NATIONAL BUREAU OF STANDARDS REPORT

8619

Supplementary

An Artificial Star Source for the OAO

By

D. Sirota and L. Chernoff

U. S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS

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1. Redefinition of the Visual Magnitude of the OAO Star-Simulator

After NBS Report 8619, "An Artificial Star Source for the OAO," had been issued, the star-simulator was used in measurements with equipment that had been calibrated by observing actual stars. The differences between the predicted values in these measurements and those actually recorded were much greater than could be explained by experimental errors. It was therefore decided to re-examine the photometric definition of the visual magnitude of a star.

Investigation in the literature concerning the photometric definition of a visual second magnitude star revealed considerable variation among the references. The values given in five of these references are given below.

References	Illuminance of a Second Magnitude Star (footcandle)
A. Middleton, Vision Through The Atmosphere (1951)	3.08×10^{-8}
B. Smithsonian Physical Tables (1954)	3.14×10^{-8}
C. Walsh, Photometry (1953)	3.3×10^{-8}
D. Allen, Astrophysical Quantities (1955)	3.58×10^{-8}
E. Allen, Astrophysical Quantities (1963)	3.90×10^{-8}

An evaluation of the validity of these values was undertaken at Georgetown University under the sponsorship of NASA. In this study it was recommended that the value given in reference E above, i.e., 3.90×10^{-8} footcandle, had the best experimental basis and therefore should be used. [1] This value is based on absolute stellar irradiance measurements made by R. V. Willstrop.[2]

If the calibration of the NBS artifical star source is to be on the revised definition of a visual second magnitude star, Table I (on page 8) of NBS Report 8619 must be revised by changing the distances, D_{OAO}, given in the table. (The distances in the report were computed for an illuminance of 3.14×10^{-8} footcandle, the value from the Smithsonian Physical Tables). The new distances are given below:

Revised Table I of NBS Report 8619

Lamp	Current (amperes)	Voltage (volts)	I_A (candela)	D_{OAO} (feet)
NBS 7544	4.263	113.7	2.32×10^{-5}	24.4
NBS 7557	4.238	113.2	2.20×10^{-5}	23.8
NBS 7552	4.184	114.2	2.32×10^{-5}	24.4

In line with this revision, the ordinates of Figure 3 of NBS Report 8619 must be increased by a factor of 1.24.

2. Evaluation of the Stellar S-Surface Magnitudes of the Star-Simulator

Since the OAO star-simulator will be used to check the calibration of several photometers having a spectral response little different from that of a nominal S-4 surface, the stellar S-4 magnitude of the star-simulator was computed. The stellar S-4 magnitude of the OAO star-simulator may be defined as

$$m_{OAO,\ S-4} = -2.5 \log \frac{\int H_{OAO,\lambda} \quad R_{S-4}(\lambda)\ d\lambda}{\int H_{AO,z,\lambda} \quad R_{S-4}(\lambda)\ d\lambda} \qquad (1)$$

where

$m_{OAO,\ S-4}$ is the stellar S-4 magnitude of the OAO star-simulator

H_{OAO} is the spectral irradiance at the receiver produced by the star-simulator at a distance from the receiver, D_{OAO}, which yields a stellar visual second magnitude. (Given in Figure 3 of NBS Report 8619 taking into account the previously noted correction),

$H_{AO,z}$ is the spectral irradiance from a visual zero magnitude AO star, and

R_{S-4} is the relative spectral response of a nominal S-4 receiver surface.[2/]

In order to define equation (1) more precisely, it was decided to use $H_{AO,z}$ of the more specific AOV class of stars. Dr. Robert E. Wilson has determined the average absolute spectral irradiance of a visual zero magnitude class AOV star.[1/] By use of his values, and equation (1), one obtains 2.33 as the stellar S-4 magnitude of the OAO star-simulator at a distance from the receiver, D_{OAO}, which yields a stellar visual second magnitude.

In a similar way the stellar S-11 and S-20 magnitudes of the OAO star-simulator at the distance, D_{OAO}, were calculated and both were found to be 2.23.

The OAO star-simulator is being used in periodic checks of the calibrations of equipment employed in star-tracking on the OAO project.

References

1. R. E. Wilson, Georgetown Observatory, Washington, D. C., private communication.

2. R. V. Willstrop, Absolute Measures of Stellar Radiation, Monthly Notices 121, 17 (1960).

3. RCA Tube Handbook (Radio Corporation of America, Harrison, N. J.).


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