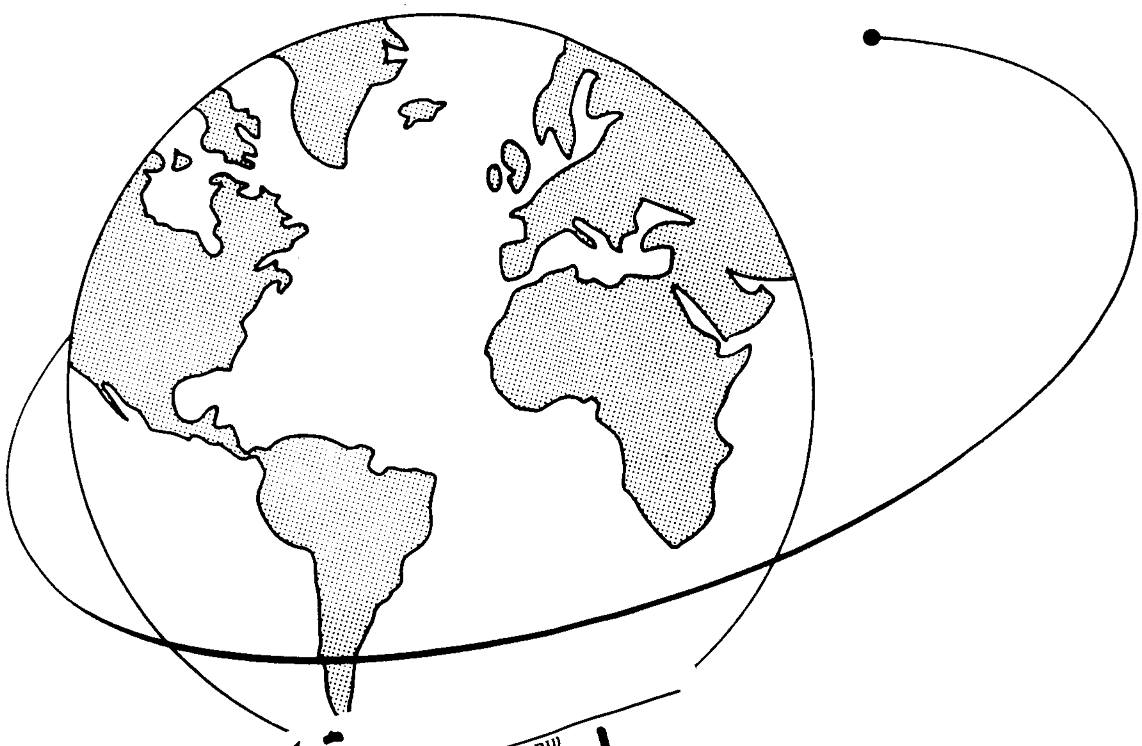
SOME RESULTS AT BAKER-NUNN TRACKING STATIONS

L. H. SOLOMON



Smithsonian Astrophysical Observatory
SPECIAL REPORT 244

Research in Space Science
SAO Special Report No. 244

SOME RESULTS AT BAKER-NUNN TRACKING STATIONS

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July 3, 1967

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612-9

This work was supported in part by
Grant No. NsG 87-60, from the
National Aeronautics and Space Administration.

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ABSTRACTS

THE LIGHT CURVE OF NOVA HERCULIS 1963 FROM BAKER-NUNN PHOTOGRAPHS

Baker-Nunn photographs of the outburst of Nova Herculis 1963 were reduced to produce the light curve presented here. These data supplement the material available from other sources.

Les photographies Baker-Nunn de l'explosion de la Nova Herculis 1963 ont été réduites pour donner la courbe lumineuse ci-jointe. Ces données complètent le matériel disponible en provenance d'autres sources.

Бэкер-Нунн фотографии взрыва Нова Геркулис 1963 были обработаны для получения световых кривых приведенных ниже. Эти данные дополняют материал доступный из других источников.

LIMITING MAGNITUDE OF THE BAKER-NUNN CAMERA

The limiting magnitude of the Baker-Nunn cameras has been measured as a function of exposure time in dark-sky conditions. The experiment was done for several film types in use at various times during the satellite-tracking program.

La magnitude limite des caméras Baker-Nunn a été mesurée comme fonction du temps d'exposition dans des conditions de ciel sombre. L'expérience a été faite pour divers types de films en usage à des instants différents pendant le programme de poursuite du satellite.

Предельная величина Бэкер-Нунн камер была измерена как функция времени экспозиции при темном небе. Опыт был проведен для нескольких типов пленки употребляемых в различное время втечение программы наблюдения спутника.

