E-NEWSLETTER

February 2014 ISSUE

THE SOCIETY OF ACOUSTICS SINGAPORE

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Registration No: 0331/1989
Year of Registration: 1989

President: Dr Gan Woon Siong
Secretary: Prof Y F Zhou
Treasurer: Mr Alvin Ong

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I CONFERENCE NEWS

Fellow members of the Society may like to take note of the following:

21st International Congress on Sound and Vibration(ICSV21)

Date: 13-17 July 2014

Venue: Beijing,China

Deadline for Early Registration : **15 March 2014**

For Non Peer Reviewed Papers:

Abstract Deadline : **31st Janurary 2014**

Notification of Acceptance of Abstracts : **15 February 2014**

Deadline of Full-Length Submission : **15 March 2014**

For Peer Reviewed Papers:

Abstract Deadline : **1 December 2013**

Notification of Acceptance of Abstracts : **31 December 2013**

Deadline of Full-Length Submission : **31 January 2014**

For more information, please visit: www.icsv21.org

Please note that Woon Siong Gan will be organising three structured sessions for ICSV21 on:(i)Nonlinear acoustics and vibration, (ii)New acoustics, based on metamaterials, and (3)Application of Metamaterials to Sound Insulation and Noise Cancellation The closing dates for the 300 words abstracts is 1st March 2014. Kindly send abstracts directly to: wsgan@acousticaltechnologies.com or to www.icsv21.org.

Western Pacific Acoustics Conference(WESPAC)

Date: **6-10 December 2015**

Venue: **Singapore**

Organiser: Society of Acoustics(Singapore)

Website and key dates will be announced soon. Please send enquiries to: wsgan@acousticaltechnologies.com

II. ANNONCEMENTS

The Society of Acoustics will be sending out invoices to members with outstanding membership subscriptions. Members are encouraged to make payment in support of the Society.

The E-Newsletters will be made available to industrial contacts in an effort to promote the activities of the Society.

The Society is also exploring the possibility of organising talks and other professional events in collaboration with acoustic societies of other countries.

Membership Certificates will soon be made available to all members who had made full payments of membership dues

The Society aims to increase membership by inviting all persons, including those from the institution of higher learning and other related societies such as the Institute of Architects, Singapore and the members of the mechanical engineering division of the Institution of Engineers, Singapore who are qualified in the various field of Acoustics to join our Society.
We are especially keen to invite students to join our society and we are establishing the Youth Chapter soon.

III. MEMBERSHIP SUBSCRIPTION

Fellow	S$70
Member	S$50
Associate	S$30
Student	S$15
Corporate	S$200

FEE BASED ON ANNUAL RATE

FOR MORE INFORMATION PLEASE CONTACT: Dr.Gan at email: wsgan@acousticaltechnologies.com

Application form: ( ) Member ( ) Associate

1) Name: ____

2) Address: ____

Fax: _____________________ E-mail: ___________________________

3) Degrees (Institutions and dates):

____

4) Employment (with dates):

____

5) Signature & Date: ____

IV NEW BOOK ON ACOUSTICS AND VIBRATION

Acoustical Imaging: Techniques & Applications for Engineers

Woon Siong Gan

Hardback | 440 pages | June 2012 | ISBN 978-0-470-66160-4

£85.00 | €98.80 | $140.00

John Wiley & Sons

The technology of acoustical imaging has advanced rapidly over the last sixty years, and now represents a sophisticated technique applied to a wide range of fields including non-destructive testing, medical imaging, underwater imaging and SONAR, and geophysical exploration. Acoustical Imaging: Techniques and Applications for Engineers introduces the basic physics of acoustics and acoustical imaging, before progressing to more advanced topics such as 3D and 4D
imaging, elasticity theory, gauge invariance property of acoustic equation of motion and acoustic metamaterials. The author draws together the different technologies in sonar, seismic and ultrasound imaging, highlighting the similarities between topic areas and their common underlying theory.

Key features:

♦ Comprehensively covers all of the important applications of acoustical imaging.

♦ Introduces the gauge invariance property of acoustic equation of motion, and symmetry properties of acoustic fields with applications
in the elastic constants of isotropic solids, time reversal acoustics, negative refraction, double negative acoustical metamaterial and acoustical cloaking.

♦ Contains up to date treatments on latest theories of sound propagation in random media,
including statistical treatment and chaos theory.

♦ Includes a chapter devoted to new acoustics based on metamaterials, a field founded by
the author, including a new theory of elasticity and new theory of sound propagation in solids and fluids and tremendous potential in several novel applications.

