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COMPUTATIONAL ACOUSTICS
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February 1, 1988 – January 31, 1990
Final Technical Report

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General Goal: To develop accurate and efficient numerical models of the acoustic propagation problem. The main considerations were: long range propagation, short range propagation, one-way outgoing or incoming (no backscatter – PE's), two-way (backscatter – Elliptics), and liquid/solid interface.

General Approach: To model physical phenonmena using partial differential equations and to apply modern numerical methods of scientific computing to their solution. The main considerations were: stability, convergence, accuracy, efficiency, error estimates, well-posedness, and applicability.

Results Were Obtained on the Following Topics:

1.) Higher Order Parabolic Methods,
2.) Error Estimates in PE's,
3.) Higher Order PE Equations with Density – Interface considerations,
4.) Elliptic Models, Backscatter, Marching,
5.) Elliptic Marching, $L1 \circ L2(u) = g(r, u)$,
6.) IFD–Shear, Liquid/Solid Interface.

Results: Seven scientific papers were written and eleven (St. Mary associated) scientific presentations were made.

Scientific Papers:

1. Accurate computation of the wide angle wave equation, *Computation Acoustics: Wave Propagation, Proceedings of the 1st IMACS Symposium on Computational Acoustics*, D. Lee, R.L. Sternberg, M.H. Schultz editors, 1, Elsevier Science Publishing Co., INC., North Holland, New York, 409-422 (1988) (with D. Lee).

2. Marching methods for elliptic models of underwater sound propagation. *Computation Acoustics: Wave Propagation, Proceedings of the 1st IMACS Symposium on Computational Acoustics*, D. Lee, R.L. Sternberg, M.H. Schultz editors, 1, Elsevier Science Publishing Co., INC., North Holland, New York, 397-407 (1988) (with G.H. Knightly).

3. Accuracy of computational methods of underwater sound propagation, *Proceedings 12th IMACS World Congress, July 18-22, 1988, Paris*, R. Vichnevetsky, P. Borne, J. Vignes, editors, IMACS, Paris, 2, 234-236 (1988) (with G.H. Knightly, D. Lee).

4. Analysis and computation using higher order parabolic equations that include density variations, *Proceedings 12th IMACS World Congress, July 18-22, 1988, Paris*, R. Vichnevetsky, P. Borne, J. Vignes, editors, IMACS, Paris, 2, 237-240 (1988) (with G.H. Knightly, D. Lee).

5. Analysis of the accuracy of a computational method for the parabolic wave equation, *Numerical and Applied Mathematics*. W. F. Ames (ed.), J.C. Baltzer AG, Scientific Publishing Co., IMACS, 329-334 (1989) (with G.H. Knightly, D. Lee).

6. Derivation and discretization of parabolic equations containing arbitrary density functions, *Numerical and Applied Mathematics*. W. F. Ames (ed.), J.C. Baltzer AG, IMACS, Scientific Publishing Co., IMACS, 323-328 (1989) (with G.H. Knightly, D. Lee).

7. Computational ocean acoustics, to appear *Proceedings of the Second Edward Bouchet Conference on Physics and Technology*, Accra, Ghana, 99-108, 1990 (with G. H. Knightly).

REPORT OF INVENTIONS AND SUBCONTRACTS

(Pursuant to "Patent Rights" Contract Clause) (See Instructions on Reverse Side)

Form Approved
OMB No. 0704-0297
Expires Jun 30 1992

1a. NAME OF CONTRACTOR / SUBCONTRACTOR	c. CONTRACT NUMBER	2a. NAME OF GOVERNMENT PRIME CONTRACTOR	c. CONTRACT NUMBER	3. TYPE OF REPORT (X one)
University of Massachusetts	N00014-88-K-0264	SAME as 1a.	SAME as 1c.	a. INTERIM ☐ b. FINAL ☐
b. ADDRESS (Include ZIP Code)	**d. AWARD DATE (YYMMDD)**	**b. ADDRESS (Include ZIP Code)**	**d. AWARD DATE (YYMMDD)**	**4. REPORTING PERIOD (YYMMDD)**
Grant & Contract Admin. Amherst, MA 01003	02/01/88 - 01/31/91	SAME as 1b.	SAME as 1d.	a. FROM b. TO

SECTION I – SUBJECT INVENTIONS

5. "SUBJECT INVENTIONS" REQUIRED TO BE REPORTED BY CONTRACTOR / SUBCONTRACTOR (If "None," so state)

a. NAME(S) OF INVENTOR(S) (Last, First, MI)	b. TITLE OF INVENTION(S)	c. DISCLOSURE NO., PATENT APPLICATION SERIAL NO. OR PATENT NO.	d. ELECTION TO FILE PATENT APPLICATIONS				e. CONFIRMATORY INSTRUMENT OR ASSIGNMENT FORWARDED TO CONTRACTING OFFICER	
			(1) United States		(2) Foreign			
			(a) Yes	(b) No	(a) Yes	(b) No	(1) Yes	(2) No
NONE	NONE							

f. EMPLOYER OF INVENTOR(S) NOT EMPLOYED BY CONTRACTOR / SUBCONTRACTOR		g. ELECTED FOREIGN COUNTRIES IN WHICH A PATENT APPLICATION WILL BE FILED	
(1) (a) Name of Inventor (Last, First, MI) NONE	(2) (a) Name of Inventor (Last, First, MI)	(1) Title of Invention NONE	(2) Foreign Countries of Patent Application
(b) Name of Employer	(b) Name of Employer		
(c) Address of Employer (Include ZIP Code)	(c) Address of Employer (Include ZIP Code)		

SECTION II – SUBCONTRACTS (Containing a "Patent Rights" clause)

6. SUBCONTRACTS AWARDED BY CONTRACTOR / SUBCONTRACTOR (If "None," so state)

a. NAME OF SUBCONTRACTOR(S)	b. ADDRESS (Include ZIP Code)	c. SUBCONTRACT NO (S)	d. DFAR "PATENT RIGHTS"		e. DESCRIPTION OF WORK TO BE PERFORMED UNDER SUBCONTRACT(S)	f. SUBCONTRACT DATES (YYMMDD)	
			(1) Clause Number	(2) Date (YYMM)		(1) Award	(2) Estimated Completion
NONE							

SECTION III – CERTIFICATION Signatures

7. ~~INFORMATION OR REPORT IS~~ CONTRACTOR / SUBCONTRACTOR

a. NAME OF AUTHORIZED CONTRACTOR / SUBCONTRACTOR OFFICIAL (Last, First, MI)		c. I certify that the reporting party has procedures for prompt identification and timely disclosure of ~~INVENTIONS~~, that such procedures have been followed and that all ~~INVENTIONS~~ required to be disclosed have been reported.	
	Lee D. Beatty		
b. TITLE		d. SIGNATURE	e. DATE SIGNED
Principal Investigator	Director Grant & Contract Admin.	W.F. St. Mary of P.I.	Contracting Official

DD Form 882, OCT 89