

## Progress Report of the Task Group on Scattering and Heterogeneity

June 19, 2006

The objectives of the Task Group are to promote the international collaborations and interactions among scientists around the world on wave propagation and scattering in heterogeneous earth. The specific tasks of the Task Group could include: Organize international meetings, workshops, training courses on the related topics; Exchange information in an international scope periodically through internet and e-mails; Compile progress reports on wave propagation and scattering in heterogeneous media, in which the theoretical and methodological progresses during the period should be summarized; Sponsor and organize special programs; Maintain a constructive relation with AGU, EGU, SEG, EAGE, SSA, SSJ, SEGJ and other regional, professional associations by co-sponsoring some symposia, workshops and training courses of common interests.

### 1. Members of the second term

The second term has started since the general assembly in Santiago. Followings are the members of the second term and Haruo SATO serves as the chair of the task group.

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## 2. Publications

### -First volume-

As a scientific product of the first term chaired by R. S. Wu, a book entitled "Advances in Wave Propagation in Heterogeneous Earth" (Eds. Wu and Maupin) has been completed as a volume of Advances in Geophysics Series of Elsevier Publishing (Series editor R. Dmowska). It is now in press and will appear this summer. Chapter titles are as follows:

1. Cerveny, V., L. Klimes and I. Psencik: Seismic Ray Method: Recent Developments
2. Maupin V.: Introduction to Mode coupling methods for surface waves
3. M. Bouchon and F. Sanchez-Sesma: Boundary Integral Equations and Boundary Element Methods in Elastodynamics
4. X. F. Chen: Generation and propagation of seismic SH waves in multilayered media with irregular interfaces
5. R. S. Wu, X. B. Xie and X. Y. Wu: One-way and one-return approximations for fast elastic wave modeling in complex media
6. R. S. Wu, X.Y. Wu and X. B. Xie: Simulation of high-frequency wave propagation in complex crustal waveguides using generalized screen propagators
7. Chaljub, E., D. Komatitsch, J. Vilotte, Y. Capdeville, B Valette and G. Festa: Spectral element analysis in seismology
8. Moczo, P., J. Robertsson and L. Eisner: The finite-difference time-domain method for modeling of seismic wave propagation
9. L. Huang: A Lattice-Boltzmann Approach to Acoustic Wave Propagation
10. H. Sato and M. Fehler: Synthesis of Scalar-Wave Evnvelopes in 2-D Random Media

### -Second volume-

Having received individual progress reports from active members and extended members of the task group, we have started to edit a book entitled "Scattering of Short-Period Seismic Waves in Earth Heterogeneity". It will be a volume of "Advances in Geophysics Series of Elsevier Publishing" supported by the Series editor, R. Dmowska. H. Sato and M. Fehler serve as editors of this book consists of 15 chapters.

### 3. Workshops and sessions

After the general assembly of IASPEI in Santiago in 2005, we have organized following workshops and sessions having the same objectives of our Task Group:

- \* Workshop on “Interpretation of physical properties of small scale heterogeneity in the lithosphere” (Convener J. Kawahara), Earthquake Research Institute, Univ. Tokyo, Tokyo, Japan, 12-13 Jan. 2006. Proceedings (in Japanese) are available from <http://www.eic.eri.u-tokyo.ac.jp/viewdoc/>
- \* Session on "Multiple Scattering, Random Wave Fields, and Dissipation" (Conveners: U. Wegler, M. Korn, and L. Margerin) was held at EGU General Assembly, Vienna, 2-7 April, 2006.
- \* Session on “Seismic wave propagation” (Conveners Nishizawa, O., H. Sato, H. Mikada, T. Matsuoka and T. Watanabe) and a Session on “Memorial session for late Kei Aki” (Conveners Yomogida, K., Sato, N. Hirata, M. Ukawa, and H. Kawase), Japan Geoscience Union Meeting, Makuhari, Japan, 14-18 May 2006.

