SEMI-ANNUAL TECHNICAL SUMMARY

for the period ending 28 February 1970

to

ADVANCED RESEARCH PROJECTS AGENCY

RESEARCH OF AEROPHYSICS INSTITUTE
FOR STRATEGIC TECHNOLOGY
ARPA Order No. 1442 Program Code No. 9E30

PIBAL
Report 70-28

for
U.S. Army Research Office - Durham
Contract No. DAHC04-69-C-0077

POLYTECHNIC INSTITUTE OF BROOKLYN

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Date of Contract: 1 September 1969

Expiration Date: 31 October 1970

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U.S. Army Research Office-Durham
Contract No. DAHC04-69-C-0077

Submitted by: Martin H. Bloom
Principal Investigat
Director of Gas
Dynamics Research
Dean of Engineering

POLYTECHNIC INSTITUTE OF BROOKLYN

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ACKNOWLEDGEMENT

This research was supported by the Advanced Research Projects Agency of the Department of Defense and was monitored by U.S. Army Research Office-Durham, Box CM, Duke Station, Durham, North Carolina 27706, under Contract No. DAHC04-69-C-0077.

ABSTRACT

This report contains a compilation of abstracts of papers which were either accepted for publication or were published. The papers are in subjects of Fluid Dynamics, Electromagnetics and Plasmas. The work described was carried out under an ARPA contract, Order No. 1442. This summary also contains a listing of papers submitted to journals, lectures, internal reports and staff activities.

I. INTRODUCTION

The Polytechnic Institute of Brooklyn is conducting an interdisciplinary program involving both theoretical and experimental research in the areas of aerodynamics, plasma dynamics and turbulence. These studies are generally applicable to both current and long-range interests of the ARPA Strategic Technology Office. Particular emphasis is placed on items relating to defense situations.

II. SUMMARY OF RESEARCH PUBLICATIONS

In this section are presented abstracts of technical papers which have been either published or accepted for publication during the reporting period covered by this report.

A. Fluid Dynamics

G. Moretti, "The Importance of Boundary Conditions in the Numerical Treatment of Hyperbolic Equations", published in The Physics of Fluids, Suppl. II, 12, 12, Part II., December 1969.

Many of the existing computations of initial- and boundary-value problems in fluid mechanics suffer from unrealistic treatment of boundary points. Three categories of boundaries are discussed briefly: rigid walls, arbitrary boundaries of a computational region in a subsonic flow, and shock waves. An attempt is made to show in what sense the numerical treatment of such boundaries may be physically wrong and what can be done instead. Examples from the blunt body problem, the transonic flow in a nozzle, the incompressible inviscid flow past a circle, and the quasi-one-dimensional flow in a Laval nozzle, are shown.

S. Lederman, M.H. Bloom, and J. Avidor, "The Electrostatic Probe: Some Applications to Hypersonic Flow Diagnostics", to be presented and published in the Proceedings of the Twelfth Israel Annual Conference on Aviation and Astronautics, held in Tel Aviv, March 4-5, 1970.

Results of an experimental investigation of the applicability of electrostatic cylindrical probes for flow field diagnostics are presented. An experimental extension of the formulation of the free-molecular collisionless operation of cylindrical probes into the transitional and continuum regime is provided. It is shown that the power law valid for the free molecular collisionless regime with $0.1 < \frac{r_p}{\lambda_\infty} < 3$ is applicable in the transitional and continuum regime where $\frac{r_p}{\lambda_\infty}$ may exceed 3. Experimental results obtained in the wake of several models, using the electrostatic probe technique, are compared with results obtained by other means. These results confirm the basic principle and soundness of this technique.

B. Plasmas

E. Friedman and E. Levi, "Plasma Shielding", accepted for publication in The Physics of Fluids.

Necessary and sufficient conditions are established for the shielding of current-carrying plasmas by means of space charge sheaths. These conditions reduce to Bohm's shielding criterion in the particular case of zero current and in general are consistent with measurements obtained by means of Langmuir probes and their current interpretation.

