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GCA-TR-70-7-N

# EFFICIENCY MEASUREMENTS OF GRATINGS AT GRAZING INCIDENTS

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FINAL REPORT  
CONTRACT NO. NAS5-11234

PREPARED FOR  
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FINAL REPORT

for

EFFICIENCY MEASUREMENTS OF GRATINGS  
AT GRAZING INCIDENCES

(30 June 1969 - 30 May 1970)

Contract No. NAS5-11234

Goddard Space Flight Center

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GODDARD SPACE FLIGHT CENTER  
Greenbelt, Maryland

## EFFICIENCY MEASUREMENTS OF GRATINGS AT GRAZING INCIDENCES

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### SUMMARY

The objective of this contract was to determine the first order efficiencies of six diffraction gratings at grazing angles of incidence and for a wavelength range between 200 and 500Å.

### INTRODUCTION

This report presents the results obtained under the Work Statement described in Contract No. NAS5-11234. The main requirements were to measure the first order efficiencies of four large gratings at an angle of incidence of  $82.5^\circ$  and of two small gratings at an angle of incidence of  $88^\circ$ . The wavelength coverage was between 200 and 500Å. The measurements have been completed and the results are tabulated in Tables I through V. All results are expressed in units of percent.

### DISCUSSION OF RESULTS

The detector used in these measurements was of a simple photo-diode construction utilizing a photocathode of Al approximately 9 cm in length. A 9 cm long slit assembly ( $\approx 2$  mm wide) was mounted in front of the photocathode. The length of the photocathode enables all of the astigmatic image to be detected. This procedure improved the accuracy of the measurements. For the four large gratings the estimated accuracy is  $\pm 4$  percent.

Serious problems were encountered with the small gratings. Owing to their size and to the fact that measurements were made at  $88^\circ$  the width of the incident light beam had to be reduced to the point where the diffracted images were barely detectable with the photo-diode assembly. Consequently, measurements were made at only the strongest lines. Absolute efficiencies were impossible to obtain. Thus, relative measurements between the two small gratings were made. The incident light beam covered the full width of the gratings but since not all of the width was ruled the resulting efficiency measurements will be too low. To further complicate the results the grating #2371 had a 20 percent smaller ruled area than grating #2458. The measured values for grating 2371 are listed

in column one, Table 5, as obtained experimentally. These values are increased by 20 percent in column two and are to be compared with column three which gives the direct measurements of grating 2458.

The spectral distribution of efficiencies of each grating is good and shows none of the anomalies previously observed (NAS5-9374).

TABLE I

EFFICIENCY MEASUREMENTS OF THE FIRST ORDER  
DIFFRACTED IMAGES BETWEEN 267 AND 530Å  
FOR BAUSCH AND LOMB GRATING #1202 A 1 B 2

| $\lambda$ (Å) | 1st Order Efficiency (%) |
|---------------|--------------------------|
| 267           | 18.2                     |
| 284           | 17.5                     |
| 303           | 17.2                     |
| 323           | 17.0                     |
| 345           | 16.9                     |
| 363           | 17.4                     |
| 375           | 17.4                     |
| 388           | 17.1                     |
| 419           | 15.3                     |
| 434           | 15.2                     |
| 452           | 15.1                     |
| 464           | 14.7                     |
| 495           | 14.7                     |
| 508           | 14.6                     |
| 530           | 14.0                     |

**TABLE II**  
**EFFICIENCY MEASUREMENTS OF THE FIRST**  
**ORDER DIFFRACTED IMAGES BETWEEN 267 and 508 Å**  
**FOR BAUSCH AND LOMB GRATING # 1203-1-3**

| $\lambda$ (Å) | 1st Order Efficiency (%) |
|---------------|--------------------------|
| 267           | 19.5                     |
| 284           | 19.7                     |
| 303           | 19.7                     |
| 323           | 19.7                     |
| 345           | 19.5                     |
| 375           | 19.8                     |
| 434           | 16.6                     |
| 452           | 16.5                     |
| 474           | 15.5                     |
| 508           | 14.6                     |

TABLE III

EFFICIENCY MEASUREMENTS OF THE FIRST ORDER DIFFRACTED IMAGES  
BETWEEN 267 and 508 Å FOR DIFFRACTION PRODUCTS GRATING # 2A

| $\lambda$ (Å) | 1st Order Efficiency (%) |
|---------------|--------------------------|
| 267           | 3.4                      |
| 284           | 3.2                      |
| 303           | 3.1                      |
| 323           | 3.1                      |
| 345           | 2.9                      |
| 375           | 2.7                      |
| 434           | 2.3                      |
| 452           | 2.3                      |
| 474           | 2.0                      |
| 508           | 1.8                      |

TABLE IV

EFFICIENCY MEASUREMENTS OF THE FIRST ORDER  
DIFFRACTED IMAGES BETWEEN 248 AND 555Å  
FOR DIFFRACTION PRODUCTS GRATING #1

| $\lambda$ (Å) | 1st Order Efficiency (%) |
|---------------|--------------------------|
| 248           | 4.8                      |
| 267           | 4.1                      |
| 284           | 3.7                      |
| 303           | 3.3                      |
| 323           | 3.3                      |
| 345           | 3.0                      |
| 375           | 2.3                      |
| 434           | 2.3                      |
| 452           | 2.5                      |
| 474           | 2.6                      |
| 508           | 2.4                      |
| 555           | 1.4                      |

**TABLE V**  
**RELATIVE EFFICIENCIES OF THE FIRST**  
**ORDER DIFFRACTED IMAGES BETWEEN 323 AND 555Å**  
**FOR DIFFRACTION GRATINGS #2371-1-1 AND #2458-1-2**

| $\lambda(\text{Å})$ | First Order Efficiencies (%) |                    |           |
|---------------------|------------------------------|--------------------|-----------|
|                     | #2371-1-1                    | #2371-1-1 plus 20% | #2458-1-2 |
| 323                 | 1.3                          | 1.6                | 1.1       |
| 335                 | 1.2                          | 1.4                | -         |
| 345                 | 1.2                          | 1.4                | -         |
| 363                 | 1.1                          | 1.3                | 0.9       |
| 375                 | 1.1                          | 1.3                | 0.7       |
| 435                 | 0.8                          | 1.0                | -         |
| 555                 | 0.5                          | 0.6                | 0.6       |
| RULED LENGTH 2 cm   |                              |                    | 2.4 cm    |