Optical Terahertz Science and Technology Topical Meeting and Tabletop Exhibit

March 18-21, 2007

Rosen Plaza Hotel
Orlando, Florida, USA

Housing deadline: February 14, 2007
Pre-Registration Deadline: February 26, 2007

2007 Optical Terahertz Science and Technology Topical Meeting

Technical Program Committee

Program Chairs

Peter Uhd Jepsen, *Technical Univ. of Denmark , Denmark*
Gwyn Williams, *Thomas Jefferson Natl. Accelerator Facility, USA*

Committee Members

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Dan Mittleman, *Rice Univ., USA*
Hiromasa Ito, *Tohoku Univ., Japan*
Andrea Markelz, *State Univ. of New York, USA*
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Masayoshi Tonouchi, *Osaka Univ., Japan*
Alan Cheville, *Oklahoma Univ., USA*
Peter Weightman, *Univ. of Liverpool, UK*
Peter Haring Bolivar, *Siegen Univ., Germany*

About OTST

SCOPE

This meeting will focus on developments in optical THz sources and detectors and their application to spectroscopy, sensing, microscopy and imaging. Emphasis will be placed on sources and applications at wavelengths between 30 and 3000 microns (0.1-10 THz).

Contemporary scientific topics will be highlighted in application areas such as:

- solid-state THz spectroscopic theory
- studies of THz electromagnetic scattering
- foundations for advanced THz imaging
- THz microscopy and microspectroscopy
- THz integrated optics
- interactions between THz photons and biological matter
- interactions between high-power THz radiation and matter
- remote sensing of gases and chemical/biological agents

The meeting also highlights the latest developments of novel coherent THz sources such as:

- quantum cascade lasers
- nonlinear media and ultrafast photoconductive materials
- advances in coherent THz antenna arrays
- emerging laser technology for use in optical THz sources and detectors

Meeting Topics To Be Considered:

- advanced THz imaging
- molecular, condensed-phase and biomolecular THz spectroscopy
- theoretical prediction of THz solid-state spectra
- THz scattering processes
- THz source development (photoconductive, electro-optic, quantum cascade lasers, accelerator-based sources)
- THz optics development
- THz systems

Invited Speakers

Progress in Long Wavelength Quantum Cascade Lasers, *Jerome Faist; Univ. of Neuchâtel, Switzerland.*

New Results with Waveguide THz-TDS, *Daniel Grischkowsky; Oklahoma State Univ., USA.*

The Nature of Terahertz Conductivity in Nanomaterials, *Frank Hegmann; Univ. of Alberta, Canada.*

Simulation and Assignment of the Terahertz Spectra of Molecular Solids, *Tim Korter; Univ. of Syracuse, USA.*

Coherent Synchrotron Radiation in Synchrotrons as a Broadband High Power Terahertz Source, *Mike Martin; Lawrence Berkeley Natl. Lab, USA.*

THz Polaritonics: Shaped Waveforms, Large Amplitudes, and Linear and Nonlinear Spectroscopy, *Keith Nelson; MIT, USA.*

Near-Field Microscopy of THz Surface Waves on Metal Structures, *Paul Planken; Delft Univ. of Technology, Netherlands.*

Terahertz Attenuated Total Internal Reflection Spectroscopy for Water and Water Solution, *Koichiro Tanaka; Kyoto Univ., Japan.*

Detection and Characterization of Detects in Aerospace Materials and Structures with Terahertz Pulses, *William Winfree; NASA Langley Res. Ctr., USA.*

