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The determination of large section cross section vortex rings and bubbles with swirl. I have been able to determine analytically vortex rings and bubbles with swirl via the Stokes stream-function from an isoperimetric variational viewpoint extending my previous work. Leapfrogging of Vortex Rings. In the case of thin vortex rings I have been able to establish analytically the Hamiltonian formulation and the calculus of variations.			
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22a. NAME OF RESPONSIBLE INDIVIDUAL Dr Arie Nachman		22b. TELEPHONE (Include Area Code) (202) 767-4939	22c. OFFICE SYMBOL NM



UNIVERSITY OF MASSACHUSETTS
AT AMHERST

1521B Lederle Graduate
Research Center Towers
Amherst, MA 01003
(413) 545-0267
(413) 545-2762

Center for Applied Mathematics
and Mathematical Computation

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Sandra E. Hudson
Department of the Air Force
Air Force Office of Scientific Research
Bolling Air Force Base, DC 20332-6448

Principal Investigator
Professor M.S. Berger

MS Berger

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A. Scientific Progress Achieved

- I. The determination of large cross section vortex rings and bubbles with swirl. I have been able to determine analytically vortex rings and bubbles with swirl via the Stokes stream-function from an isoperimetric variational viewpoint extending my previous work. I have begun (with a postdoctoral student) implementing my approach numerically.
- II. Vortex Breakdown and Bifurcation. I have been able to utilize my ideas in (I) above to study bubble-type (B type) vortex breakdown in terms of bifurcation between axisymmetric subcritical and supercritical equilibria.
- III. Leapfrogging of Vortex Rings. In the case of thin vortex rings I have been able to establish analytically the Hamiltonian formulation and the calculus of variations (large amplitude study of strictly periodic relative motion of (thin) vortex rings) (joint work with a Ph.D. student).
- IV. A New Type of Bifurcation for Time-Dependent Partial Differential Equations with Periodic Forcing. I discovered a type of bifurcation for nonlinear parabolic systems of p.d.e. (like the Navier-Stokes equations) periodic forcing differing substantially



D. Research Publications

- (i) Super-conducting vortices for the Ginzberg Landau equations,
to appear Journal of Function Analysis Nov. 1988 (66 page
manuscript)
- (ii) Axisymmetric Swirling Motion for Ideal Fluids, Contemporary
math vol. 72 p. 27-32
- (iii) Bifurcation from Equilibrium for Forced Nonlinear Evolution
equations (to appear) Bulletin Amer. Math. Soc.
- (iv) Remarks on Vortex Breakdown (to appear) Conference on
Vortex Dynamics AMS-SIAM
- (v) Vortex Rings with Swirl via the Streamfunction (in preparation)
- (vi) Leapfrogging Interaction of Vortex Rings in an Ideal Fluid
(in preparation).
- (vii) Helical Vortex Breakdown (to appear)
- (viii) Vortices in High T_c Superconductivity - A Historical Perspective
(to appear in volume Advances in Superconductivity 1988
Elsevier Publishers)



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No research was relevant to patents.