EFFECT OF BRIGHT SKY ON BAKER-NUNN OPERATION

The effect of the sky in fogging Baker-Nunn film is given for the limiting dark-sky case. Bright-sky modification to this result is discussed.

L'effet du ciel dans le brouillage du film Baker-Nunn est donné pour le cas limite du ciel sombre. La modification de ce résultat dûe au ciel lumineux est discutée.

Влияние неба на затуманивание Бэкер-Нунн пленки приводится для предельного случая темного неба. Изменение этого результата при ясном небе обсуждается.

THE LIGHT CURVE OF NOVA HERCULIS 1963 FROM BAKER-NUNN PHOTOGRAPHS

L. H. Solomon

Upon the discovery of Nova Herculis 1963, the Baker-Nunn cameras (Henize, 1957) were used to photograph the star and the surrounding region. The purpose was to obtain a light curve made up of many individual magnitude estimates spaced somewhat evenly throughout the day, although we did not obtain so many films as we had hoped. Furthermore, routine satellite-tracking films taken before discovery were scanned to obtain prediscovery estimates, and possibly to yield a good estimate of the time of maximum light.

In each case of special photography (postdiscovery), several short (0.4 or 0.8 sec) exposures were obtained. For prediscovery estimates, we used as many exposures as were available, and as these generally contained the nova image near the edge of the field, or otherwise disturbed, the precision is considered to be low. In all cases, the 20-inch f/1 camera contained Kodak Royal-X Pan Recording film (SO 283). The photometric system has previously been estimated (Solomon, 1966) to be close to the International Photovisual (i.e., V) system, and comparison of our present results with AAVSO visual estimates for this nova reveals no significant discrepancy.

The photometric work was done visually, using the modified Argelander system described by Solomon (1966). All stars in the comparison sequence were combined to form a master calibration curve, from which the estimated magnitudes of the nova were read. Postdiscovery estimates have a standard error of $\sigma \approx \pm 0.1$ mag. Prediscovery error estimates were made for individual cases.

All the data have been combined to form a light curve (Figure 1) covering the period of the Baker-Nunn observations. The two earliest observations, reported by the Tokyo Astronomical Observatory, are included with large error estimates, as only very approximate magnitudes were submitted. That observatory is expected to publish a further light curve in the near future.

I wish to acknowledge the aid of Miss Marjorie David in the calculations, and useful discussions with Mr. K. Tomita.

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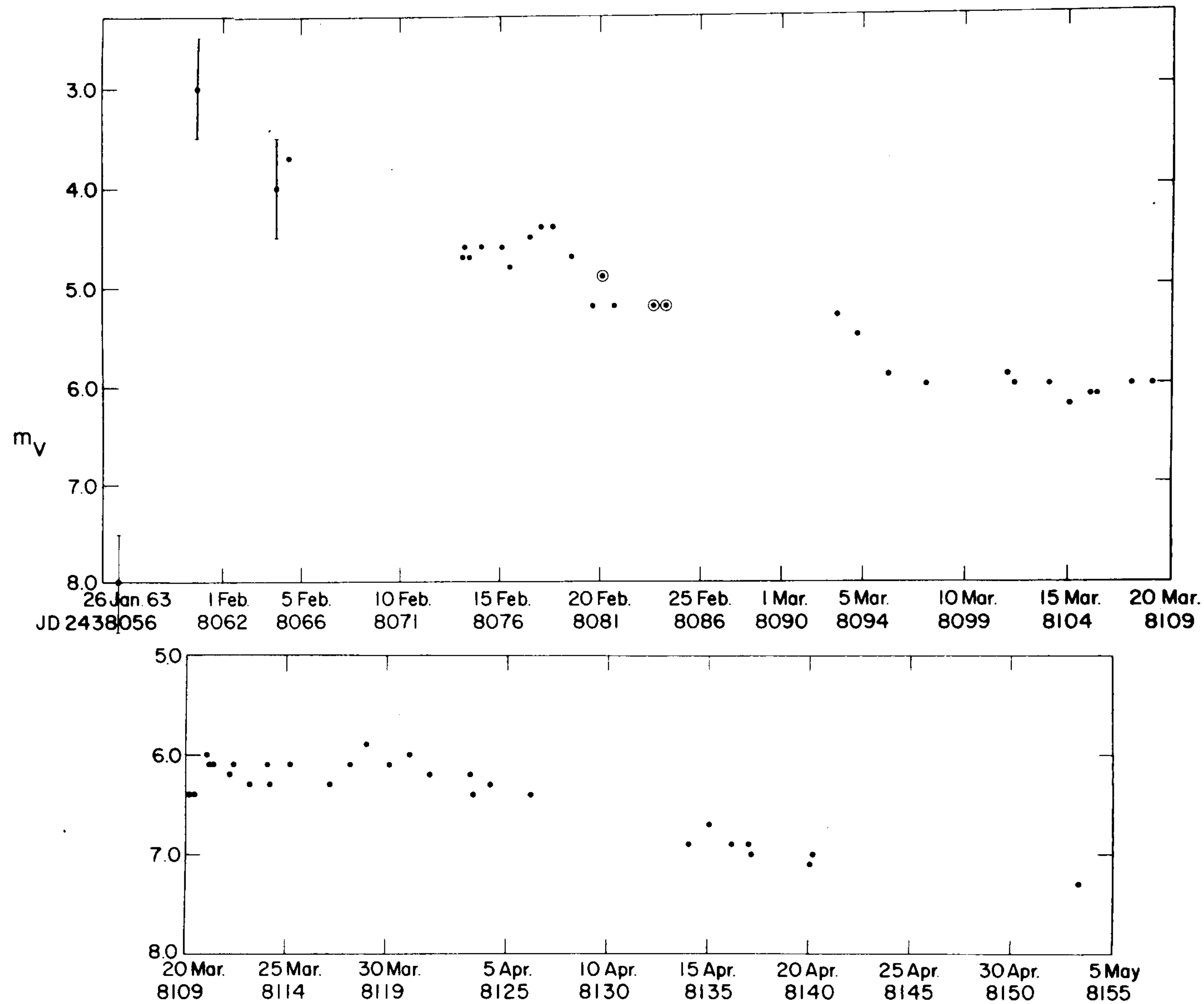