Program Agenda

	Sunday, March 18, 2007	
3:00 p.m.–6:00 p.m.	**Registration Open**	*Regency Foyer*
	Monday, March 19, 2007	
7:00 a.m.–5:00 p.m.	**Registration Open**	*Regency Foyer*
7:30 a.m.-8:15 a.m.	**Continental Breakfast**	*Salon 5*
8:15 a.m.–10:00 a.m.	**MA • THz Nonlinear and Emission Spectroscopy**	*Salon 6&7*
10:00 a.m.–5:30 p.m.	**Exhibits Open**	*Salon 5*
10:00 a.m.–10:30 a.m.	**Coffee Break**	*Salon 5*
10:30 a.m.–12:30 p.m.	**MB • Biological Applications of THz Spectroscopy**	*Salon 6&7*
12:30 p.m.–2:00 p.m.	**Lunch Break (on your own)**	
2:00 p.m.–3:30 p.m.	**MC • THz Optics and Methodology I**	*Salon 6&7*
3:30 p.m.–5:30 p.m.	**MD • Poster Session, Coffee Break and Exhibits**	*Salon 5*
5:30 p.m.–7:30 p.m.	**Dinner Break (on your own)**	
7:30 p.m.–9:00 p.m.	**ME • Postdeadline Session**	*Salon 6&7*
	Tuesday, March 20, 2007	
7:00 a.m.–5:00 p.m.	**Registration Open**	*Regency Foyer*
7:30 a.m.-8:00 a.m.	**Continental Breakfast**	*Salon 5*
8:00 a.m.–10:00 a.m.	**TuA • THz Spectroscopy of Semiconductors and Nanomaterials**	*Salon 6&7*
10:00 a.m.–4:00 p.m.	**Exhibits Open**	*Salon 5*
10:00 a.m.–10:30 a.m.	**Coffee Break**	*Salon 5*
10:30 a.m.–12:30 p.m.	**TuB • THz Nondestructive Evaluation and Imaging**	*Salon 6&7*
12:30 p.m.–2:00 p.m.	**Lunch Break (on your own)**	
2:00 p.m.–3:30 p.m.	**TuC • THz Optics and Methodology II**	*Salon 6&7*
3:30 p.m.–4:00 p.m.	**Coffee Break**	*Salon 5*
4:00 p.m.–6:00 p.m.	**TuD • THz High-Power Sources**	*Salon 6&7*
6:00 p.m.–7:30 p.m.	**Conference Reception**	*Poolside*
	Wednesday, March 21, 2007	
7:00 a.m.–2:00 p.m.	**Registration Open**	*Regency Foyer*
7:30 a.m.-8:00 a.m.	**Continental Breakfast**	*Salon 5*
8:00 a.m.–10:00 a.m.	**WA • THz Spectroscopy of Solid-State and Metamaterials**	*Salon 6&7*
10:00 a.m.–10:30 a.m.	**Coffee Break**	*Salon 5*
10:30 a.m.–12:30 p.m.	**WB • Quantum Cascade Lasers and Other THz Sources**	*Salon 6&7*
12:30 p.m.–2:00 p.m.	**Lunch Break (on your own)**	
2:00 p.m.–3:30 p.m.	**WC • Guided THz Waves**	*Salon 6&7*

Optical Terahertz Science and Technology Abstracts

• Sunday, March 18, 2007 •

Regency Foyer
3:00 p.m.–6:00 p.m.
Registration Open

• Monday, March 19, 2007 •

Regency Foyer
7:00 a.m.–5:00 p.m.
Registration Open

Salon 5
7:30 a.m.–8:15 a.m.
Continental Breakfast

MA • THz Nonlinear and Emission Spectroscopy

Salon 6&7
8:15 a.m.–10:00 a.m.
MA • THz Nonlinear and Emission Spectroscopy
Masayoshi Tonouchi; Osaka Univ., Japan, Presider

MA1 • 8:15 a.m. **•Invited•**
THz Polaritonics: Shaped Waveforms, Large Amplitudes and Linear and Nonlinear Spectroscopy, *Keith Nelson; MIT, USA.* No abstract available.

MA2 • 8:45 a.m.
Generation of Strong Short Coherent Terahertz Pulses in Gases and Solids Using Quantum Coherence, *Nikolai G. Kalugin[1,2], Yuri V. Rostovtsev[2], Elena Kuznetsova[2], Marlan O. Scully[2,3]; [1]New Mexico Tech, USA, [2]Texas A&M Univ., USA, [3]Princeton Univ., USA.* An excitation of maximal quantum coherence in coherently driven media potentially yield strong controllable short pulses of THz radiation: the energies range from several nJ to micro-J and time durations from several fs to ns.

MA3 • 9:00 a.m.
Terahertz Emission from Indium Nitride Multiple Quantum Wells, *Grace D. Chern[1], Hongen Shen[1], Michael Wraback[1], Gregor Koblmüller[2], Chad Gallinat[2], James Speck[2]; [1]ARL, USA, [2]Univ. of California at Santa Barbara, USA.* We report enhanced terahertz emission from N-face InN/InGaN multiple quantum wells relative to that from bulk N-face InN when excited by 800 nm femtosecond optical pulses with low pump intensities.

MA4 • 9:15 a.m.
Investigation of Mechanism for Highly Efficient Terahertz Generation in InN Thin Films, *Xiaodong Mu[1], Yujie J. Ding[1], Kejia Wang[2], Debdeep Jena[2], Yuliya B. Zotova[3]; [1]Lehigh Univ., USA, [2]Univ. of Notre Dame, USA, [3]ArkLight, USA.* Efficient optical rectification has been demonstrated in InN thin films with sub-picosecond pump pulses at 790 nm. The highest average terahertz power of 931 nW has been generated at a pump power of 1 W.

MA5 • 9:30 a.m.
Ultrafast Nonlinear Terahertz Spectroscopy of n-Type GaAs, *Peter Gaal[1], Klaus Reimann[1], Michael Woerner[1], Thomas Elsaesser[1], Rudolf Hey[2], Klaus H. Ploog[2]; [1]Max-Born-Inst. Berlin, Germany, [2]Paul-Drude-Inst., Germany.* Nonlinear propagation experiments on n-type GaAs at room temperature reveal coherent polarizations with lifetimes of more than 1 ps upon excitation with intense ultrashort THz pulses.

