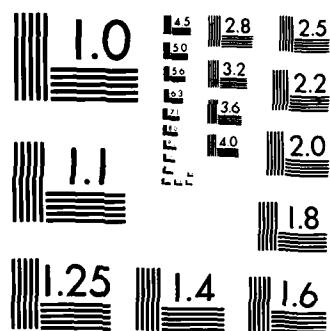


AD-A158 941 EFFECTIVE BEHAVIOR OF COMPOSITE MATERIALS(U) NEW YORK 1/1
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Title

EFFECTIVE BEHAVIOR OF COMPOSITE MATERIALS

Principal Investigator

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103

During this period two thesis ~~students~~ ^{visitors} have completed their work and have obtained the Ph.D. (September 1984):

M. Z. Guo -- Selfdiffusion of interacting Brownian motions

K. Golden -- Analytic continuation method for effective parameters

Guo is back in China now while Ken Golden won a National Science Foundation Fellowship and is at Rutgers University. In addition to Guo and Golden, B. Le Mesurier is supported by AFOSR for his thesis work on the nonlinear Schrödinger equation.

A. S. Sznitman was partially supported by AFOSR. P. L. Sulem and C. Sulem visited with us during June and July 1984, supported by AFOSR. Renato Spigler was also partially supported.

A list of papers, published and submitted for publication, is attached.

The main results of our work fall into three categories which we list in order of significance to our present and future work.

1. Focusing a singularity of the nonlinear Schrödinger equation.

We have solved by a careful analytical-numerical method the basic question of what the local rate of blow-up is for solutions of the nonlinear Schrödinger equation with cubic nonlinearity in 2 space dimensions. This problem is a basic one that arises in many aspects of nonlinear wave propagation.

The mathematical problem is at the center of a canonical problem to determine the nature of the self focusing singularity. We have found that the blowup is not like $t^{-2/3}$ ($t \rightarrow 0$ corresponds to reaching the singularity) by rather $t^{-1/2}$ times a slowly varying function that goes to infinity slower than $\log t$.

2. Selfdiffusion of interacting Brownian motions.

Using methods of wave propagation in random media that we had developed earlier, we were able to study the effective behavior of a tagged Brownian particle in interaction with an infinite system of other such particles. The problem is technically difficult but of basic importance in composite fluid materials, suspensions for example. This is the first complete mathematical theory for the problem.

3. Bounds for effective properties of composites by analytic continuation

Following earlier work (supported by AFOSR) on the use of analytic continuation, Golden and Papanicolaou obtained bounds for multicomponent media that was previously unknown and impossible to get by variational methods. The reason variational methods fail is because the problem is not selfadjoint. Interest in the nonselfadjoint case comes from trying to obtain frequency dependent bounds (not just static ones). The analytic continuation method was known to work only for two component

materials. In our work we extend it to multicomponent materials by using the theory of several complex variables.

Copies of the papers listed on the following page were sent to AFOSR on August 3, 1984, along with our proposal for renewal of this grant.

LIST OF PUBLICATIONS

Convection of Microstructure and Related Problems, D.W. McLaughlin, G.C. Papanicolaou and O.R. Pironneau, SIAM J. Appl. Math. To appear June 1985.

A Random Wave Process, D.A. Dawson and G.C. Papanicolaou, Appl. Math. Optim. 12 (1984) pp. 97-114.

Dynamic Theory of Suspensions with Brownian Effects, R. Caflisch and G.C. Papanicolaou, SIAM J. Appl. Math. 43 (1983) pp. 885-906.

Macroscopic Properties of Composites, Bubbly Fluids, Suspensions and Related Problems, G.C. Papanicolaou, Eyrolles, Paris, 1985.

Bounds for Effective Parameters of Heterogeneous Media by Analytic Continuation, K. Golden and G. Papanicolaou, J. Stat. Phys. To appear.

Focusing Singularity for the Nonlinear Schroedinger Equation, G. Papanicolaou, D. McLaughlin, P.L. Sulem, C. Sulem and B. LeMesurier, SIAM J. Appl. Math. Submitted.

Self-Diffusion of Interacting Brownian Particles, Part I, M.Z. Guo and G. Papanicolaou, Annals of Probability. Submitted.

Nonlinear Parametric Oscillations in Certain Stochastic Systems: A Random van der Pol Oscillator, Renato Spigler, J. Stat. Phys. Submitted.

A Stochastic Model for Lower Hybrid Wave Scattering by Density Fluctuations, William Grossmann and Renato Spigler, Phys. of Fluids. To appear.

A Stochastic Model for Nonlinear Oscillators of Duffing Type, Renato Spigler, SIAM J. Appl. Math.

A Propagation of Chaos Result for Burgers' Equation, A.S. Sznitman, Zeitschrift für Wahr. Submitted.

A Multidimensional Process Involving Local Time, A.S. Sznitman and S.R.S. Varadhan, Zeitschrift für Wahr. Submitted.

Bounds for Effective Parameters of Multicomponent Media by Analytic Continuation II, K. Golden, J. Mech. of Solids and Structures.

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