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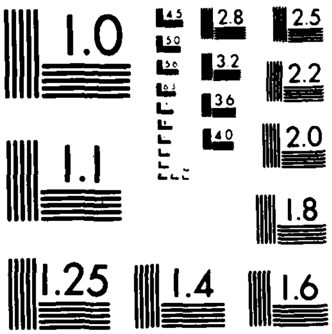

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David J. Kaub

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A total of 14 publications resulted from this work and 6 others have been accepted for publication. Short summaries for each publication are as follows:

Soliton Dynamics in the Presence of External Forces: a recent conjecture that solitons are not "newtonian particles" is discussed. It is shown that whether or not newtonian motion is observed will depend critically on the definition of the soliton's center.

Nonlinear Scattering of Whistlers by Electrostatic Fluctuations: sharply localized is demonstrated that such distributions could possible be explained by a modulational instability arising from interactions with ion-cyclotron waves.

The Forced Toda Lattice: An example od an Almost Integrable System: forced integrable systems are discussed using the forced Toda lattice as an example. It is demonstrated how these systems are almost integrable.

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FINAL REPORT

on AFOSR Grant #82-0154

for the three year period ending 30 Sept. 1986

The following is a final report on the work achieved during the above period.

1. Soliton Dynamics in the Presence of External Forces
[Phys. Rev. B 29, 1072-4 (1984)]

In this paper, a recent conjecture that solitons are not "newtonian particles" is discussed. It is shown that whether or not newtonian motion is observed will depend critically on the definition of the soliton's center.

2. Nonlinear Scattering of Whistlers by Electrostatic Fluctuations
[Phys. Rev. A 29, 396-8 (1984)] (coauthored by P.K. Shukla, M.Y. Yu and S.N. Antani)

Sharply localized distributions of whistler waves have been observed in the ionosphere and the solar wind. In this paper it is demonstrated that such distributions could possibly be explained by a modulational instability arising from interactions with ion-cyclotron waves.

3. The Forced Toda Lattice: An Example of an Almost Integrable System
[J.Math.Phys. 25, 277-81 (1984)]

In this paper, I discuss forced integrable systems using the forced Toda lattice as an example. I also demonstrate how these systems are 'almost integrable.'

4. The Soliton Birth Rate in the Forced Toda Lattice
[J.Math.Phys. 25, 282-4 (1984)] (co-authored with D.H. Neuberger)

The numerical analysis of the forced Toda lattice allowed us to demonstrate that one could quite easily predict the soliton birth rate in this system.

5. Whistler Scattering from Density Fluctuations in Magnetized Plasmas
[Phys. Fluids 27, 1169-75 (1984)] (coauthored with S.N. Antani)

The nonlinear interactions of whistler waves with density fluctuations in magnetized plasmas is studied. It is found that this will be a major interaction in proposed commercial Tokamaks, and that instead of nonlinearities dominating, the diffusion effects would dominate with a subsequent loss in the coherence of any such whistler beam.

6. The Squared Eigenfuntions of the Sine-Gordon Eigenvalue Problem [J. Math. Phys. 25, 2467-71 (1984)]

In this paper, the problem of closure for perturbations of the sine-Gordon equation in laboratory coordinates is solved. Most remarkable, it is shown that the eigenvalue problem for the squared eigenfunctions can be cast into the form of a standard eigenvalue problem. In this form, it is rather easy to prove closure.

7. The Toda Lattice as a Forced Integrable System [J. Phys. Soc. Japan 54, 4126-32 (1985), coauthored by P.J. Hansen]

It is demonsrated that the analytical properties of the Jost functions for the inverse scattering transform of the Toda lattice may be used to determine the time evolution of the scattering data. In this paper we demonstrate this for small but finite values of the time.

8. Forced Integrable Systems, D.J. Kaup, article in Wave Phenomena: Modern Theory and Applications, pp. 163-174, C. Rogers and T.B. Moodie (eds.), Elsevier Science Publishers B.V. (North Holland), 1984.

9. Motion of Damped Sine-Gordon Kinks in the Presence of Thermal Fluctuations [Phys. Rev. B 33, 1762-73 (1986), coauthored with El-sayed Osman]

10. Approximations for the Inverse Scattering Transform [in Dynamica Problems in Soliton Systems, pp 12-22. ed. S. Takeno, Springer-Verlag, NY (1985)].