Figure 1. Light curve of Nova Herculis 1963. Bars denote error estimates of low-accuracy observations; circled points indicate duplicate observations.

LIMITING MAGNITUDE OF THE BAKER-NUNN CAMERA

L. H. Solomon

The limiting magnitude of the Baker-Nunn camera (Henize, 1957) has been investigated at various times (Slowey, private communication 1960; Solomon, private communication 1964) during the operation of the Smithsonian Satellite-Tracking Program. Results of this continuing study have been used for several purposes, such as comparison with other tracking systems, testing of new or improved films, and evaluation of camera optics and operating quality.

We have collected some of the data from this observational program and plotted limiting magnitude as a function of exposure time. This is shown in Figures 1 through 3. All magnitudes were reduced to zenith, using the expression $m_z = m - 0.20 (\sec z - 1)$ (Allen, 1963), where z is zenith distance (effective λ 5400 Å). From previous measurements (Solomon, 1966) we have found that camera response is close to visual (V). We have used visual magnitudes throughout without any color correction. The exact form of the color equation is now being determined.

Values given here are absolute limits of detection of known stars. For practical limits for the detection of satellites, the images must be ~0.25 mag brighter than this absolute limit. To be useful for precision position measurement, images must be about 0.7 to 1.0 mag brighter than the limit. Some of these films were recently taken under good conditions expressly for this study; others were taken at different times for quite different reasons. Most films were of the two standard film types, Kodak Royal-X Pan Recording (SO-283) and its successor Kodak Extended-Red Royal-X Pan Recording (SO-338). Some data are available for I-D film; these are indicated separately.