### 4. Web site “Scattering and Heterogeneity in the Earth”

For exchanging scientific information about seismic wave scattering in the heterogeneous earth medium, we have maintained a special web site of our task group since 2001: <http://www.scat.geophys.tohoku.ac.jp/>. News about workshops, recent publications, and key references are updated.

### 5. Reports of scientific activities for 2003-2006

We have compiled scientific reports of individual members and active extended members of the task group as a state of the art summary for developments of studies on seismic wave propagation through earth medium heterogeneity since IUGG 2003 in Sapporo, Japan. A pdf file of this progress report “ProgRep2006.pdf” can be downloaded from the web site of this task group: <http://www.scat.geophys.tohoku.ac.jp/>. Contributing authors of this progress reports are N. Biswas, E. Del Pezzo, A. Kaslilar, J. Kawahara, M. Korn, Yu. A. Kravtsov, W. S. Lee, T. Maeda, S. Matsumoto, M. Miyazawa, T. M. Müller, Y. Murai, H. Nakahara, O. Nishizawa, J. Przybilla, T. Saito, F. J. Sánchez-Sesma, H. Sato, T. Takahashi, A. Ugalde, U. Wegler and K. Yoshimoto. The reports are in alphabetical order.

-Theoretical works and experimental works-

Francisco J. Sánchez-Sesma reported to deal with the Green function retrieval from correlations in the elastic 2D and 3D cases. Ayse Kasiliar, S. Shapiro, S. Buske and Yu. A. Kravtsov reported inverse scattering of surface waves and the analysis of travel time fluctuations in random media by using geometrical optics method. Kawahara reported envelope synthesis of SH waves in a crack distributed 2D medium based on numerical simulation. Michael Korn, Jens Pszbill and Ulrich Wegler reported the envelope synthesis of vector waves in random media based on the radiative transfer theory with the Born approximation. Ulrich Wegler reported diffusion of wave energy in layered scattering media. Haruo Sato and Michael Korn reported the envelope synthesis of vector waves in random

elastic media based on the Markov approximation for the parabolic equation. Tatsuhiko Saito reported the envelope synthesis of scalar waves in nonisotropic random media. Tobias Müller and Serge A. Shapiro reported scattering characteristics of seismic primary wave fields in 2-D and 3-D random media. Tobias Müller and Boris Gurevich reported attenuation and dispersion of seismic waves due to wave-induced flow in random poroelastic media. Osamu Nishimura and Genshiro Kitagawa reported phase fluctuation in random media revealed by laboratory rock experiments by using laser Doppler vibrometers.

-Observational works in regional scale-

Hisashi Nakahara reported envelope inversion studies for high-frequency seismic energy radiation from earthquake faults. Separation of attenuation into intrinsic and scattering loss characteristics was reported by Niren Biswas in Alaska and by Edoardo Del Pezzo at volcanoes in Italy, by Aranza Ugalde in western India. Kazuo Yoshimoto reported spatial distribution of S-coda-wave energy and seismic attenuation structure in Japan. Tsutomu Takahashi reported the path dependence of broadening of S-wave envelopes in Honshu, Japan. He found strong heterogeneity beneath Quaternary volcanoes and transparency between them. Satoshi Matsuoto developed a new method for inverting the array seismic data for the spatial distribution of S-wave scattering coefficient. Aranza Ugalde, E. Carcolé, and J. N. Tripathi reported coda envelope inversion for imaging the distribution of scatterers in the crust in southern India. Yoshio Murai reported the determination of a scatterer location by using an ocean bottom seismograph and controlled sources. Masatoshi Miyazawa detected triggering effect of earthquakes caused by a passage of seismic waves. Ulrich Wegler reported temporal change in velocity in volcanoes based on the coda interferometry.

-Observational works in global scale-

Won Sang Lee measured scattering coefficient in the mantle from the coda envelope analysis before and after ScS arrivals. Won Sang Lee found that a power law decay is more appropriate for explaining coda envelope decay for period from 1-10s in a long lapse time window. Takuto Maeda reported the dominance of higher modes for a period band of 100-200 sec at long lapse time as 20 hours from the origin time.

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