MA6 • 9:45 a.m.
Influence of Increased Magnetization and Conductivity to the Terahertz Radiation Characteristics of Mn-Doped BiFeO3 Thin Films, *Kouhei Takahashi, Masayoshi Tonouchi; Inst. of Laser Engineering, Osaka Univ., Japan.* We have observed an enhancement of terahertz radiation in multiferroic BiFeO3 thin films by Mn doping, which however was less susceptible compared to the drastic change in magnetization and conductivity.

Salon 5
10:00 a.m.–10:30 a.m.
Coffee Break

Salon 5
10:00 a.m.–5:30 p.m.
Exhibits Open

MB • Biological Applications of THz Spectroscopy

Salon 6&7
10:30 a.m.–12:30 p.m.
MB • Biological Applications of THz Spectroscopy
Peter Haring; Univ. of Siegen, Germany, Presider

MB1 • 10:30 a.m. **•Invited•**
Terahertz Attenuated Total Internal Reflection Spectroscopy for Water and Water Solution, *Koichiro Tanaka; Kyoto Univ., Japan.* No abstract available.

MB2 • 11:00 a.m.
Determination of Alcohol Concentration in Aqueous Solutions and Food Analysis Using Reflection Terahertz Time-Domain Spectroscopy, *Uffe Møller[1], Hannes Merbold[2], Jacob R. Folkenberg[3], Peter U. Jepsen[1]; [1]Technical Univ. of Denmark, Denmark, [2]Univ. of Freiburg, Germany, [3]Foss A/S, Denmark.* We use self-referencing reflection THz spectroscopy to measure the alcohol- and sugar concentration with high precision in small volumes of aqueous solutions, independent of carbonation and the contents of yeast or other small organic particles.

MB3 • 11:15 a.m.
Dynamical Transition Observed in Lysozyme Solutions at THz Frequencies, *Joseph Knab, Jing-Yin Chen, Yunfen He, Andrea Markelz; State Univ. of New York at Buffalo, USA.* Temperature-dependent THz dielectric response of hen egg-white lysozyme (HEWL) solution was measured using THz-TDS. We observe a dynamical transition at 200K, corresponding to greater protein flexibility as a function of increasing temperature.

MB4 • 11:30 a.m.
Photonic Crystal Waveguides for Terahertz and Sub-Terahertz Sensing, *H. Kurt[1], T. Hasek[2], M. Koch[2], David Citrin[1]; [1]Georgia Tech, USA, [2]Inst. für Hochfrequenztechnik, Technische Univ. Braunschweig, Germany.* Two-dimensional photonic-crystal waveguides show promise for chemical sensing of fluids. It is shown theoretically that sensitivity to nanolitre volumes of analyte may be enabled. Actual structures functioning at ~0.1 THz are prototyped, characterized as proof-of-concept.

MB5 • 11:45 a.m.
Saturation of the Hydration Dependence of the Terahertz Dielectric Response of Ferri Cytochrome C, *Jing-Yin Chen[1], Joseph R. Knab[1], Andrea G. Markelz[1], Susan Gregurick[2]; [1]Physics Dept., State Univ. of New York at Buffalo, USA, [2]Dept. of Chemistry and Biochemistry, Univ. of Maryland, Baltimore County, USA.* THz dielectric response of ferri-cytochrome c films increases with increasing hydration with a turn over in the increase at 25% water by weight. Our calculated normal mode density shows a similar increase with increasing hydration.

MB6 • 12:00 p.m. **•Invited•**
Low-Frequency Protein Dynamics: A Combined Approach Using Scattering Experiments and Computer Simulation, *Lars Meinhold; Caltech, USA.* No abstract available.

12:30 p.m.–2:00 p.m.
Lunch Break (on your own)

MC • THz Optics and Methodology I

Salon 6&7
2:00 p.m.–3:30 p.m.
MC • THz Optics and Methodology I
Alan Cheville; Oklahoma State Univ., USA, Presider

MC1 • 2:00 p.m.
Rapid-Scanning THz Spectrometer Based on High-Speed ASOPS with >3 THz Bandwidth, *Albrecht Bartels[1,2], Roland Cerna[1], Caroline Kistner[1], Christof Janke[1,2], Thomas Dekorsy[1]; [1]Univ. of Konstanz, Germany, [2]Gigaoptics GmbH, Germany.* A rapid-scanning THz-spectrometer with 1GHz spectral resolution based on high-speed asynchronous optical sampling (ASOPS) is presented. Asynchronously linking two 1-GHz femtosecond-oscillators at their third repetition rate harmonic permits an improved system bandwidth of >3THz.

MC2 • 2:15 p.m.
Arbitrary THz Pulse Shaping via Optical Rectification in Fanned-out Periodically-Poled Lithium Niobate, *Yun-Shik Lee, Jeremy R. Danielson, Naaman Amer; Oregon State Univ., USA.* We demonstrate a flexible THz-pulse-shaping, manipulating spatially dispersed multi-frequency components generated by optical rectification in fanned-out PPLN. The spatial pattern and dispersion of THz pulses were controlled by a spatial mask and a spherical mirror.

