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The main achievement in this grant were developing a scientific understanding of the role of variational principles in symplectic and energy - mometum integrators, and using this structure to study the energy oscillation properties of symplectic integrators. The role of locking phenomena that comes up in the numerical solution of structural dynamics problems has also been investigated.

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FINAL REPORT

Professor Jerrold E. Marsden - Grant # AFOSR-91-0133 Period: 1/1/91-12/31/91
Title: Dynamics of Deformable Bodies

This grant was used primarily for the partial support of the postdoctoral fellows, Shmuel Weissman and Vivien Kirk.
With Weissman, we developed, and are continuing to develop, mechanical integrators. The main achievements were:
--an understanding of the role of variational principles in symplectic and engergy-momentum integrators.
--the use of this structure to study the energy oscillation properties of symplectic integrators in both explicit examples, and with some partial theory.
--the role of locking phenomena that comes up in structural dynamics in the framework of general algorithms.
Some of this work is described in
Marsden, J.E. Lectures on Mechanics, London Mathematical Society Series, Volume 124, 1992. Other works are in preparation.

The work with Kirk focussed on Hamiltonian heteroclinic cycles. We found some interesting examples of the Hamiltonian analogue of heteroclinic cycles by taking the Hamiltonian part of the normal form of various problems, especially fluid problems of the sort studied by Armbruster and others, Silber and Knobloch. We have also obtained further insight into the link between Poisson structures and resonances that should be useful in this topic. We expect that our methods will be useful in the study of heteroclinic cycles and other phenomena in slightly dissipative systems.

Finally, the grant also partially supported the ongoing work of Marsden and Simo on stability and bifurcation in mechanical systems with symmetry, and the attendant numerical algorithms. Some relevant publications are:

1990 %Stabilization of rigid body dynamics by the energy-Casimir method, (with A. Bloch), Syst. Cont. Lett. 14, 341-6.

%Normalizing connections and the energy-momentum method, (with Lewis, Ratiu, and Simo), Proceedings of the CRM conference on Hamiltonian systems, Transformation Groups, and Sprctral Transform Methods, CRM Press, ed by Harnad and Marsden, 207-227.

%A note on symmetry and stability for fluid flows, (with S.-J. Chern), Geop. and Astro. Fluid Dyn. 51, 1-4.

%The energy-momentum method, (with Simo), La "Mecanique Analytique" de Lagrange et son H ritage, Atti della Accademia delle Scienze di Torino 124, 245-268.

%Stability of coupled rigid bodies and geometrically exact rods: Block diagonalization and the Energy-Momentum method, (with Simo and Posbergh), Physics Reports 193, 280-360.

1991 %Symmetry, stability, geometric phases, and mechanical integrators, (with O'Reilly, Wicklin, and Zombro), Nonlinear Science Today. 1, 1991

%Stability of relative equilibria, parts I and II (with Simo, Lewis, and Posbergh), ARMA 115, 15-100.

%The rotor and the pendulum, (with Darryl Holm), Symplectic Geometry and Mathematical Physics ed. by. P. Donato, C. Duval, J. Elhadad, and G.M. Tuynman, Birka
user, Boston, 189-203.

%Asymptotic stability, instability, and stabilization of relative equilibria, (with A.M. Bloch, P.S. Krishnaprasad, and T. S. Ratiu), Proc. American Control Conf. IEEE, TA2, 1120-1125.

1992 %Symplectic reduction and topology for applications in classical molecular dynamics, (with F. J. Lin), J. Math. Phys. 33, 1281-1294