns every star in the field into a tiny spectrum simultaneously, and hundreds of such plates, exposed by the Draper Memorial's instruments, are what the Harvard computers actually classified, the spectral classifications and the discoveries of Payne and Cannon were read not from star images but from these streaks of rainbow, each one a star's chemistry photographed wholesale.

Provenance is a characteristic in itself, and plate archives grade it. A plate whose logbook records the instrument, emulsion batch, exposure, hour, and observer is a calibrated measurement; a plate of unknown origin, however beautiful, is an illustration. The stacks' three supporting generations of paper, logbooks, notebooks, and plate sleeves annotated by hand, are therefore not archival decoration but the archive's scientific metadata layer, and the digitization projects spend as much effort scanning paper as glass, because a plate without its paper is mute in exactly the way an unlabeled frame file is.

The instruments that read plates deserve their place among the characteristics. The blink comparator, which alternates two plates of the same field before the eye, made differences leap out, and it was with such a machine that Pluto was found; the measuring engine, a microscope on calibrated screws, gave star positions to a few microns; and the densitometer read photographic blackening as a number, which is the ancestor of every digital photometry pipeline. Each of these devices extended the plate's usefulness beyond what its taker could have foreseen, which is the mark of a true measuring medium rather than a picture medium.

End of free sample. The full book is available at putrabooks.github.io

ABOUT THE AUTHOR

Aira Astralis is a science writer specializing in astronomy and space exploration. Her work spans the full breadth of humanity's relationship with the cosmos -- from the earliest naked-eye observations to the engineering marvels of modern space missions.

Her books are built on a foundation of primary sources: peer-reviewed research, mission archives, and direct engagement with the scientific community. She writes for readers who want to understand not just what we know about the universe, but how we came to know it.

She believes that the most important frontier is not out there but in the gap between what scientists discover and what the public understands. Her books exist to close that gap.