# NONLINEAR ACOUSTICS State-of-the-Art and Perspectives ISNA19

19th International Symposium on Nonlinear Acoustics

Tokyo, Japan 21 - 24 May 2012

#### Hosted by

Nonlinear Acoustics Society of Japan



# **EDITORS**

Tomoo Kamakura The University of Electro-Communications, Tokyo, Japan

> Nobumasa Sugimoto Osaka University, Osaka, Japan

## All papers have been peer reviewed.

#### **SPONSORING ORGANIZATIONS**

Acoustical Society of Japan (ASJ) Acoustical Society of America (ASA) International Union of Pure and Applied Physics (IUPAP)







## **DVD INCLUDED**



Melville, New York, 2012 AIP | CONFERENCE PROCEEDINGS ■ 1474

#### **Editors**

Tomoo Kamakura Graduate School of Informatics and Engineering The University of Electro-Communications 1-5-1 Chofugaoka Chofu-shi, Tokyo 182-8585 Japan

E-mail: kamakura@ee.uec.ac.jp

Nobumasa Sugimoto Department of Mechanical Science Graduate School of Engineering Science Osaka University Toyonaka, Osaka 560-8531 Japan

E-mail: sugimoto@me.es.osaka-u.ac.jp

Authorization to photocopy items for internal or personal use, beyond the free copying permitted under the 1978 U.S. Copyright Law (see statement below), is granted by the American Institute of Physics for users registered with the Copyright Clearance Center (CCC) Transactional Reporting Service, provided that the base fee of \$30.00 per copy is paid directly to CCC, 222 Rosewood Drive, Danvers, MA 01923, USA: http://www.copyright.com. For those organizations that have been granted a photocopy license by CCC, a separate system of payment has been arranged. The fee code for users of the Transactional Reporting Services is: 978-0-7354-1082-4/12/\$30.00.

© 2012 American Institute of Physics

No claim is made to original U.S. Government works.

Permission is granted to quote from the AIP Conference Proceedings with the customary acknowledgment of the source. Republication of an article or portions thereof (e.g., extensive excerpts, figures, tables, etc.) in original form or in translation, as well as other types of reuse (e.g., in course packs) require formal permission from AIP and may be subject to fees. As a courtesy, the author of the original proceedings article should be informed of any request for republication/reuse. Permission may be obtained online using RightsLink. Locate the article online at http://proceedings.aip.org, then simply click on the RightsLink icon/"Permissions/ Reprints" link found in the article abstract. You may also address requests to: AIP Office of Rights and Permissions, Suite 1NO1, 2 Huntington Quadrangle, Melville, NY 11747-4502, USA; Fax: 516-576-2450; Tel.: 516-576-2268; E-mail: rights@aip.org.

ISBN: 978-0-7354-1082-4 (Book)'\*Qtki kpcn'Rtkpv+ ISBN: 978-0-7354-1083-1 (DVD) ISBN 978-0-7354-1081-7 (Set) ISSN 0094-243X Printed in the United States of America

# AIP Conference Proceedings, Volume 1474 NONLINEAR ACOUSTICS State-of-the-Art and Perspectives 19th International Symposium on Nonlinear Acoustics

## **Table of Contents**

Preface: NONLINEAR ACOUSTICS State-of-the-Art and	
Tomoo Kamakura and Nobumasa Sugimoto	1
Scope of the Symposium	3
Committees	4
List of Participants	7
Early history of ISNA Mark F. Hamilton, Thomas G. Muir, and David T. Blackstock	11
<b>INVITED LECTURES</b> Sources and propagation of atmospherical acoustic shock waves François Coulouvrat	19
Understanding of thermoacoustic phenomena and their applications	
Tetsushi Biwa	29
Nonlinear acoustic/seismic waves in earthquake processes Paul A. Johnson	39
GENERAL THEORY OF NONLINEAR ACOUSTICS	
On the evolution of a spherical short pulse in nonlinear acoustics Bengt O. Enflo and Claes M. Hedberg	47

