THE UNIVERSITY OF MICHIGAN
COLLEGE OF ENGINEERING
Department of Electrical Engineering
Space Physics Research Laboratory

Semi-Annual Report

THEORETICAL INVESTIGATION OF LANGMUIR PROBE CHARACTERISTICS AND OF ELECTRON TEMPERATURES IN THE IONOSPHERE AND PROTONOSPHERE AND OF AIRGLOW

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ORA Project 06106

supported by:

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
GRANT NO. NsG-525
WASHINGTON, D.C.

Administered Through:

OFFICE OF RESEARCH ADMINISTRATION ANN ARBOR

February 1968

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STATUS REPORT UNDER GRANT NO. NsG-525

COVERING THE PERIOD FROM 1 APRIL 1967 to 31 JANUARY 1968

The work on the problem of the nighttime cooling of the protonosphere has been completed. This work involved the simultaneous solution of the continuity, momentum, and energy equations along three geomagnetic field lines from an altitude of 1000 km in one hemisphere to the same altitude in the conjugate hemisphere. The field lines under consideration are the ones at 30°, 40°, and 50° geomagnetic latitudes. Our calculations include the effects of conduction, convection, and adiabatic expansion. Preliminary results were reported at the Spring URSI meeting in Ottawa (May 1967)[1]. This research constitutes the doctoral dissertation of P. Bauer. Copies of this thesis will be forwarded to the contracting office shortly. A paper based on the thesis is in preparation. It is planned to extend this work to higher latitudes in conjunction with our research on aurorae which is reported below.

The work on the calculation of the predawn electron temperature increase and the airglow enhancement has been completed, and the results were presented at the Conjugate Point Symposium held as part of the XIVth General Assembly of the International Union of Geodesy and Geophysics in Switzerland (September 1967)[2]. A paper based on this research has been accepted for publication by the Annales de Géophysique[3].

The photoelectron flux spectrum calculation which is part

of the above mentioned predawn work is at the present time being improved to include angular scattering and to use a more accurate electron-electron scattering cross section for lower energies. The program will also be modified to include photoelectron creation in both hemispheres so that it can be applied to a number of daytime problems. One of these is a cooperative effort with H. G. Mayr of the Goddard Space Flight Center to calculate ion composition profiles in the ionosphere. Another one is the calculation of daytime electron temperature profiles for comparison with experimental data.

During the reporting period a study of auroral emissions was begun. By using the energy dissipation data of Grün[4] it is possible to obtain the incident primary electron flux from the intensity of the N_2 3914Å emission. From these primary fluxes the secondary electron production rate spectra have been calculated by means of the method of Stolarski and Green[5]. With the assumption that the secondaries lose their energy locally, the excitation rate of any state due to primaries and secondaries has then been obtained and from it the intensities of emission of the corresponding lines. A paper containing these calculations has been written and will be submitted shortly to Planetary and Space Science.

The spherical ion trap experiment was launched aboard the University of Illinois - G.C.A. Nike-Apache NASA 14-305 from Puerto Rico on September 7. Unfortunately as on the previous flights the Vector telemetry transmitter failed again and telemetry signal was received only during the following

periods; 3·5 to 23·7 seconds, 30·3 to 56·2 seconds and 355·5 to 380 seconds. This means that no data were received above 70 km, and therefore no scientific information could be deduced from the ion trap experiment which operated perfectly throughout the flight. Since this was the third failure of the transmitter in that many flights of the type B payload, Dr. L. G. Smith of GCA Corporation undertook a thorough investigation of the problem; his findings[6] have already been reported.

During the reporting period the report on Langmuir probe characteristics[7] has been completed, and a paper based on this report has been submitted to the Journal of Applied Physics. In this paper the current-voltage characteristics of cylindrical and spherical Langmuir probes have been derived analytically for a general class of potentials. This led to a family of current-voltage characteristics which are identified by a variable parameter. By a comparison with the numerically determined current-voltage characteristics of Laframboise[8] it was then possible to determine the value of this parameter which lead to current-voltage curves in agreement with the numerically obtained ones. The method developed by us[7] will be used in the future to obtain the probe characteristics of a moving probe.

PERSONNEL PARTICIPATING DURING THE REPORTING PERIOD

Pierre Bauer	Ernest G. Fontheim
Abigail E. Beutler	Madhoo Kanal
William G. Dow	Andrew F. Nagy
Ahmad Z. Faruqi	Richard S. Stolarski

Various supporting and student (hourly) personnel

MONTHLY COST BREAKDOWN

Month	Wages		Overhead	Materials & Supplies	Travel
	Student	Non-Student			
April (67)	166.21	$5,888.92	$ 2,656.45	$ 198.54	$ 106.83
May	128.00	7,222.40	3,407.43	366.99	335.13
June	128.73	5,580.44	2,368.96	1,831.08	817.70
July	138.00	3,014.25	1,323.17	397.96	-
August	203.60	6,525.88	3,106.52	817.32	279.02
September	230.00	9,799.19	4,575.24	449.72	305.21
October	415.06	7,727.33	3,731.88	965.34	663.79
November	248.51	4,243.11	2,312.87	1,666.92	1,526.56
December	1,440.89	4,585.07	3,026.05	513.10	387.94
January (68)	242.29	3,358.72	1,801.39	1,090.32	-
Totals	$3,341.29	$57,945.31	$28,309.96	$8,297.29	$4,422.18

Grant Funding (1 October 1966 to 31 August 1968) NASA..$162,770.00
U of M... 8,566.00

Expenses Reported in previous semi-annual report covering period from 1 October 1966 to 31 March 1967.....45,868.00

Expenses Reported in this status report covering period from 1 April 1967 to 31 January 1968..... 102,316.03

Balance as of 31 January 1968 $ 23,151.97

As the above cost breakdown indicates, the financial support will in all likelihood be exhausted before the end of the grant period. Consequently work on some of the above mentioned problems will have to be suspended unless additional support becomes available under the grant or from other sources. This would affect

mainly the interesting and important new problems growing out of the just completed ones, like the calculation of ion composition in the ionosphere, the theory of the moving Langmuir probe, and the investigation of ionosphere-protonosphere interaction in the auroral region.

REFERENCES

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3) E. G. Fontheim, A. E. Beutler, A. F. Nagy, Theoretical Calculations of the Conjugate Predawn Effects, Annales de Géophysique, to be published (1968).

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6) L. G. Smith, Investigation of the D and E Regions by Integrated Payloads, Bi-Monthly Report No. 11 GCA Corporation, Bedford, Massachusetts (1967).

7) M. Kanal, W. G. Dow, E. G. Fontheim, Volt-Ampere Characteristics of Cylindrical and Spherical Langmuir Probes for Various Potential Models, Space Physics Research Laboratory, University of Michigan, Report No. 06106-8-T.

8) J. G. Laframboise, Theory of Spherical and Cylindrical Langmuir Probes in a Collisionless, Maxwellian Plasma at Rest, UTIAS Report No. 100, University of Toronto (1966).