ERCIM "ALAIN BENSOUSSAN"
FELLOWSHIP PROGRAMME

ERCIM
European Research Consortium
for Informatics and Mathematics

Scientific Report

First name / Family name	Jun Tang
Nationality	China
Name of the *Host Organisation*	NTNU
First Name / family name of the *Scientific Coordinator*	Hefeng Dong
Period of the fellowship	01/04/2019 to 31/03/2020

I – SCIENTIFIC ACTIVITY DURING YOUR FELLOWSHIP

The goal of this one-year research program was to extend the capability of the mode parabolic equation (MPE) method, which is a prediction method for the 3D acoustic fields in the oceans. More precisely, the MPE method was originally developed with an assumption of a fluid sea bottom, and our goal was to extend it to the case of an elastic

bottom. The difficulty of this goal turned out beyond our expectation at the time proposing it, so instead of fully achieving it we did some preliminary study on this topic as follows.

1. A series of numerical tests were carried out to check the feasibility of an idea: predicting the 3D acoustic fields in an elastic-bottom ocean waveguide by directly substituting the modal eigenvalues of such waveguide into the original version MPE. It turned out such idea is not feasible because in the MPE method, besides the eigenvalues, there are several other parameters related to media parameters of the bottom. Thus, the only way to extend the MPE method to the elastic-bottom case is reestablishing this method starting from the elastic motion equations instead of the acoustic wave equation.

2. The normalization and orthogonality relation (ONR) of the normal modes in an elastic-bottom waveguide was revisited. The ONR is the key to derive the adiabatic equation corresponding to each individual normal mode, and the adiabatic equation is a cornerstone of the MPE method. We found that even for a 2D sound propagation problem, the ONR for the elastic-bottom case is in a much more complicated form than that for the fluid-bottom case. We revisited the different versions of the ONR for the elastic-bottom case for a 2D problem and compared their capabilities. Meanwhile, the proper form of ONR for the elastic-bottom case for a 3D problem is still vague (to me) at this moment.

3. The derivation of the adiabatic equation for a 2D problem considering an infinite line source along the y direction in (x,y,z) coordinates was revisited. While derivation of the adiabatic equation for a 2D problem considering a point source in (r,φ,z) coordinates is still ongoing.

II – PUBLICATION(S) DURING YOUR FELLOWSHIP

Jun Tang, Hefeng Dong et al. On the adiabatic normal-mode method for P-SV wave propagation in oceans: Some notes on the derivation of the mode amplitude equation, *Proceedings of the 43rd Scandinavian Symposium on Physical Acoustics, Geilo, Norway, Jan. 26 – 29, 2020.* (to be published soon)

Chuanxiu Xu, **Jun Tang**. A propagation matrix method for the solution of the parabolic equation in ocean acoustics, *The Journal of the Acoustical Society of America*, 2019, 146(6): EL464-469

III – ATTENDED SEMINARS, WORKHOPS, CONFERENCES

43rd Scandinavian Symposium on Physical Acoustics, Geilo, Norway,

26-29 January 2020

IV – RESEARCH EXCHANGE PROGRAMME (REP)

I visited the wave propagation research group in FORTH, Greece during 10~14 February, 2020. My hosting scientific coordinator was Prof. John Papadakis.

I received warm welcome and hospitality from their group. I had a series of discussions with Prof. M. Taroudakis, Dr E. Skarsoulis, Dr E. Karasmani, and Dr E. Flouri, on the topics related to my previous and present research. I also gave a presentation covering all these topics. They gave me many valuable comments, advice, and criticism, and also great encouragement of continuing the research of this project despite the difficulties.