MC3 • 2:30 p.m.
Holographic Fourier Transform Spectrometer for THz Region, *Nikolay I. Agladze, Albert J. Sievers; Cornell Univ., USA.* A multichannel spectrometer for THz region has been designed and built based on a static version of a Fourier transform spectrometer. Performance factors of this device are analyzed and first experimental results are presented.

MC4 • 2:45 p.m.
Frequency Counter for Optical Frequencies up to 40 THz, *Peter Gaal[1], Markus B. Raschke[1,2], Klaus Reimann[1], Michael Woerner[1]; [1]Max-Born-Inst., Germany, [2]Dept. of Chemistry, Univ. of Washington, USA.* Optical frequencies in the mid- and far-infrared spectral range are directly measured by electro-optic sampling with a femtosecond oscillator. First results are shown for a cw CO_2 laser.

MC5 • 3:00 p.m.
Terahertz Frequency-Domain Spectroscopy Referring to as Terahertz Frequency Comb, *Takeshi Yasui, Yasuhiro Kabetani, Shuko Yokoyama, Tsutomu Araki; Osaka Univ., Japan.* We proposed a high-accurate, high-resolution terahertz (THz) spectroscopy technique based on a THz frequency comb by combination of two mode-locked-frequency-stabilized femtosecond lasers and multi-frequency-heterodyning photoconductive detection.

MC6 • 3:15 p.m.
Electro-optic Effect with a Chirped Probe Pulse, *Balakishore Yellampalle, Ki-Yong Kim, George Rodriguez, James H. Glownia, Antoinette J. Taylor; Los Alamos Natl. Lab, USA.* We resolve a conflict that exists in literature on the theory of terahertz pulse detection schemes employing a chirped optical probe pulse. The correct expression differs from the conventionally used equation by a phase factor.

MD • Poster Session, Coffee Break and Exhibits

Salon 5
3:30 p.m.–5:30 p.m.
MD • Poster Session, Coffee Break and Exhibits

MD1 • 3:30 p.m.
Non-Destructive Terahertz Testing of Textured Liquid Crystal Polymers, *Frank Rutz[1], Steffen Wietzke[1], Heike Richter[2], Uwe Ewert[3], Martin Koch[1]; [1]Inst. für Hochfrequenztechnik, TU Braunschweig, Germany, [2]Inst. für Chemie und Biochemie – Kristallographie, FU Berlin, Germany, [3]Inst. for Materials Res. and Testing (BAM), Germany.* The texture of liquid crystal polymer (LCP) components determines their mechanical properties. Here, we demonstrate that the molecular alignment in injection molded LCP parts can be determined by their birefringence in the terahertz range.

MD2 • 3:30 p.m.
Fast THz Imaging of Styrofoam, *Boris Pradarutti[1], Gabor Matthäus[2], Stefan Riehemann[1], Gunther Notni[1], Stefan Nolte[2], Andreas Tünnermann[1,2]; [1]Fraunhofer IOF, Germany, [2]Inst. of Applied Physics (IAP), Germany.* Imaging of styrofoam with the help of ultrashort Terahertz pulses is investigated. With a combination of pulse amplitude and time delay imaging it is possible to speed up the measurement about two orders of magnitudes.

MD3 • 3:30 p.m.
TeraHertz Laser Generation by Optically Pumped Polar Molecules, *Leverson F. L. Costa[1], Ronaldo C. Viscovini[2], João C. S. Moraes[3], Flávio C. Cruz[1], Daniel Pereira[1]; [1]Univ. Estadual de Campinas - UNICAMP, Brazil, [2]Univ. Estadual de Maringá - UEM, Brazil, [3]Univ. Estadual Paulista - UNESP, Brazil.* Twelve new optically pumped far-infrared (FIR) laser lines is reported from CH_3OH and 19 from $^{13}CH_3OH$. A $^{13}CO_2$ laser was used as pump source, and a Fabry-Perot cavity was used as a FIR laser resonator.

MD4 • 3:30 p.m.
Does Hair Impose a Significant Effect on the Propagation of Terahertz Radiation in Human Skin?, *Peter M. Corridon[1], David Claudio[2], Ingrid Wilke[1]; [1]Rensselaer Polytechnic Inst., USA, [2]Pennsylvania State Univ., USA.* Thus far studies reported on the interactions of terahertz radiation and skin have centered on the dermal layers. However, we determined that there is a need to account for the effects from hair structures.

MD5 • 3:30 p.m.
Resonantly Enhanced Terahertz Transmission Using Aperiodic Arrays of Subwavelength Apertures, *Amit K. Agrawal[1], Tatsunosuke Matsui[2], Z. Valy Vardeny[2], Ajay Nahata[1]; [1]Dept. of Electrical and Computer Engineering, Univ. of Utah, USA, [2]Physics Dept., Univ. of Utah, USA.* We demonstrate that specific classes of aperiodic arrays of subwavelength apertures are capable of exhibiting strong, well-defined transmission resonances. The corresponding resonance frequencies can be well described by considering the aperture array structure factor.