III. ARPA-RELATED ACTIVITIES, LECTURES, CONSULTANTS, PAPERS SUBMITTED TO OUTSIDE JOURNALS, AND INTERNAL REPORTS

A. ARPA-Related Activities

Dean Martin H. Bloom is a member of the Atomic and Molecular Physics Panel of the Institute for Defense Analyses (IDA); Associate Editor of the Journal of Ballistic Missile Defense Research, published by IDA for ARPA; and is a member of the AIAA Technical Committee on Entry Vehicles.

Professor Robert J. Cresci is a member of the AIAA Ground Test and Simulation Technical Committee, and was a Session Chairman at the AIAA 6th Aerospace Sciences Meeting, held in New York, January 19-21, 1970.

Participation at meetings relevant to the program:

September 1969:

(a) L. B. Felsen presented an invited survey paper entitled "Ray Methods for Propagation and Scattering in Waveguides", at the 1969 European Microwave Conference, London, England, September 8-21, 1969.

(b) J. Griemsmann attended a DMB Meeting held in Washington, D. C., September 25, 1969.

October 1969:

(c) E.F. Widhopf and S. Lederman are authors of a paper, "Individual Specie Concentration and Vibrational Temperature Measurements Utilizing Laser Induced Raman Scattering", which was presented at the 20th Congress of the International Astronautical Federation, held

at Mar del Plata, Argentina, October 5-21, 1969.

November 1969:

(d) G. Moretti attended the Third Annual Aerodynamic Hypersonic Slender Cone Symposium, held in Arlington, Va., November 21, 1969.

December 1969:

(e) M.H. Bloom attended the AIAA Strategic Offensive/Defensive Missile Systems Meeting, held at the Naval Postgraduate School, Monterey, California, December 1-3, 1969.

(f) M.H. Bloom participated in an ARPA laser design review, held at AVCO-Everett, Everett, Mass., December 17-18, 1969.

January 1970:

(g) PIB-ARPA Workshop on "Gas Dynamics from a Numerical Standpoint", held at City University, New York, January 17, 1970.

Participants included:

Robert Moore - Advanced Research Projects Agency
F.L. Fernandez and M.H. Steiger - Aerospace Corporation
Michael Abbett - Aerotherm Corporation
Roberto Vaglio-Laurin - Advanced Technology Labs., Inc.
John G. Trulio - Applied Theory, Inc.
Dr. Magnus - General Dynamics Corp., Convair Div.
Paul Gordon - G.E., Valley Forge Space Tech. Center
N. D'Souza - McGill University
John V. Rakich - NASA Ames Research Center
S.Z. Burstein - New York University

S. A. Powers - Northrop Aircraft Div.
Thomas Taylor - Northrop Corporate Labs.
Morton Cooper - Office of Naval Research
C. Kentzer and Dr. Thompson - Purdue University
Raymond Sedney - Research Institute for Advanced Studies
M.H. Bloom, G. Moretti, R. Cresci, S.G. Rubin, E.L. Rubin, P.K. Khosla - Polytechnic Institute of Brooklyn

(h) L. B. Felsen presented an invited seminar entitled "Transients in Dispersive Media" at Wayne State Univ., Detroit, Mich., January 26, 1970.

(i) S. Lederman presented a paper entitled "Specie Concentration Measurements Utilizing Laser Induced Raman Scattering" (co-authored by G.F. Widhopf) at the AIAA 8th Aerospace Sciences Meeting, New York, N.Y., January 19-21, 1970.

B. Lectures

September 1969:

Dr. C. duP. Donaldson Aeronautical Research Associates of Princeton, Inc.	Calculation of Turbulent Shear Flows Through Closure of the Reynolds Equations by Invariant Modeling

October 1969:

Prof. B.W. McCormick, Jr. Pennsylvania State University	The Structure of Trailing Vortices and the Rotor-Vortex Interaction Problem
Dr. James Vollmer RCA Advanced Technology Labs.	Applied Science, Technology and Curricula
Dr. Mario D. Grossi and Mr. Irwin Shear Raytheon Company	Electromagnetic Probing of Planetary Atmospheres and Ionospheres

D. Datorsky Polytechnic Institute of Brooklyn	Radiation from a Directive Source in an Inhomogeneous Duct

November 1969:

Prof. A.R. Seebass Cornell University	Generation and Propagation of Sonic Booms
Dr. Herbert J. Carlin Cornell University	Helicon Mode Semiconductor Devices
J. C. Sureau Polytechnic Institute of Brooklyn	Element Pattern for Circular Arrays of Waveguide-Fed Axial Slits on Large Conducting Cylinders

December 1969:

Dr. Y. Zhidko Gorki State University, USSR	Compression of FM Pulses Propagating in an Inhomogeneous Plasma
Dr. G W. Sutton AVCO-Everett Research Laboratory	Fluid Mechanics Research at AVCO-Everett
Dr. H.L. Bertoni Polytechnic Institute of Brooklyn	The Local Properties of Radiation in Lossy Media

January 1970:

Prof. C.M. Tchen City College of the City University of New York	Cascade Model of Plasma Turbulence
Dr. W.D. Jones Oak Ridge National Laboratory	Some Basic Plasma Physics Research at Oak Ridge National Laboratory
Prof. Hans Wilhelmsson University of Uppsala, Sweden	Plasma and Related Research Activities at the University of Uppsala

February 1970:

Dr. J. Grey Greyrad Corporation	Diagnostics of High Temperature Gas Flows

During the course of this six-month period, Professor N. Marcuvitz (of N.Y.U.) gave a weekly lecture series on Plasma Turbulence.

C. Consultants

Dr. Nathan Marcuvitz, Professor of Applied Physics, New York University.

D. Internal Reports

C. F. Widhopf and S. Lederman, "Specie Concentration Measurements Utilizing Raman Scattering of a Laser Beam", PIBAL Report No. 69-46, Dept. of Aerospace Engineering and Applied Mechanics, Polytechnic Institute of Brooklyn, November 1969.

M. Pierucci, "An Axisymmetric Near Wake Analysis Using Rotational Characteristics", PIBAL Report No. 70-4, Dept. of Aerospace Engineering and Applied Mechanics, Polytechnic Institute of Brooklyn, February 1970.

Coordinated by M.H. Bloom, "Research of Aerodynamic Physics Institute for PROJECT STRATEGIC TECHNOLOGY". Semi-Annual Technical Summary for the period ending 31 August 1969, PIBMRY-R-1295.9-69.

IV. PERSONNEL

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E. F. Dawson	Research Assistant

R. Eichler	Graduate Assistant, Senior Grade
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J.W.E. Griemsmann	Professor
K. Huang	Graduate Assistant, Senior Grade
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Unclassified

Security Classification

DOCUMENT CONTROL DATA - R & D

(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)

1. ORIGINATING ACTIVITY *(Corporate author)*
Polytechnic Institute of Brooklyn
333 Jay Street
Brooklyn, New York 11201

2a. REPORT SECURITY CLASSIFICATION
Unclassified

2b GROUP

3. REPORT TITLE
Research of Aerophysics Institute for STRATEGIC TECHNOLOGY

4. DESCRIPTIVE NOTES *(Type of report and inclusive dates)*
Semi-Annual Technical Summary for period ending 28 February 1970

5. AUTHOR(S) *(First name, middle initial, last name)*
Principal Investigator: Martin H. Bloom

6. REPORT DATE	7a. TOTAL NO. OF PAGES	7b. NO. OF REFS
	8	0

8a. CONTRACT OR GRANT NO.	9a. ORIGINATOR'S REPORT NUMBER(S)
DAHC04-69-C-0077	PIBAL Report No. 70-28
b. PROJECT NO. ARPA Order No. 1442	
c. Program Code No. 9E30	9b. OTHER REPORT NO(S) *(Any other numbers that may be assigned this report)*
d.	

10. DISTRIBUTION STATEMENT
Distribution of this document is unlimited.

11. SUPPLEMENTARY NOTES	12. SPONSORING MILITARY ACTIVITY
	Advanced Research Projects Agency and U.S. Army Research Office-Durham

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DD FORM 1 NOV 65 1473

Unclassified

Security Classification

14. KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
Dispersive media						
Electron density distributions						
Kinetic theory						
Langmuir probes						
Near wake						
Numerical techniques						
Plasma striations						
Raman scattering						
Shock tube diagnostics						
Test facilities						