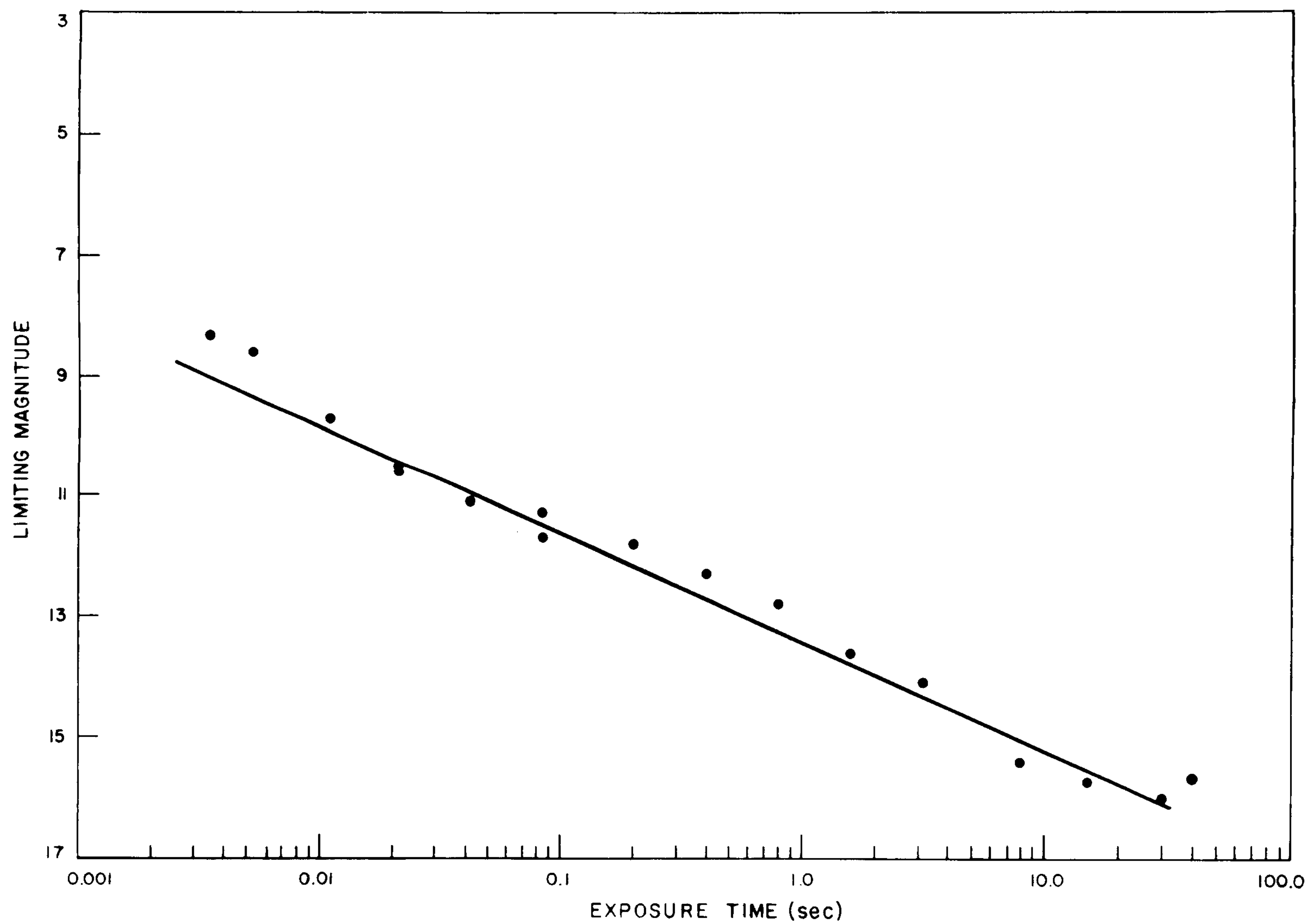

Figure 1. Limiting magnitude versus exposure time. Kodak Extended-Red Royal-X Pan Recording Film (SO-118, SO-338). Magnitudes corrected to zenith; Baker-Nunn camera at full aperture. SO-338 used from 1965 to present.