MD6 • 3:30 p.m.
Theory of THz Excitation in High Mobility Nanowires due to a Hybrid Plasmon-Phonon-Polariton Instability, *Spilios Riyopoulos; SAIC, USA.* Unstable interaction of streaming electron plasma waves with phonon lattice waves causes THz excitation in high mobility nanowires. The coupled plasmon-phonon-polariton dispersion yields the instability growth rate and threshold. High gain amplification may allow lasing.

MD7 • 3:30 p.m.
Efficient THz Generation by Minimizing Two-Photon Absorption in a 450-μm-Thick GaP Wafer, *Xiaodong Mu[1], Yujie J. Ding[1], Yuliya B. Zotova[2]; [1]Lehigh Univ., USA, [2]ArkLight, USA.* We demonstrate that efficient THz generation is competing with two-photon absorption in GaP crystals. Through an optimization, the output power for the THz pulses as high as 4.4 μW was generated from a thin crystal.

MD8 • 3:30 p.m.
Narrow-Line, High-Repetition-Rate THz-Wave Generation from Collinearly Phase-Matched Difference-Frequency Mixing in Periodically Poled Lithium Niobate, *Tsong-Dong Wang, H. L. Chang, A. C. Chiang, Yen-Chieh Huang; Natl. Tsinghua Univ., Taiwan.* We report difference frequency generation of THz waves from collinearly phase-matched, periodically poled lithium niobate crystals. Transform-limited THz-wave pulses with a wavelength range between 191~211 μm were generated at a kHz repetition rate.

MD9 • 3:30 p.m.
A THz Transducer for On-Chip Label-Free DNA Sensing, *Mohammad Neshat, Daryoosh Saeedkia, Safieddin Safavi-Naeini; Univ. of Waterloo, Canada.* A new THz planar transducer is proposed, and its performance in terms of the analytic sensitivity and selectivity is investigated. Full-wave analysis results show promising capabilities of the transducer when used in THz DNA-base biosensors.

MD10 • 3:30 p.m.
Refractive Index at THz Frequencies of Various Plastics, *William R. Folks, Sidhartha K. Pandey, Glenn Boreman; Univ. of Central Florida, USA.* We measure the refractive index via a minimum deviation prism technique of various plastics from 70-290μm (1-4THz) using a tunable terahertz gas laser. We find these plastics have indices varying from 1.43-1.61 over this range.

MD11 • 3:30 p.m.
Monitoring the Dehydration of Artificial Skin by Time-Domain Terahertz Transmission Measurements, *Peter M. Corridon, Ingrid Wilke; Rensselaer Polytechnic Inst., USA.* We quantified the variations in the terahertz-frequency dielectric properties in artificial skin hydrated in saline spanning hypo-normal, normal and hyper-normal physiological conditions, during a 24-hour dehydration period in-vitro.

MD12 • 3:30 p.m.
Terahertz Emission from InGaP/InGaAs/GaAs Double Grating Gate HEMT Device, *Yahya M. Meziani[1], Mitsuhiro Hanabe[1], Akira Kouizumi[1], Taiichi Otsuji[1], Eiichi Sano[2]; [1]Tohoku Univ., Japan, [2]Hokkaido Univ., Japan.* We observed an emission of terahertz radiation from our new grating gate emitter. It was subjected to CW laser at room temperature. We report on the tuning of the resonance frequency by the gate bias.

MD13 • 3:30 p.m.
Terahertz Spectroscopy of Acetone Vapor, *Robert E. Peale[1], Andrei V. Muravjov[1], Justin W. Cleary[1], Tatiana Brusentsova[1], Chris J. Fredricksen[1], Glenn D. Boreman[1], V. L. Vaks[2], A. V. Maslovsky[2], S. D. Nikifirov[2]; [1]Univ. of Central Florida, USA, [2]Inst for Physics of Microstructures, Russian Federation.* Original terahertz spectra of acetone vapor-phase vibrational, torsional, and rotational transitions determine peak absorption cross sections for sensing applications.

MD14 • 3:30 p.m.
Terahertz Probing of Carrier Dynamics in Hg-Based High-Temperature Superconducting Thin Films, *Xuemei Zheng[1], Xia Li[2], Paul Cunningham[1], L. Michael Hayden[1], M. Valerianova[3,4], Š. Chromik[3], V. Štrbík[3], P. Odier[5], D. De Barros[5], Roman Sobolewski[2]; [1]Univ. of Maryland, Baltimore County, USA, [2]Univ. of Rochester, USA, [3]Slovak Acad. of Science, Slovakia, [4]Laboratoier de Cristallographie, France, [5]Lab de Cristallographie, France.* We report on our investigation of time-resolved carrier dynamics in a Hg-based high-temperature superconducting film (Hg-Ba-Ca-Cu-O), using optical excitation and THz probing. The observed picosecond time-scale photoresponse suggests the material's potential applications for high-speed photodetectors.

