ALL-SKY MONITORING

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The Plate Collection at the Harvard College Observatory

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Abstract: This review presents an overview of the large and important photographic plate collection at the Harvard College Observatory, including its history, uniqueness, contents, storage, uses and successes.

1 History

In 1839, Louis Daguerre announced his discovery of a process by which an image made by light on silver grains could be made permanent. Very soon thereafter, in 1840, Henry Draper of New York City first successfully daguerreotyped an astronomical object, the moon; this image no longer survives. Daguerreotyping began at Harvard in 1849 with the recently installed Great Refractor (0.38 m aperture), and four daguerreotypes of the moon taken with this instrument in 1851 and 1852 remain in our collection. Four daguerreotypes of a partial eclipse of the sun in 1851 also remain.

In 1852, daguerreotyping ceased at Harvard, due to limitations on exposure time posed by an inadequate clock drive on the Great Refractor. With a new drive installed in 1857, photography began again with the then new wet-plate, or collodion, process. Many hundreds of collodion plates from 1857 to 1885 are included in Harvard's collection, including a beautiful series of an occultation of Spica by the moon in 1857, images of Saturn and Jupiter from 1857-60, images of the inner solar corona from eclipses in 1869 and 1870, several hundred detailed solar plates from the 1870s, and the majority of Benjamin Gould's plates from Córdoba, Argentina, in the 1870s and 1880s.

The research plate collection began in 1885, with the aquisition of Harvard's first photographically corrected refractor, the 0.2 m Bache telescope, with which 75 000 plates were taken up until 1955 when the telescope was closed. The arrival of this telescope allowed the Harvard astronomers to take full advantage of the new dry plate, a much easier and more sensitive photographic medium, which was developed in the early 1880s.

The late 1880s and early 1890s also saw the establishment of Harvard's southern station in Arequipa, Peru. Harvard maintained southern hemisphere telescopes until 1955; the southern station was moved from Arequipa to South

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Africa in 1924. The southern patrol program was reinstated in New Zealand in the late 1970s, and ran until 1988.

2 Uniqueness

The collection at the Harvard College Observatory is unique among plate archives in at least three ways. It has the longest time span of coverage, from 1885 to 1989, with some unfortunately notable gaps. The number of plates, approximately 500 000, is the largest of any archive. It should be noted that most are direct blue plates, although some 5 to 10% are objective prism spectrum plates, and a small percentage is red or yellow plates. Finally, Harvard's collection, unlike others, covers the entire sky, beginning in 1889. Most of the other important archives of wide angle plates cover mainly the northern celestial hemisphere.

3 Contents

The collection at Harvard comprises plates taken with 50-60 different photographic telescopes; about 20 of these are responsible for the bulk of the collection. A summary of the important telescopes is shown in Table 1, where instruments are divided into groups by focal scale. In some cases, several telescopes are grouped together. For each instrument are listed aperture, focal scale, hemisphere, approximate total number of plates, and years of operation. It is of interest to mention briefly some of the telescopes and their work.

The 0.325 m telescope, the Boyden refractor, was the instrument used by Solon Bailey at the turn of the century to study the RR Lyrae stars in globular clusters like Omega Centauri. The 0.6 m Bruce refractor produced the plates used by Henrietta Leavitt to discover the period-luminosity relation for Cepheids in the Small Magellanic Cloud. And two of the three telescopes of 0.2 m aperture, the Bache and Draper refractors, took the spectral plates used for the Henry Draper Catalog of stellar spectral types. The patrol plates were taken by many different instruments that are grouped together in Table 1 by focal scale. The last entry, the 42 mm telescopes, were Harvard's most recent patrols.

As a practical indication of coverage of the sky, one can say that, for a given object of blue magnitude 15 or brighter, from 100 to several thousand images may be found in our collection. If the blue magnitude is 17.5, there will be from two or three to several hundred images.