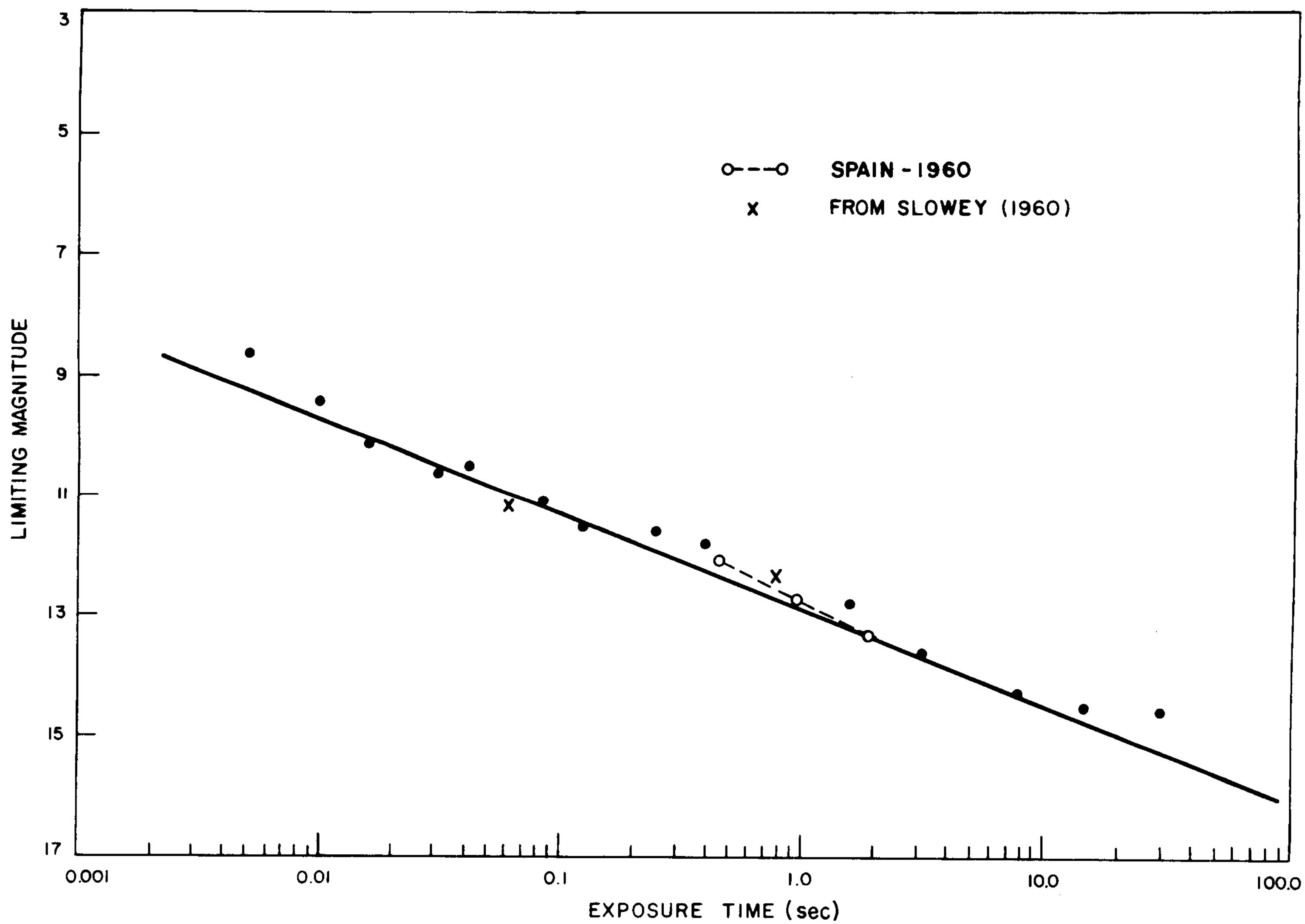

Figure 2. Limiting magnitude versus exposure time. Kodak Royal-X Pan Recording Film (SO-283, SO-232). Magnitudes corrected to zenith; Baker-Nunn camera at full aperture. SO-283 used from 1960 to 1965.

