P.G. Saffman
Professor of Applied Mathematics

CALIFORNIA INSTITUTE OF TECHNOLOGY

APPLIED MATHEMATICS 217-50
FIRESTONE LABORATORY
PASADENA, CALIFORNIA 91125

pgs@ama-1.caltech.edu
FAX (818) 449-2677

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Dr M. Reischman
Office of Naval Research
Code 1132F
800 N. Quincy Street
Arlington, VA 22217-5000

Dear Mike

Research in Nonlinear Water Waves
Navy Grant No. N00014-89-J-1164

Quarterly letter progress report Apr 1, 1990 - Jun 30, 1990

Work has progressed in two areas. First, the study of finite amplitude waves and wave instabilities in the presence of a thin wind drift layer has continued. With regard to finite amplitude waves, the formulation of the problem in terms of integral equations for the surface shape, which will allow steep (or even overhanging) waves to be calculated, has been completed. The remaining task is to settle the counting issue, i.e. ensure that the number of waves is equal to the number of unknowns, which is proving to be a difficult and tricky problem, and then we should be able to start calculating wave shapes.

The stability work is also progressing well. Algorithms have been successfully developed to calculate the stability boundaries and growth rates for arbitrary profiles. We are now analysing various profiles and beginning to prepare the work for publication. It appears that the assumption of a 'stick' profile is good, provided the wind drift speed is high, but badly overestimates the growth rates in critical conditions when the instability is marginal. Comparison with experiment is uncertain, as there appears to be disagreement in the observational community about realistic values of the wind drift speed. It is clear, however, that uncovering the reasons for a discrepancy between the theoretical predictions and the observations will lead to an improved understanding of the generation mechanisms by which wind gusts produce waves. To date, the stability investigation has been restricted to two–dimensional disturbances. It is planned shortly to study the behavior of three–dimensional disturbances.

This work was recently presented at a DARPA/URI spring school in fluid dynamics at the Institute for Nonlinear Science at UCSD, and apparently well received.

The second area where progress has been made is in connection with the Hamiltonian formulation of water waves. Recent work by Zakharov and by Henyey has suggested that it would be worthwhile eliminating the cubic terms in the Hamiltonian for gravity waves on deep water by a normal form transformation. We have been studying, in the water wave context and other fields, the use of 'symplectic integrators' for Hamiltonian systems which make explicit use in the numerical solution of the equations of the fact that the system is Hamiltonian. Numerical methods are then employed that preserve the symplectic structure. We have tested the approach on model problems and shown that there is a significant increase in accuracy. This suggests that symplectic integrators may be an accurate method for calculating water waves. It is our intention to test this if and when resources allow.

I wish to inform you that I shall probably be on sabbatical leave in the period Jan 1 1991 to June 30 1991. However, I intend to continue devoting the same proportion of my time to research supported by the grant, and I expect to remain in contact with students and/or other colleagues working on the research through e-mail and by frequent visits to Caltech. I anticipate no difficulties in carrying out the research will be occasioned by my being on leave; in fact I expect significant benefit will be gained from discussions with other groups at the Universities which I visit.

With best wishes

Yours sincerely

Philip

P.G. Saffman

cc: ONR Pasadena
cc: Director, Naval Research Laboratory
cc: Defense Technical Information Center