

## 16<sup>th</sup> International Symposium on Nonlinear Acoustics

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30 August 2002

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## 1. Keywords

**Nonlinear acoustics, Cavitation, nonlinear testing, medicine and biology, nondestructive testing. Optics, Mathematics.**

## 2. Introduction

The 16<sup>th</sup> International Symposium on Nonlinear Acoustics (ISNA-16) was held at M. V. Lomonosov Moscow State University (MSU) from 19-23 August 2002. The conference was supported by ONRIFO, MSU, the Russian Foundation for Basic Research (RFBR), the International Union of Pure and Applied Physics (IUPAP), the Ministry of Industry, Science and Technology of Russia (MISTR) and the Russian Academy of Sciences (RAS). This triennial event is the premier forum for the reporting of new and continuing work in this fast developing area of physical acoustics. The primary applications of nonlinear acoustics appear to be in the fields of diagnostic and therapeutic ultrasound and in non-destructive testing. There were approximately 350 registered attendees at this meeting with about one half traveling from outside Russia. A parallel conference in Modern Group Analysis (MOGRAN) was held in conjunction with ISNA-16. This meeting was dominated by Russian mathematics papers and had no US presentations.

## 3. Conference sessions

The conference ran in four simultaneous sessions ( one devoted to the MOGRAN meeting); hence it was not possible to cover every topic. Each session featured one or more invited half-hour presentations from leading scientists in that field followed by shorter contributed talks sessions were titled:

**1. General Theory, Mathematics, Numerical methods of Nonlinear Acoustics.**

General theory of nonlinear acoustic wave propagation, mathematical models, equations, analytical and numerical methods for solving nonlinear acoustics (NA) problems.

**2. Nonlinear Acoustics in Solid State Physics.**

Interaction of elastic waves. Nonlinear acousto-electronics, magneto-acoustics, and NA of crystals. Nonlinear phenomena accompanying high-intensity wave propagation in solids.

**3. Nonlinearity of Media and Structures, Nonlinear testing.**

Nonlinear properties of solids with inhomogeneities. Nonlinearities of structures. Nonlinear nondestructive testing of industrial products, materials, buildings, and geological structures.

**4. Nonlinear Acoustics of Fluids and Multi-Phase Media, Cavitation Phenomena.**

Nonlinear properties of fluids, polymers, composites and multi-phase media. Nonlinear wave propagation in such media. Acoustic cavitation, sonoluminescence, sonochemistry.

- 5. Nonlinear Acoustics in Medicine and Biology.**  
Nonlinear waves in biological tissue. NA methods in the diagnostics, therapy and surgery. Tissue harmonic imaging, bubble harmonic imaging, High-Intensity Focused Ultrasound (HIFU), and lithotripsy. Interaction of high-intensity waves with biological systems.
- 6. Nonlinear Acoustics of the Atmosphere, the Ocean and the Earth.**  
Nonlinear wave propagation through inhomogeneous geophysical media. Nonlinear phenomena in the atmosphere, the ocean and the earth. Sonic booms, acoustics of explosions and earthquakes.
- 7. Nonlinear Acoustics and Flows, Instabilities, Turbulence and Thermoacoustics.**  
Interaction of sound with gas-dynamic flows and generation of sound. Hydrodynamic instabilities and acoustic fields. Sound, jets, vortices and turbulence, Heat exchange stimulated by sound.
- 8. Nonlinear Noise and Chaos.**  
Statistical nonlinear acoustics. High-intensity noise and waves in randomly inhomogeneous media. Dynamic chaos in acoustical systems. Fractals in nonlinear acoustics.
- 9. Nonlinear Acoustics and Optics.**  
Interactions of light and sound. Acousto-optics and opto-acoustics. Related nonlinear phenomena in acoustics and optics. Self-focusing, stimulated scattering, selective dispersion and absorption phenomena.
- 10. Nonlinear Acoustics and Time Reversal Phenomona.**  
Nonlinear processes in the generation of phase conjugate waves. Nonlinear time reversed waves in homogeneous and inhomogeneous media. Applications of time reversed NA. Numerical methods and studies of nonlinear time reversal processes.
- 11. Devices and Industrial Applications of Nonlinear Acoustics.**  
Nonlinear acoustics phenomena used in devices, instruments, and technologies. Ideas, progress and perspectives.
- 12. Modern Group Analysis.**  
New theoretical developments and applications of Lie group analysis to nonlinear mathematical models in natural and engineering sciences.

## 4. Assessment

This conference offered an excellent opportunity to see and hear about international progress in this rapidly developing area of science. The fact that

nonlinear effects in acoustics are never very distant has been known and well documented since Lord Raleigh's time. However, until about 30 years ago, these nonlinearities were mostly seen as complicating factors in an otherwise tractable closed form analytical model of acoustics. With the advent of powerful computerized analysis methods these nonlinearities have now become essential elements of both theory and devices. Indeed, most of the topics investigated at this conference simply could not be studied and observed, and in the case of many devices, not operated, without the overt use of the nonlinear properties of acoustic and optic wave transmission. The next ISNA will be held in three years at Penn State University. Prof. Anthony Atchley is the chair of this conference. Additional information concerning this conference is available from the author of this report.

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