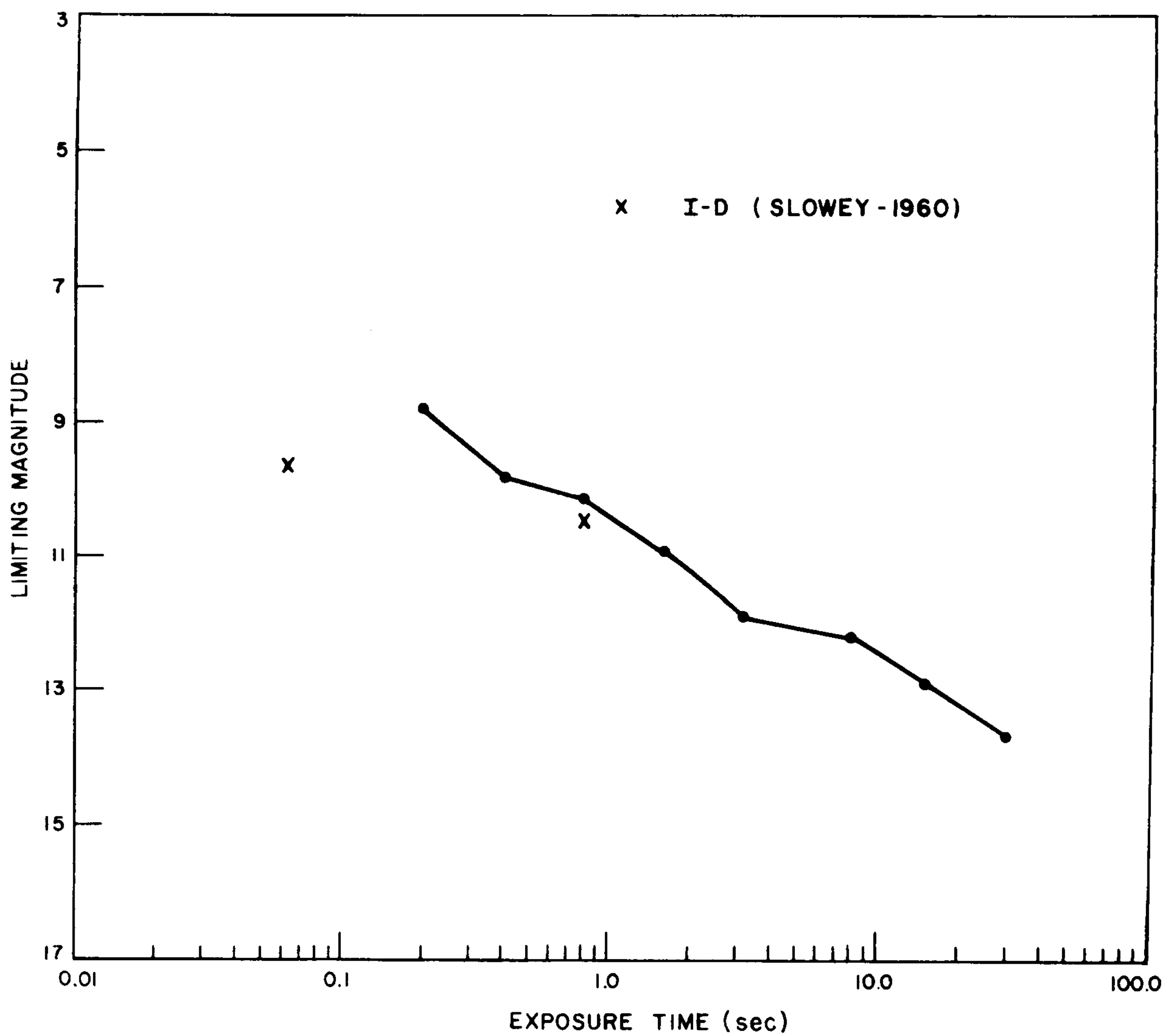

Figure 3. Limiting magnitude versus exposure time. Spectroscopic I-D emulsion; magnitudes corrected to zenith; Baker-Nunn camera at full aperture. I-D used until ~ 1961.

The present camera-film combination appears to be roughly 15 times as sensitive as the original system. Further development will almost necessarily be in the direction of increased film acutance and contrast and decreased grain size.

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EFFECT OF BRIGHT SKY ON BAKER-NUNN OPERATION

L. H. Solomon

The Baker-Nunn camera (Henize, 1957), operating at f/1, 20-inch aperture, is used primarily to photograph faint moving objects against a dark-sky background. The detection limit is set essentially by the contrast of a faint point or trailed image against the fog background. For an exploration of the useful operating range of the instrument, it is therefore desirable to know how the sky fog (and normal chemical fog) grows as a function of exposure time. Then simple models, based on the known characteristic curve of the film, may be used to estimate the optimum exposure times for image detection (i. e., that exposure time for which the faintest object can be detected or that for which the least difference in image density is required for detection). Such a procedure is also useful for deciding on optimum methods of observing new objects of interest when no experimentation is possible.

Film was exposed at the Organ Pass station (elevation 1450 m) in the zenith under dark-sky conditions. A plot of fog density versus exposure time for Kodak Extended-Red Royal-X Pan Recording film (SO-338) is given in Figure 1. A sample characteristic curve (ASA diffuse density) for the film is given in Figure 2. For the case of a single film frame, assuming a density difference of 0. 3 is required to conform an image as real and (if a point or short trail) measurable, the "optimum" exposure occurs when background fog is at density 0. 40. Similar estimations can be made for other films of interest, but results are not yet available for Extended-Red Royal-X Pan Recording film.

As sky brightness is the determiner of film fog, then optimum exposure is clearly a function of such items as the distance of the field of view from the bright moon, haze, city lights, or other disturbing agents. As the sky

