GEORGIA INSTITUTE OF TECHNOLOGY — OFFICE OF CONTRACT ADMINISTRATION

PROJECT ADMINISTRATION DATA SHEET

[x] ORIGINAL [ ] REVISION NO. _____

Project No. G-41-621 (follow-on to G-41-619) DATE 11/6/81

Project Director: Dr. J. Ford School/~~Lab~~ Physics

Sponsor: Department of Energy, Oak Ridge Operations

Type Agreement: Contract DE-AS05-81ER40003, Mod No. A001

Award Period: From 11/1/81 To 11/30/82 (Performance) _____ (Reports)

Sponsor Amount: $62,000 Contracted through:

Cost Sharing: none GTRI/~~GIT~~

Title: Numerical Studies of Arnol'd and Modulational Diffusion in the Beam-Beam Interaction of Intersecting Storage Rings

ADMINISTRATIVE DATA OCA Contact William F. Brown x4820

1) Sponsor Technical Contact:

2) Sponsor Admin/Contractual Matters:

J. D. Burleson, Contr. Officer
Contract Mgmt. Branch
Porcurement & Contracts Div.
Dept. of Energy
Oak Ridge Operations
P. O. Box E
Oak Ridge, TN 37830

Defense Priority Rating: _____ Security Classification: none

RESTRICTIONS

See Attached DOE Supplemental Information Sheet for Additional Requirements.

Travel: Foreign travel must have prior approval — Contact OCA in each case. Domestic travel requires sponsor approval where total will exceed greater of $500 or 125% of approved proposal budget category.

Equipment: Title vests with GIT, if acquired by us and listed in Appendix "A"

COMMENTS:

COPIES TO:

Administrative Coordinator
Research Property Management
Accounting
Procurement/EES Supply Services
Research Security Services
~~Reports Coordinator (OCA)~~
Legal Services (OCA)
Library
EES Public Relations (2)
Computer Input
Project File
Other _____

GEORGIA INSTITUTE OF TECHNOLOGY OFFICE OF CONTRACT ADMINISTRATION

2 BR407 224

SPONSORED PROJECT TERMINATION/CLOSEOUT SHEET

Date 10/24/83

Project No. G-41-621 School/~~Lab~~ XXX Physics

Includes Subproject No.(s) N/A

Project Director(s) Dr. J. Ford GTRI/~~GTL~~ XXX

Sponsor DOE, Oak Ridge, TN

Title: Numerical Studies of Arnol'd and Modulation Diffusion in the Beam-Beam Interaction of Intersecting Storage Rings

Effective Completion Date: 11/30/82 (Performance) 11/30/82 (Reports)

Grant/Contract Closeout Actions Remaining:

- [X] None
- [ ] Final Invoice or Final Fiscal Report
- [ ] Closing Documents
- [ ] Final Report of Inventions
- [ ] Govt. Property Inventory & Related Certificate
- [ ] Classified Material Certificate
- [ ] Other _____

Continues Project No. G-41-619

Continued by Project No. G-41-609

COPIES TO:

Project Director
Research Administrative Network
Research Property Management
Accounting
Procurement/EES Supply Services
Research Security Services
~~Reports Coordinator~~ (OCA)
Legal Services

Library
GTRI
Research Communications (2)
Project File
Other _____

Form OCA 58:1004

II. PROGRESS REPORT ON PREVIOUS AWARD: DE-AS05-81ER40003,A001

Our research has led to the following publications:

a) F. Vivaldi, "Weak Instabilities in Many-Dimensional Hamiltonian Systems," to appear in the Proceedings of the Workshop on the Beam-Beam Interaction, Fermilab (1982).

b) M. A. Liberman, B. V. Chirikov, and F. Vivaldi, "The Modulational Diffusion in the Beam-Beam Interaction," (in preparation).

c) F. Vivaldi, J. Ford, G. Casati, and I Guarneri, "Decay of Correlations in a Class of Hamiltonian Systems," Preprint, 1982, submitted to Physica D.

d) B. V. Chirikov, F. Vivaldi, and J. Ford, "Decay of Correlations in Near-Integrable Hamiltonian Systems," (in preparation).

e) N. Budinsky, F. Vivaldi, and A. Bountis, "Effects of Dissipation in Cylindrical Beams," (in preparation).

In References a-d above, we have developed a detailed analysis of the nature and features of stochastic motion in many-dimensional Hamiltonian systems with emphasis on the phenomenon of modulational diffusion. Our results allow one to determine analytically for any given system parameters the local rate of diffusion along stochastic (modulational) layers and to estimate the corresponding critical parameter values. With these tools, conditions for beam stability over long time scales can be formulated without the need for direct numerical simulations. Reference a contains a general introduction to the subject of weak instabilities as they appear in the beam-beam interaction. A more theoretical presentation of the phenomenon of modulational diffusion will be found in Reference b.

Previous numerical investigations of ours had revealed the existence of a set of critical values for one system parameter-- detune-- yielding a dramatic increase in the diffusion rate. This phenomenon has been further investigated in Reference c because of its great practical significance. The source of this instability has been found in a slow (power-law) decay of autocorrelation functions within the nodulational layers thereby disproving a widely held belief that correlations in stochastic layers exhibit an exponential decay rate. A theoretical discussion on the dynamical basis of the phenomenon is described in Reference c. Its application to the more delicate case of modulational layers in beam-beam models is currently under investigation and will be described in Reference d.

In our most recent research, we have begun a systematic analysis of the effects of dissipation in the beam-beam interaction. Specifically, we consider the case of cylindrically symmetric beams for which an invariant of the motion has been recently discovered.[10] This fact allows one to reduce the dimensionality of the problem and the problem is now that of a dissipative (area-contracting) map of the plane onto itself. Conditions for the beam stability as a function of machine parameters are formulated analytically and in closed form employing various perturbation schemes. This investigation is near completion and will be published shortly as Reference e.

III. PROPOSED RESEARCH

Our future research will be directed toward systematic investigation of four-dimensional dissipative maps which model the beam-beam interaction.