4 Storage and care

A special fireproof building was erected in 1934 to house the collection, with extra reinforcing to support the weight of the plates. Each plate is stored in a bond paper, or more recently Tyvek, envelope. Plates stand vertically in steel cabinets. The plate stacks are temperature controlled to 20 C in the winter and

Table 1. Summary of Principal Plate Series

Aperture	Scale	N/S	No. of Plates	Years
		Scales < 80"/mm		
1.5 m	26"/mm	N	13 000	1934-1989
		S	6 000	1933-1955
0.325	42	S	19 000	1888-1951
0.6	60	S	27 000	1893-1950
		Scales 80-300"/mm		
0.2 m	170	N	76 000	1885-1976
		S	71 000	1889-1954
0.3	100	N	10 000	1905-1983
0.4	100	N	40 000	1909-1988
0.25	170	S	40 000	1915-1955
		Scales > 300"/mm = Patrol Plates		
75 mm	390	N,S	33 000	1928-1963
38	600	N,S	75 000	1898-1957
42	580	N,S	9 600	1962-1989

22 C in the summer. No attempt has been made to control the humidity, except by the air conditioning.

The current personnel comprises a quarter-time Curator and a half-time Assistant Curator. The cost of the entire care of the plates, including heating, electricity, building maintenance, etc., is roughly US$ 80K per year. About half of this comes from an endowed restricted fund of the Harvard College Observatory.

Patrol plates are filed by region, and are therefore easy to access. The remaining plates are filed by individual telescope and date (or plate number); these must be located by card catalogs, which are filed by position. We are currently working on a machine readable catalog, although the projected completion date is well into the next century.

The plate collection at Harvard is open to any astronomer by arrangement with the Curator.

5 Problems

As with any similar archival collection, Harvard's plate archives do have problems. As mentioned before, there are notable time gaps in the data, the most recent being from the early 1950s to the 1970s. However, as noted below, the collection at Sonneberg fills this in for the northern hemisphere. A second problem, as noted above, is a lack of a machine readable catalog.

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Table 2. Observations of KR Aurigae

Dates	Harvard plates	Sonneberg plates
1895-99	7	—
1900-09	20	—
1910-19	32	—
1920-29	93	—
1930-39	318	54
1940-49	72	62
1950-59	13	28
1960-69	3	229
1970-79	40	$\gg 10^*$
1980-82	14	11

* Popova (1975) looked at 10 Sonneberg plates 1970–1971. There are no published Sonneberg data 1972–1979.

The plate stacks occupy a rather large volume of space in a choice location at Harvard. This has not escaped the notice of higher authorities, and from time to time there begins a move to relocate or store the plates somewhere else. However, the plate stacks were so beautifully and specifically built to house the collection that to convert the space to offices, etc., appears, at least up to now, to be prohibitively expensive.

6 Uses and successes

In the early days, the direct plates were used largely to help in setting up a system of photometric standards and to discover and study variable stars. The objective prism plates were used, to develop a scheme of stellar spectral classification and to apply this to stars brighter than magnitude 10; the product of this work is, of course, the Henry Draper Catalog.

More recently, the direct plates have been used to derive historical light curves of newly discovered objects and types of objects. With use of the Harvard plate collection, the rapid optical variation of the QSOs was first recognized. Light variations found for HZ Herculis from the collection first showed the turn-off and turn-on of this X-ray source (Jones et al. 1973). And the first (and only?) possible optical counterpart of a γ-ray burster was found in the plate collection (Schaefer 1981, Schaefer et al. 1984).

A study of the optical variation of the X-ray source KR Aurigae (Popova 1975, Liller 1980, Liller & Popova 1984) shows how nicely the Harvard and Sonneberg plate collections can mesh. Table 2 lists for 10 year intervals the number of plates from each observatory used in the study; clearly the major decline in

numbers of plates at Harvard, beginning in the 1950s, has been matched by an increase of those at Sonneberg.

The Harvard plates are also being used currently to derive light histories of many other types of variable stars of interest. In 1994, eleven different individuals or groups each searched from several hundred to many thousands of plates to determine light curves for variables of interest.

7 Summary

The astronomical photographic plate collection at the Harvard College Observatory, because of its long time base (1885-1989), large number of plates (500 000), and equal coverage of both hemispheres of the sky, is a valuable resource for the international astronomical community. We welcome visitors interested in taking advantage of what the collection has to offer.

References

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M. Tsvetkov: Do you have plans to digitize your plates in Harvard?
M. Hazen: Although I hope this may be done in the future, the sheer labor involved in such a task has discouraged us from starting this. Perhaps more important at the moment is completion of the machine readable catalog, which will take many more years at the current rate.

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