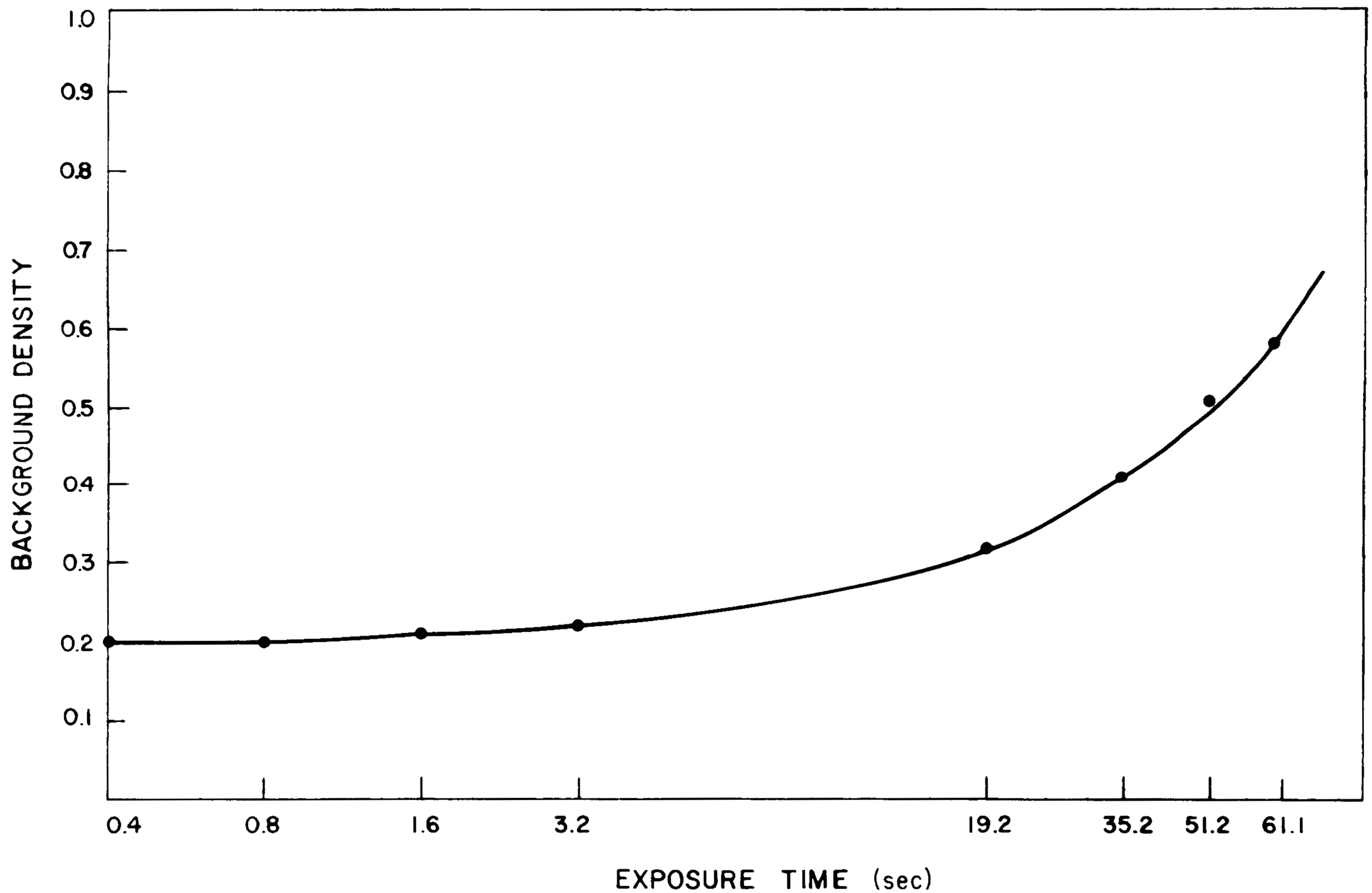

Figure 1. Sky background-density versus exposure time, photographed under dark-sky conditions, using the Baker-Nunn camera at Organ Pass.