Low-frequency intrinsic localized modes in a spatially periodic and articulated structure of rigid members with elastic supports Yosuke Watanabe, Sojiro Awata, and Nobumasa Sugimoto	51
A study on bifurcations and structure of phase space concerning intrinsic localized modes in a nonlinear magneto-mechanical lattice	
Masayuki Kimura, Yasuo Matsushita, and Takashi Hikihara	55
Existence and stability of localized modes in one-dimensional nonlinear lattices	50
Kazuyuki Yoshimura	59
Modulational instability and chaotic breathers in two dimensional Fermi-Pasta-Ulam lattices	
Yusuke Doi and Akihiro Nakatani	63
<b>Controlled translation of an intrinsic localized mode</b> M. Sato, N. Fujita, S. Nishimura, Y. Takao, Y. Sada, W. Shi,	
S. Shige, and A. J. Sievers	67
NONLINEAR ACOUSTICS IN FLUIDS	
Peculiarities of shocks forming in high intensity acoustic beams in	
Mikhail Deriabin, Dmitry Kasyanov, and Vasily Kurin	71
Molecular dynamics study of sound propagation in a gas Takeru Yano	75
<b>Resonant gas oscillation with evaporation and condensation</b> Masashi Inaba, Takeru Yano, Masao Watanabe,	
Kazumichi Kobayashi, and Shigeo Fujikawa	79
Experimental study of acoustic streaming in a high level standing wave guide: Influence of mean temperature and higher harmonics	
I. Reyt, S. Moreau, H. Bailliet, and J-C. Valière	83
Numerical study of nonlinear streaming inside a standing wave resonator	
V. Daru, D. Baltean Carlès, and C. Weisman	87

Finite difference calculation of acoustic streaming including the boundary layer phenomena in an ultrasonic air pump on graphics processing unit array	
Yuji Wada, Daisuke Koyama, and Kentaro Nakamura	91
NONLINEAR ACOUSTICS IN MULTI-PHASE AND CAVITAT	ΓΙΟΝ
[Invited Paper] News from bubble dynamics: High static pressures, shock waves and interior dynamics	
W. Lauterborn, T. Kurz, P. Koch, M. Alizadeh, H. Sohnholz, and D. Schanz	95
[Invited Paper] Observing multi-bubble sonoluminescence in phosphoric acid	
Yang Kai, Maimaititusong Maimaitiming, Zhang Cui Ying, Zhu Qi Rong, and An Yu	103
[Invited Paper] Generation and aggregation of BaTiO <sub>3</sub> nanoparticles under ultrasound	
Kyuichi Yasui, Toru Tuziuti, and Kazumi Kato	111
<b>Instability and breakup of a gas-cored viscous annular jet</b> Takao Yoshinaga	119
Focused ultrasound induced free-surface breakup and damage in acrylic plates	
Yukio Tomita and Shigenori Tanaka	123
Bubble dynamics and decompression wave structure in a magmatic melt: Diffusion effects	
Valeriy K. Kedrinskiy	127
Theoretical study on the shape instability of an encapsulated bubble in an ultrasound field	
and Yoichiro Matsumoto	131
Pattern formation on the wall of acoustically driven gas bubble A. O. Maksimov and T. G. Leighton	135

Direct numerical simulations of nonspherical bubble collapse with nonequilibrium phase transition by the improved ghost fluid method	
Yoshinori Jinbo and Hiroyuki Takahira	139
Derivation of nonlinear wave equations for ultrasound beam in nonuniform bubbly liquids Tetsuya Kanagawa, Takeru Yano, Junya Kawahara, Kazumichi	1 4 2
Kobayashi, Masao Watanabe, and Shigeo Fujikawa	143
Model for the dynamics of a bubble undergoing small shape oscillations between elastic layers	
Yurii A. Ilinskii, Todd A. Hay, Evgenia A. Zabolotskaya, and Mark F. Hamilton	147
Nonlinear interaction among oscillating non-spherical bubbles Eru Kurihara	151
<b>Orbital motions of bubbles in an acoustic field</b> Minori Shirota, Ko Yamashita, and Takao Inamura	155
Two components of Na atom emission from collapsing bubbles in surfactant solutions	
Yuichi Hayashi and Pak-Kon Choi	159
Sonoluminescence, sonochemistry and bubble dynamics of single bubble cavitation	
Shin-ichi Hatanaka	163
Autoreduction of tetrachloride gold(III) ions and spontaneous formation of gold nanoparticles in sonicated water Toshio Sakai, Shoichi Miwa, Tomohiko Okada,	
and Shozi Mishima	167
NONLINEAR ACOUSTICS IN SOLIDS AND STRUCTURES	
Non-linear elasto-plastic shock wave simulation in high-velocity compaction by discrete element method	
Muhammad Shoaib and Leif Kari	171