Covers the hot topics on acoustical imaging including time reversal acoustics, negative refraction and acoustical cloaking.
Acoustical Imaging: Techniques and Applications for Engineers is a comprehensive reference on acoustical imaging and forms a valuable resource for engineers, researchers,
senior undergraduate and graduate students

V.ARTICLES

Symmetry is the Theoretical Framework of Metamaterials by Woon Siong Gan

In 2007 W S Gan proposed application of gauge invariance to acoustic fields [1]. This has been supported by the successful fabrication of acoustical metamaterials or sonic crystals. Since crystal, metamaterial has repetitive pattern or periodic structure or symmetry in pattern. Metamatrerial is a product of the form invariance of the acoustic equation of motion and the symmetry properties of the acoustic fields. Veselago[2] proposed double negative metamaterial based on the equation of dispersion relation for isotropic materials. This has the ambiguity of the choice of the negative sign in front of the square root of the product of dielectric constant and permeability. The application of symmetry principle avoids this ambiguity and in turn provides a unified theory for negative refraction amd cloaking[3] based on gauge invariance as negative refraction is a special case of cloaking when the determinant of the transformation matrix equals -1. The usual theory of cloaking is coordinates transformation. In fact, coordinates transformation like group theory are all mathematics of symmetry. The application of symmetry to acoustics has exploded in tremendous consequences. For instance, time reversal acoustics is an outcome of time reversal symmetry of the acoustic fields, isotropic solids have symmetrical elastic properties, acoustic diode is a consequence of broken symmetry in nonlinear acoustics, spontaneous symmetry breaking is the key to understanding of turbulence, the explanation of sonoluminescence by spontaneous symmetry breaking etc. This article is the first of a series of articles on the application of symmetry to acoustics which will appear in subsequent issues of this e-newsletter.

References

1. Gan,W S, Gauge invariance approach to acoustic fields, Acoustical Imaging,vol.29,ed, Iwaki Akiyama, 389-394,Springer,2007.
2. Veselago,V G, The electrodynamics of substances with simultaneously negative values of ε and μ.,Soviet Physics USPEKHI,vol.10,no.4,509-514,1968.
3. Gan,W S, Gauge invariance approach, a unified theory of negative refraction and cloaking, J.A.S.A.,vol.131,no.4, 3325,2012.

VI.RESEARCH NEWS

QUANTUM METAMATERIAL

by Woon Siong Gan

On September 30 2013 world's first quantum metamaterial unveiled. German researchers have designed, built and tested the first metamaterial made out of superconducting quantum resonators. In recent years, physicists have been excitedly exploring the potential of an entirely new class of materials known as metamaterials. This stuff is build from repeating patterns of sub-wavelength sized structures that interact with photons, steering them in ways that are impossible with naturally occurring materials. The first metamaterials were made from split-ring resonators(C-shaped pieces of metal) the size of dimes that were designed to interact with microwaves with a wavelength of few centimetres. These metamaterials had exotic properties such as a negative refractive index that could bend light"the wrong way". It does not take much imagination to think of a solution to this problem: use superconducting resonators that have zero internal resistance. That is a good idea in theory. In practice, however, it is hugely challenging. Apart from the obvious difficulty of operating at superconducting temperatures just above absolute zero, the main problem is that superconducting resonators are quantum devices with strange quantum properties that are fragile and difficult to handle. In particular, these properties are exponentially sensitive to the physical shape of the resonator. So tiny differences between one resonator and another can lead to huge differences in their resonant frequency. And since metamaterials are period array of structures with identical properties, that is a problem. Indeed, nobody has ever made a quantum metamaterial for precizely this reason. Today that changes thanks to the work of Pascal Macha at the Karlsruhe Institute of Technology in Germany and a few pals. These guys have build and tested the first quantum metamaterial,which they constructed as an array of 20 superconducting quantum circuits embedded in a microwave resonator. This experiment is a significant challenge. These guys fabricated their quantum circuits out of aluminium in a niobium resonator which they operated below 20 millikelvin. Their success comes from two factors. The first was in minimising the differences between each quantum circuit so there was less than 5per cent difference in the current passing through each. The second was in clever design. A quantum circuit influences an incoming photon by interacting with it. To do this as a group, the quantum circuits must also interact with each other. The problem in the past is that physicists had arranged the circuits in series so that the combined state must be a superposition of the states of all the circuits. So if a single circuit was out of kilter, the entire experiment failed. Macha et al got around this by embedding the quantum circuits inside a microwave resonator chamber about a wavelength long in which the microwaves become trapped. To interact with a photon, each quantum circuit need only couple with the resonator itself and its nearest neighbours. That is much easier to do with a large ensemble of quantum circuits. And the results show that is worked, at least in part. The interaction with the quantum circuits changes the phase of the outgoing photons in subtle but measurable ways. So by studying this change, Macha et al were able to work out exactly what kind of interaction was occurring. What they saw was that eight of the circuits formed a coherent group that influenced the photons. But over time, this dissociated into two separate groups of four quantum circuits. That raises the tantalising question of why the large assemble dissociated into two smaller ones, something that Macha et al will surely be investigating in future work. It also raises the prospect of a new generation of devices:"Quantum Circuits" based on this proof-concept experiment offer a wide range of prospects, from detecting single microwave photons to phase switching, quantum birefringence and superradiant phase transitions, say Mach et al. All in all, a significant first step for quantum metamaterials.

Reference

http://arxiv.org/abs/1309.5268: Implementation of Quantum

Metamaterial

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VII. USEFUL LINKS

Bodies

www.mom.gov.sg

www.nea.gov.sg

Technical and Research Sites

Corporate Sites

www.acousticaltechnologies.com

www.noisecontrols.com

(The Society welcomes interested parties to contribute relevant websites to the above e useful links. For more information, please contact us. Thank you.)

President: Woon Siong Gan
E-Newsletter compiled by: Woon Siong Gan