11. Forced Integrable Systems - An Overview, D. J. Kaup, Lectures in Applied Mathematics 23, 195-215 (1986), eds. Basil Ncolaenko, Darryl D. Holm, and James M. Hyman.

12. Creation of a Soliton out of Dissipation, D. J. Kaup, Physica 19D, 125-134 (1986).

In this paper, I demonstrate that inverse scattering techniques can be useful even when one has heavy damping and the system is quite nonintegrable. In fact, I was able to show that the heavy damping does create solitons and could also somewhat predict the trajectories of their eigenvalues

13. The Forced Nonlinear Schroedinger Equation, D.J. Kaup and P.J. Hansen, Physica 18D, 77-84 (1986).
The numerical analysis of the forced nonlinear Schroediger equation is presented. It is demonstrated that a rather simple model allows us to quite easily predict the soliton birth rate in this system.

14. A New Interpretation of the Time Evolution of the Electric Field in a Crossed-field Device, Gary E. Tomas, W.M. Bollen, D.J. Kaup, B. Goplen, and L. Ludeking, International Electron Devices Meeting Technical Digest, Washington DC, Dec. 1-4, 1985, pp. 180-3.
In this paper, the numerical simultion of crossed-field devices are described along with the formation of the convective cell. These calculations are frequently referred to by our subsequent theoretical calculations.

In addition to the above, there are also the following preprints in various stages of being accepted for publication.

1. Nonlinear Schroedinger Solitons in the Forced Toda Lattice, D.J. Kaup (accepted for publication in Physica D). [INS preprint #48R, Nov. 1985]
In this manuscript I demonstrate that the long time asymptotics of the forced Toda lattice may be described in terms of the dark solitons of the stable form of the nonlinear Schroedinger equation.

2. Comments on the Inverse Scattering Transform for the Forced Toda Lattice, D. J Kaup and P. J. Hansen (accepted for publication in Physica D)
In this manuscript, we obtain a set of transformation kernals for the forced Toda lattice problem, and discuss how one could obtain the time-evolution of the scattering data by solving a particular Riemann-Hilbert problem. These results on the transformation kernals are expected to be essential in solving the singular integral equation which shall arise in this problem.

3. Linear Stability Analysis of the Vlasov-Poisson Equations in High Density Plasmas in the Presence of Crossed-Fields and Density Gradients, D.J. Kaup, P.J. Hansen, S. Roy Choudhury and Gary E. Thomas (accepted for publication in Phys. Fluids).
A singular perturbation method is used to solve this linear problem for a nonneutral electron plasma. With this solution of the linear problem, we are now able to go ahead and analyze the nonlinear problem for microwave devices.

4. The Full Second-Order Cold Fluid Theory of the Dioctron and Magnetron Instabilities, D. J. Kaup, S. Roy Choudhury, and Gary E. Thomas (submitted for publication in Phys. Rev. A).
In this manuscript, we show that the evolution of the cold fluid theory at the magnetron instability is also via a diffusion-like process which reshapes the zeroth-order profile on the slow-time scale. With this understanding of the evolution of the zeroth-order solution, we may now proceed on to the third-order, where we would expect to find the nonlinear Schroedinger equation.

5. Second-Order Stability Analysis of the Vlasov-Poisson Equations in High Density Plamas in the Presence of Crossed-Fields and Density Gradients, D.

J. Kaup, S. Roy Choudhury and G. E. Thomas (submitted for publication in Phys. Fluids).

This analysis demonstrates that the Vlasov theory of high frequency microwave devices can be different from that of the cold fluid model. In particular, it is demonstrated that the Vlasov theory predicts an updraft of all particles which lie above the wave-particle resonance layer.

6. Linear Stability of Vlasov-Poisson Electron Plasma in Crossed-Fields: Perturbations Propagating Parallel to the Magnetic Field, H.J. Lee, D.J. Kaup, and Gary E. Thomas (submitted for publication in Phys. Fluids).

In this manuscript, we demonstrate that the perturbations parallel to the magnetc field in this Vlasov system are stable as are their counterparts in the cold fluid theory. The proof of stability relies on a remarkable feature of the plasma dispersion relation which apparently was not recognized before.

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