Muhammad Shoaib and Leif Kari

Subharmonic wave analysis in crack using the developed FEM	
Tsuyosni Minara, Koji Snimaya, Yasusni ikegami, Takashi Furukawa, and Jehiro Komura	175
Takashi Tutukawa, and tenno Komura	175
Two dimensional model for subharmonic generation at closed	
cracks with damped double nodes	
Kazushi Yamanaka, Yohei Shintaku, and Yoshikazu Ohara	179
Formation and evaluation of closed stress corrosion cracks in	
Ni-based alloy weld metal for nuclear power plants	
Yoshikazu Ohara, Yohei Shintaku, Satoshi Horinouchi,	400
and Kazushi Yamanaka	183
Analysis of harmonic generation in Lamb wayes by finite-	
difference time-domain method	
Naoki Matsuda and Shiro Biwa	187
[Invited Paper] Nonlinear spectroscopy of closed delaminations	
and surface breaking cracks: Finite element simulations of	
clapping and nonlinear air-coupled emission	
Steven Delrue and Koen Van Den Abeele	191
[Invited Paper] Modeling of processes in structurally nonlinear modio with polovotion	
Lev Ostrovsky and Andrey Labedey	100
Lev Ostrovsky and Andrey Lebedev	199
Nonlinear Resonant Ultrasound Spectroscopy (NRUS) applied to	
fatigue damage evaluation in a pure copper	
Toshihiro Ohtani and Yutaka Ishii	203
Imaging of partial plastic deformation in thin metal plates by	
immersion nonlinear ultrasonic local resonance	
Koichiro Kawashima, Ryusuke Imanishi, Fumio Fujita,	
and Takumi Aida	207
Snear waves in a cubic nonlinear innomogeneous resonator	211
Theorem B. Krit, valery G. Andreev, and Oleg A. Sapoznnikov	211
A novel method for detecting second harmonic ultrasonic	
components generated from fastened bolts	
Makoto Fukuda and Kazuhiko Imano	215

Consideration of nonlinear vibration characteristic of object for irradiating highintensity ultrasonic waves by a	
Ayumu Osumi and Youichi Ito	219
Acoustic harmonic generation in a multilayered structure with nonlinear interfaces	
Yosuke Ishii and Shiro Biwa	223
NONLINEAR ACOUSTICS IN MEDICINE AND BIOLOGY	
Effects of the liposomal formulation on the behavior and physical characteristics of acoustic liposomes	
Nicolas Sax, Sachiko Horie, Li Li, Maya Sakamoto, Shiro Mori, and Tetsuya Kodama	227
Analysis of a bubble deformation process in a microcapsule by shock waves for developing DDS	
Masaaki Tamagawa and Kenshi Morimoto	231
Enhancement of cavitation inception by second-harmonic superimposition	
Shin Yoshizawa, Ryo Takagi, Jun Yasuda, and Shin-ichiro Umemura	235
Effective bandwidth extension by combined harmonics	
and Tomoo Kamakura	239
Linearization strategies for the Iterative Nonlinear Contrast Source method for full-wave simulation of nonlinear ultrasound fields	
Martin D. Verweij, Libertario Demi, and Koen W. A. van Dongen	243
Endoscopic optical coherence elastography using acoustic radiation force and a vibrating fiber	
Kentaro Nakamura, Ryoichi Isago, and Daisuke Koyama	247
Ultrasonic actuation of biological tissues using dual acoustic radiation force for assessment of elastic properties	
Hideyuki Hasegawa, Jun Yamaguchi, and Hiroshi Kanai	251

Acoustic radiation force on a sphere in tissue Yurii A. Ilinskii, Evgenia A. Zabolotskaya, and Mark F. Hamilton	255
Experimental study on temperature rise of acoustic radiation force elastography Marie Tabaru, Hideki Yoshikawa, Takashi Azuma, Rei Asami, and Kunio Hashiba	259
<b>Temperature elevation of biological tissue model exposed by</b> <b>focused ultrasound with acoustic radiation force</b> Naotaka Nitta, Nobuki Kudo, and Iwaki Akiyama	263
<b>Tissue lesion created by HIFU in continuous scanning mode</b> Tingbo Fan, Zhenbo Liu, and Dong Zhang	267
<b>Real-time sonoporation through HeLa cells</b> Spiros Kotopoulis, Anthony Delalande, Chantal Pichon, and Michiel Postema	271
Study of laser induced stress waves emerged by laser-target interaction Motoaki Nishiwaki, Mieko Kogi, Koji Aizawa, and Yoshiaki Tokunaga	275
THERMOACOUSTICS Improvement of energy conversion efficiency of thermoacoustic engine by a multistage stack with multiple pore radii Kohei Yanagimoto, Shin-ichi Sakamoto, Kentaro Kuroda, Yosuke Nakano, and Yoshiaki Watanabe	279
Thermoacoustic design using stem of goose down stack Irna Farikhah, Sigit Ristanto, Hadiyati Idrus, Ummi Kaltsum, Affandi Faisal, Ihsan Setiawan, and Agung Bambang Setio Utomo	283
Investigation of the acoustic field in a standing wave thermoacoustic refrigerator using time-resolved particule image velocimetry	
Ph. Blanc-Benon, G. Poignand, and E. Jondeau	287

