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THE UNIVERSITY OF MICHIGAN RADIO ASTRONOMY OBSERVATORY

OGO-III Data Reduction
OGO-II and IV Data Analysis

Final Technical Report
NASA Grant NGR 23-005-371

Submitted by:
Fred T. Haddock
Project Director

January 1971



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DEPARTMENT OF ASTRONOMY

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SUMMARY

The OGO-III radio astronomy experiment data processing effort has been completed for all data received to date. The data reduction completed under this Grant covered the period from September 30, 1967, through August 15, 1968. These data have been shipped to the NSSDC to supplement data previously submitted.

The OGO-II and OGO-IV data reduction and analysis effort has been completed to the fullest extent possible. These data will be shipped to the NSSDC in the very near future.

The purpose of the OGO-II and OGO-IV radio astronomy experiments were to map the brightness temperature of the sky at a frequency of 2.5 MHz, using a short monopole antenna on the spacecraft, and depending upon the ionospheric focussing effect to achieve angular resolution. The experiments operated for the life of the spacecraft, returning data from radiometers operating at 2.0 and 2.5 MHz, respectively, and measurements of the complex impedance of the antenna at 2.5 MHz as the spacecraft passed up and down through the ionosphere.

Radio-frequency interference generated within the spacecraft external to this experiment makes the interpretation of the radiometer data very difficult, and it appears impractical to extract mapping information from OGO-IV and impossible to extract it from the spinning OGO-II.

The antenna impedance measurements are not affected by the interference and represent a useful body of data for the study of the properties of the ionosphere, and the behavior of antennas in plasma.

In connection with the project, theoretical investigations have been carried out and papers and reports have been published in such fields as the behavior of antennas in plasma, and the propagation of electromagnetic waves in plasma.

I. INTRODUCTION

This is the Final Technical Report concerning the work supported under the National Aeronautics and Space Administration Grant NGR 23-005-371 for "OGO-III Data Reduction, OGO-II and OGO-IV Data Analysis". This Grant was awarded for a one year effort commencing on December 1, 1969. The OGO-III Data Reduction effort was started under NASA Contract NAS 5-2051 and continued under NASA Grant NGR 23-005-311. The OGO-II Antenna Impedance Study effort was started under NASA Contract NAS 5-3099 and continued under NASA Grant NGR 23-005-068. The OGO-IV Data Reduction and Analysis effort was started under NASA Contract NAS 5-3099.

The Radio Astronomy Observatory of the University of Michigan has carried out an extensive program of low-frequency observations from spacecraft. Measurements of the integrated brightness temperature of the celestial sphere were made from rockets, and low-frequency radiometers have been carried aboard each of the first five of the OGO-series spacecraft. Three of these, carried on OGO's I, III, and V, were designed primarily to study the low-frequency components of solar radio bursts. Radiometers aboard OGO's II and IV were designed to utilize the focusing effect of the ionosphere to obtain low-resolution maps of the low-frequency brightness temperature of the celestial sphere.

II. TECHNICAL DISCUSSION

A. OGO-III DATA REDUCTION

The effort on this portion of the Grant was to process all OGO-III data tapes received since processing was completed

under Grant NGR 23-005-311. This effort has been completed and the reduced data has been submitted to the NSSDC to supplement previously submitted data. The data tapes that were processed covered the time period from September 30, 1967 through August 15, 1968 with the exception of the following days for which we have not received data tapes:

<u>MONTH</u>	<u>YEAR</u>	<u>DAY NUMBER FOR MONTH</u>	<u>MISSING DAYS</u>
September	1967	273 - 274	274
October	"	275 - 304	276, 280, 283, 284, 286
November	"	305 - 334	326
December	"	335 - 365	
January	1968	1 - 31	
February	"	32 - 60	
March	"	61 - 91	
April	"	92 - 121	102, 103
May	"	122 - 152	129, 130, 141, 143
June	"	153 - 182	177
July	"	183 - 213	187
August	"	214 - 228	

B. OGO-II DATA ANALYSIS

The mapping experiment has encountered various problems, the most serious of which was the extremely high radio noise level. It gradually became obvious that no mapping information could be extracted from the OGO-II data because of the high noise level, the failure of the spacecraft to stabilize, and the high orbit of OGO-II (Potter, 1968). It has been possible, however, to utilize OGO-II data to study the wake produced by

the spacecraft as it moves through the ionosphere, an unexpected benefit (Yorks, Weil, and Potter, 1968; Yorks and Weil, 1970).

The study of the behavior of antennas in plasma constituted the entire effort under this portion of the Grant. This effort, in conjunction with support under other NASA Grants, resulted in the publication of three papers (Weil, April 1970; Weil and Yorks, 1970; and Weil and Lafon, 1971) and the presentation of another (Weil, June 1970).

C. OGO-IV DATA ANALYSIS

The data analysis effort performed under this portion of the grant was a continuation of the effort started under NASA Contract NAS5-3099. A convenient termination point could not be found and therefore the analysis continued without interruption from the Contract to this Grant. Most of the data reduction effort, as well as the engineering of the flight instrument, was supported under the contract. Work done under the grant has consisted largely of review and re-assessment of the method of scientific analysis, in an effort to find a satisfactory way of extracting mapping information.

The Final Report on this portion of the Grant has been written in conjunction with the Final Report on Contract NAS5-3099 for the above reasons. A brief outline of the OGO-IV Final Report (Potter, 1970), which is included herein as part of this Final Report, is as follows:

OGO-IV experienced a lower noise level than OGO-II, but higher than either OGO-III or V. It was obvious that this noise level would make it difficult to extract useful mapping information. Subsequent detailed analysis

and study has shown that it is indeed extremely difficult to extract mapping information, and probably impossible to do so. The large body of experiment data should, however, be useful in analyzing the properties of the ionosphere, and the behavior of the radio antennas in it.

Chapter II of this report covers the scientific background for the experiment. It includes discussions of the state of the art of low-frequency radio astronomy, the theory of ionospheric focusing, upon which the mapping experiment depends, and a discussion of the behavior of antennas in a plasma, such as the ionosphere.

Chapter III describes briefly the experiment, the spacecraft, and their history. A more complete report on this topic is the OGO-IV Final Engineering Report (Yorks and Cohen, 1969).

Chapter IV describes the methods developed for the analysis of the data, the various kinds of data collected by the experiment, and the forms in which the data now exist.

Chapter V summarizes the conclusions which may be drawn from the OGO-IV experience.

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