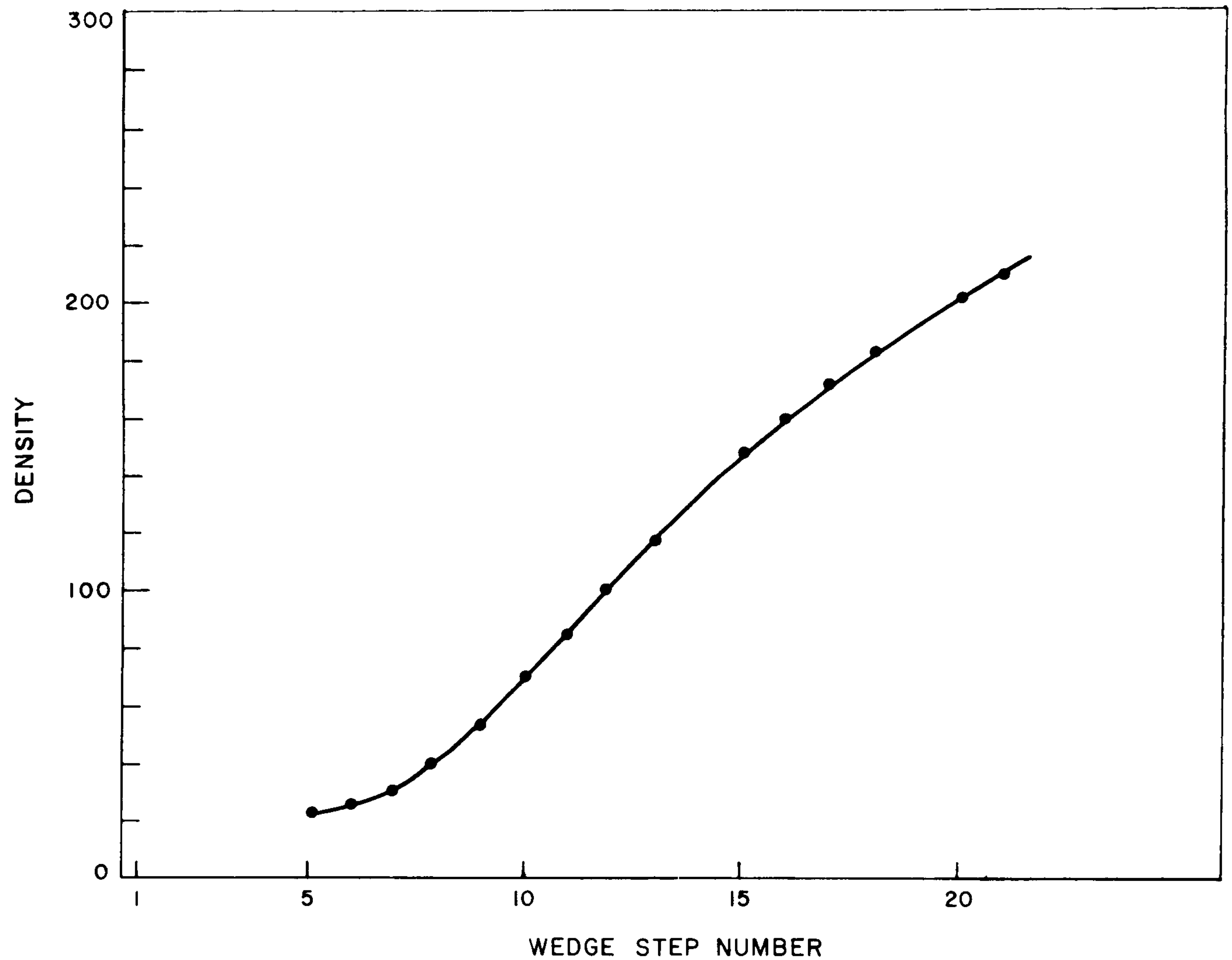

Figure 2. Sample characteristic curve; Kodak Extended-Red Royal-X Pan Recording Film. Illumination is given in arbitrary units rather than the usual log exposure. Density measured with Macbeth Quantalog Densitometer.

brightness increases, the optimum exposure, determined as above, becomes less, and either aperture or exposure time must be decreased. Under bright-moon conditions, it is possible to have sky background reach density ~ 0.6 in less than 3 sec, with the moon outside the field. The optimum exposure is roughly 30 sec in dark sky, as seen in the curves in Figures 1 and 2. It should be noted that the data on limiting magnitude (Solomon, 1967) seem to show a tendency to depart from the linear-magnitude increase with exposure time in the region of 20- to 30-sec.

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BIOGRAPHICAL NOTE

LEONARD H. SOLOMON received the B. A. degree from Brooklyn College in 1957 and the M. S. degree from Cornell University in 1966.

Prior to his affiliation with Smithsonian Astrophysical Observatory in 1959, Mr. Solomon held a teaching assistantship at Cornell University. Currently, he is an astronomer for SAO's satellite-tracking program.

Mr. Solomon's research is directed toward the application of photographic photometry with the Baker-Nunn cameras to observations of flare stars and other variable stars. His research also includes the investigation of methods of optical satellite tracking and general analysis of combinations of different satellite-tracking systems.

NOTICE

This series of Special Reports was instituted under the supervision of Dr. F. L. Whipple, Director of the Astrophysical Observatory of the Smithsonian Institution, shortly after the launching of the first artificial earth satellite on October 4, 1957. Contributions come from the Staff of the Observatory.

First issued to ensure the immediate dissemination of data for satellite tracking, the reports have continued to provide a rapid distribution of catalogs of satellite observations, orbital information, and preliminary results of data analyses prior to formal publication in the appropriate journals. The Reports are also used extensively for the rapid publication of preliminary or special results in other fields of astrophysics.

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