5:30 p.m.–7:30 p.m.
Dinner Break (on your own)

ME • Postdeadline Session

Salon 6&7
7:30 p.m.–9:00 p.m.
ME • Postdeadline Session
Peter U. Jepsen; Technical Univ. of Denmark, Denmark, Presider

• Tuesday, March 20, 2007 •

Regency Foyer
7:00 a.m.–5:00 p.m.
Registration Open

Salon 5
7:30 a.m.–8:00 a.m.
Continental Breakfast

TuA • THz Spectroscopy of Semiconductors and Nanomaterials

Salon 6&7
8:00 a.m.–10:00 a.m.
TuA • THz Spectroscopy of Semiconductors and Nanomaterials
Daniel Mittleman; Rice Univ., USA, Presider

TuA1 • 8:00 a.m. **•Invited•**
The Nature of Terahertz Conductivity in Nanomaterials, *Frank A. Hegmann[1], David G. Cooke[2], Markus Walther[3]; [1]Univ. of Alberta, Canada, [2]Technical Univ. of Denmark, Denmark, [3]Univ. of Freiburg, Germany.* Time-resolved terahertz spectroscopy is ideal for probing carrier dynamics, transport, and localization in nanomaterials. Models to describe the terahertz conductivity observed in nanomaterials are discussed, with an emphasis on the applicability of the Drude-Smith model.

TuA2 • 8:30 a.m.
Terahertz Probe of Carrier Trapping in Polymer Transistors, *James Lloyd-Hughes[1], Tim Richards[2], Henning Sirringhaus[2], Enrique Castro-Camus[1], Laura M. Herz[1], Michael B. Johnston[1]; [1]Univ. of Oxford, UK, [2]Univ. of Cambridge, UK.* The trapped charge density at the polymer-insulator boundary of polymer transistors was monitored by terahertz time-domain spectroscopy. Additionally, the thermal removal of trapped holes and the light-induced transmission change were studied.

TuA3 • 8:45 a.m.
Enhancement of Ultrafast Conductivity in Surface-Passivated GaAs, *James Lloyd-Hughes[1], Suzannah K. E. Merchant[1], Lan Fu[2], Hoe H. Tan[2], Chennupati Jagadish[2], Michael B. Johnston[1]; [1]Univ. of Oxford, UK, [2]Australian Natl. Univ., Australia.* Optical-pump/terahertz-probe spectroscopy and terahertz emission spectroscopy were used to measure the conductivity and surface electric field change resulting from passivating the surface of GaAs. An enhanced terahertz radiation generation from passivated photoconductive antenna was observed.

TuA4 • 9:00 a.m.
Photoconductivity of P3HT Films Measured by Time-Resolved THz Spectroscopy, *Okan Esenturk[1], Joseph Melinger[2], Edwin J. Heilweil[3]; [1]Univ. of Maryland, USA, [2]NRL, USA, [3]NIST, USA.* Photoconductivities of P3HT polymer films varying in molecular weight were directly measured and compared using optical pump-THz probe spectroscopy. Conductivities of P3HT polymers depend on the polymer length, ring orientation regularity and film morphology.

TuA5 • 9:15 a.m.
Characterization of Porous Silicon Using Terahertz Differential Time-Domain Spectroscopy, *Suchitra Ramani[1], Alan Cheville[1], J. Escorcia Garcia[2], Vivechana Agarwal[2]; [1]Oklahoma State Univ., USA, [2]CIICAP-UAEM, Mexico.* Porous silicon (PS) films of different porosities are investigated using Terahertz Differential Time-Domain spectroscopy (THz-DTDS). Preliminary measurements indicate a power law type of behavior in the PS conductivity response.

TuA6 • 9:30 a.m. **•Invited•**
Near-Field Microscopy of THz Fields near Metal Structures, *Paul Planken; Delft Univ. of Technology, Netherlands.* We present measurements and calculations of the THz electric field in the near-field of sub-wavelength metal structures.

Salon 5
10:00 a.m.–10:30 a.m.
Coffee Break

Salon 5
10:00 a.m.–5:30 p.m.
Exhibits Open

TuB • THz Nondestructive Evaluation and Imaging

Salon 6&7
10:30 a.m.–12:30 p.m.
TuB • THz Nondestructive Evaluation and Imaging
Mark Allen; Physical Sciences Inc., USA, Presider

TuB1 • 10:30 a.m. **•Invited•**
Detection and Characterization of Detects in Aerospace Materials and Structures with Terahertz Pulses, *William Winfree; NASA Langley Res. Ctr., USA.* No abstract available.

TuB2 • 11:00 a.m.
Time Domain Terahertz Non Destructive Evaluation of Ground Based Composite Radome Panels, *Jeffrey S. White, David A. Zimdars; Picometrix, LLC, USA.* We demonstrate the location and identification of delaminations and water intrusion in advanced composite materials used in ground based radome panels, shelters and towers using time domain terahertz imaging.

TuB3 • 11:15 a.m.
Terahertz Detection of Concealed Vibrations with a Sub-Micron Noise Floor, *Jerry Chen, Sumanth Kaushik; MIT Lincoln Lab, USA.* Our terahertz interferometer senses at a standoff sub-wavelength vibrations behind optically opaque barriers, such as cardboard, clothing and plastic. Measured spectral response compares favorably with optical vibrometry without barriers.