Account of heat convection by Rayleigh streaming in the description of wave amplitude growth and stabilization in a standing wave thermoacoustic prime-mover.	
Guillaume Penelet, Matthieu Guedra, and Vitalyi Gusev	291
Numerical analysis of thermoacoustic spontaneous oscillations in a 2D rectangular and an axisymmetric closed tube Masahiro Ishigaki, Koichiro Shirai, Shizuko Adachi, and Katsuya Ishii	295
Numerical simulations of thermoacoustic oscillations in a looped tube	
D. Shimizu, K. Nishikawa, and N. Sugimoto	299
Measurement of temperature gradient in a stack of a prime mover in a loop-tube-type thermoacoustic cooling system Shin-ichi Sakamoto, Yoshitaka Inui, and Yoshiaki Watanabe	303
AEROACOUSTICS AND NONLINEAR ACOUSTICS IN ATMOSPH Nonlinearity analysis of model-scale jet noise Kent L. Gee, Anthony A. Atchley, Lauren E. Falco, and Micah R. Shepherd	<b>IERE</b> 307
[Invited Paper] A sonic boom propagation model including mean flow atmospheric effects Joe Salamone and Victor W. Sparrow	311
<b>Computational fluid dynamics simulations of infrasound</b> <b>generation process by meteorites</b> Martin Henneton, Philippe Delorme, Olaf Gainville, and François Coulouvrat	319
Interference patterns in non-homogeneous flow over the obstacles N. I. Makarenko and J. L. Maltseva	323
Acoustic waves in the atmosphere and ground generated by	
Mie Ichihara, John Lyons, Jun Oikawa, and Minoru Takeo	327

Numerical simulation of shock wave propagation in flows Mathieu Rénier, Régis Marchiano, Eric Gaudard, Louis-Jonardan Gallin, and François Coulouvrat	331
Global variation of sonic boom overpressure due to seasonal changes in atmosphere Hiroshi Yamashita and Shigeru Obayashi	335
Numerical simulation for sonic boom propagation through an inhomogeneous atmosphere with winds Masafumi Yamamoto, Atsushi Hashimoto, Takashi Takahashi,	
Tomoo Kamakura, and Takeharu Sakai Infrasound propagation in realistic atmosphere using nonlinear	339
ray theory Olaf Gainville, Philippe Blanc-Benon, and Julian Scott	343
Numerical and asymptotic solutions of generalised Burgers' equation Paul Hammerton and John Schofield	347
NONLINEAR ACOUSTICS AND OPTTICS/EXPERIMENTAL METHODS IN NONLINEAR ACOUSTICS	
Acoustic effects at interaction of laser radiation with a liquid	
A. V. Bulanov and I. G. Nagorny	351
Three-dimensional focus scanning by an acoustic variable-focus optical liquid lens	
Daisuke Koyama, Ryoichi Isago, and Kentaro Nakamura	355
Observation of acoustic streaming in water/sensor plate/thin water layer/128YX–LiNbO <sub>3</sub> for realizing disposable digital microfluidic system	
Jun Kondoh and Hitoshi Toyoizumi	359
Acoustic micromanipulation in a microchannel Teruyuki Kozuka, Kyuichi Yasui, and Shin-ichi Hatanaka	363

APPLICATION OF NONLINEAR ACOUSTICS TO DEVICE	'S TO DEVICES
--	---------------

[Invited Paper] Actively created quiet zones by parametric loudspeaker as control sources in the sound field	
Chao Ye, Ming Wu, and Jun Yang	367
Estimation of parametric sound field controlled by source amplitudes and phases using numerical simulation Hideyuki Nomura, Claes M. Hedberg, and Tomoo Kamakura	375
Modeling the directivity of parametric loudspeaker Chuang Shi and Woon-Seng Gan	379
Inverse system design based on the Volterra modeling of a	
parametric loudspeaker system Wei Ji and Woon-Seng Gan	383
<b>3D simulation of parametric ultrasound fields</b> Fabrice Prieur	387
Droplet propulsion on non-piezoelectric substrates induced by	
Lamb waves Wei Liang, Sabrina Tietze, Martin Schmitt, and Gerhard Lindner	391
On the two-dimensional patterning of inorganic particles in resin using ultrasound	
Toru Tuziuti	395
Dynamics of second harmonic in nonlinear surface acoustic waves and a proposal of its device application	
Koji Aizawa aliu Toshiaki Tokuliaga	398
Fujio Tsuruoka	402
Author Index	407