TuB4 • 11:30 a.m.
Non-destructive Testing of Plastic Welding Joints with Terahertz Imaging, *Steffen Wietzke[1], Frank Rutz[1], Benjamin Baudrit[2], Karsten Kretschmer[2], Martin Bastian[2], Martin Koch[1]; [1]Inst. für Hochfrequenztechnik, Technische Univ. Braunschweig, Germany, [2]Sueddeutsches Kunststoff-Zentrum, Germany.* We discuss the potential of pulsed terahertz imaging for non-destructive testing of plastic welding joints. Imperfections and contaminations within the weld joint face can clearly be detected by displaying the transmitted intensity.

TuB5 • 11:45 a.m.
Terahertz Time Domain Measurements of Marine Paint Thickness, *David J. Cook, Scott J. Sharpe, Seonkyung Lee, Mark G. Allen; Physical Sciences Inc., USA.* The suitability of time-domain THz methods for non-contact measurements of marine paint thickness was investigated. Under laboratory conditions a 95% confidence interval of 120 nm was observed when a 134 μm thick film was measured.

TuB6 • 12:00 p.m.
Terahertz Synthetic Aperture and Interferometric Imaging, *John Federici, Alexander Sinyukov, Robert Barat, Dale Gary, Zoi-Heleni Michalopoulou; New Jersey Inst. of Technology, USA.* Experimental results of terahertz 2-D synthetic aperture/ interferometric imaging are presented. The imaging method can be used to detect objects behind a barrier and spectroscopically identify materials that exhibit a characteristic THz reflection spectra.

TuB7 • 12:15 p.m.
Development of Fiber-Coupled High-Speed THz-TDS Imaging System for Large-Area Inspection of Post Matters, *Ryotaro Inoue, Masayoshi Tonouchi; Inst. of Laser Engineering, Osaka Univ., Japan.* We developed high-speed Terahertz Time-Domain Spectroscopy (THz-TDS) imaging system for large-area inspection of post matters. Fiber-coupled THz emitter and detector are mounted on a high-speed automatic stage for system-scanning imaging with the measured sample fixed.

12:30 p.m.–2:00 p.m.
Lunch Break (on your own)

TuC • THz Optics and Methodology II

Salon 6&7
2:00 p.m.–3:30 p.m.
TuC • THz Optics and Methodology II
David A. Zimdars; Picometrix, Inc., USA, Presider

TuC1 • 2:00 p.m.
Spatially Resolved Terahertz Pulse Propagation from an Aspheric Lens, *M. T. Reiten, R. A. Cheville; Oklahoma State Univ., USA.* High numeric aperture silicon lenses in terahertz systems incur strong aberration which impact spatial pulse profiles and coupling efficiencies. An aspheric lens's spectral response demonstrates less spatial amplitude variation compared to a standard collimating lens.

TuC2 • 2:15 p.m.
Fixed Thickness Differential THz-TDS to Improve SNR of Low Concentrations in the Liquid State, *Muthulingam Suresh, Paul Alexander, Sally Carruthers, Mike Johns, Lynn Gladden; Univ. of Cambridge, UK.* The capability of measuring low concentration liquid in highly absorbing THz medium of water is experimentally demonstrated by fixed thickness. Differential THz-TDS technique with highly increased sensitivity compare to the conventional THz experimental system.

TuC3 • 2:30 p.m.
Broadband Antireflective Surface-Relief Structure for THz Optics, *Claudia Brückner, Boris Pradarutti, Olaf Stenzel, Ralf Steinkopf, Stefan Riehemann, Gunther Notni, Andreas Tünnermann; Fraunhofer IOF, Germany.* An optimized antireflective surface-relief structure for THz optics was manufactured by single-point diamond turning into Topas® samples. Two effects of the structure are demonstrated: Increased transmittance and reduction of the modulations in the spectrum.

TuC4 • 2:45 p.m.
A Soleil-Babinet Compensator for THz Pulses, *Kyrus Kuplicki, Nicholas Oswald, Alan Cheville; Oklahoma State Univ., USA.* We report a frequency independent Soleil-Babinet compensator using a rotatable metal grating attached to a silicon prism. Rotation of the grating induces a frequency independent phase shift that can be varied over more than 3/2pi.

TuC5 • 3:00 p.m.
Monolithic Integration of a Waveguide-Integrated p-i-n-Photodiode and a Planar Antenna for THz Applications, *Reinhard Kunkel[1], Andreas Beling[1], Heinz-Gunter Bach[1], Giorgis G. Mekonnen[1], Detlef Schmidt[1], Cezary Sydlo[2], Daniel Schoenherr[2], Michael Feiginov[2], Hans L. Hartnagel[2], Peter Meissner[2]; [1]FhG Inst. for Telecommunications, Germany, [2]Inst. für Hochfrequenztechnik, TU Darmstadt, Germany.* A THz emitter chip has been designed and fabricated by combining a circularly-toothed planar logarithmic-periodic antenna and a waveguide integrated p-i-n photodiode monolithically in InP technology. Emitter is characterised at frequencies up to 120 GHz.

TuC6 • 3:15 p.m.
Terahertz Generation Using Unitravelling Carrier Photodiodes with Type-II Heterojunctions, *Angela Dyson, Ian D. Henning, Michael J. Adams; Univ. of Essex, UK.* Numerical simulation of unitravelling carrier photodiodes with type-II GaAsSb-InP heterojunctions gives good agreement of 3-dB bandwidth with published experimental results. Optimisation of this structure as a photomixer shows excellent potential for THz generation.

Salon 5
3:30 p.m.–4:00 p.m.
Coffee Break

TuD • THz High-Power Sources

Salon 6&7
4:00 p.m.–6:00 p.m.
TuD • THz High-Power Sources
Gwyn P. Williams; Jefferson Lab, USA, Presider

TuD1 • 4:00 p.m. **•Invited•**
Coherent Synchrotron Radiation in Synchrotrons as a Broadband High Power Terahertz Source, *Mike Martin; Lawrence Berkeley Natl. Lab, USA.* No abstract available.

TuD2 • 4:30 p.m.
The Jefferson Lab High Power THz User Facility, *Mike Klopf[1], Gwyn P. Williams[1], Alan Todd[2]; [1]Jefferson Lab, USA, [2]Advanced Energy Systems, USA.* We describe a broadband THz user facility at Jefferson Lab, which delivers an average power of 100 Watts, and a peak power of 10 MW of light into a user laboratory.

TuD3 • 4:45 p.m.
Production of kW-Power Pulses Tunable in the 0.5-3 THz Range for Amplification in a High-Gain FEL, *Sergei Tochitsky, Chieh Sung, Chan Joshi; Dept. of Electrical Engineering, Univ. of California at Los Angeles, USA.* 2 kW, 200 ns pulses were generated in a noncollinear phase-matched GaAs crystal pumped by line-tunable CO2 lasers. This pulse in the range 0.5-3.0 THz can be amplified to 5-100 MW in a single-pass FEL.

TuD4 • 5:00 p.m.
Toward High-Power Semiconductor Terahertz Laser, *Andrei V. Muravjov[1], Robert E. Peale[1], V. N. Shastin[2], Chris J. Fredricksen[3], Oliver Edwards[3]; [1]Univ. of Central Florida, USA, [2]Inst. for Physics of Microstructures, Russian Federation, [3]Zyberwear, USA.* Injection seeding can increase electric-to-optical conversion efficiency and output power of p-Ge lasers. Preliminary experimental results support the approach to the maximum theoretical limit of 10-100 W in the frequency range 1.5 - 4.2 THz.

TuD5 • 5:15 p.m.
Generation of Single-Cycle THz Pulses with μJ Energy by Tilted Pulse Front Excitation, *Ka-Lo Yeh, János Hebling, Keith A. Nelson; MIT, USA.* Generation of single-cycle THz pulses on the μJ energy range is demonstrated with optical rectification using tilted intensity front of the excitation laser pulse. Further scaling-up on the 10 μJ levels is in progress.

TuD6 • 5:30 p.m.
Power Scaleable, Fiber Pumped Optical Terahertz Source, *Daniel Creeden, John C. McCarthy, Peter A. Ketteridge, Timothy Southward, Peter G. Schunemann, James J. Komiak, Webster Dove, Evan P. Chicklis; BAE Systems, USA.* We have developed a power scaleable terahertz source based on fiber amplification and difference frequency mixing. Currently, 2mW of average THz power (20W peak) has been produced with 1ns pulses and a 0.137% conversion efficiency.

TuD7 • 5:45 p.m.
Intense Coherent Terahertz Radiation from Two-Color Photocurrent Mixing in Atmospheric Air, *Ki-Yong Kim, Balakishore Yellampalle, James H. Glownia, Antoinette Taylor, George Rodriguez; Los Alamos Natl. Lab, USA.* A transient photocurrent model is developed to explain terahertz emission from ultrafast ionization of air irradiated by femtosecond two-color laser fields. THz power scalability was also examined resulting in generation of 150 kV/cm field amplitudes.

Poolside
6:00 p.m.–7:30 p.m.
Conference Reception

• Wednesday, March 21, 2007 •

Regency Foyer
7:00 a.m.–2:00 p.m.
Registration Open

Salon 5
7:30 a.m.–8:00 a.m.
Continental Breakfast

WA • THz Spectroscopy of Solid-State and Metamaterials

Salon 6&7
8:00 a.m.–10:00 a.m.
WA • THz Spectroscopy of Solid-State and Metamaterials
Andrea Markelz; Univ. at Buffalo, USA, Presider

WA1 • 8:00 a.m. **•Invited•**
Simulation and Assignment of the Terahertz Spectra of Molecular Solids, *Timothy Korter; Syracuse Univ., USA.* The investigation of advanced theoretical methods to model and predict the terahertz (THz) spectra of molecular solids (e.g. explosives) will be described with the goal of understanding the underlying chemical origins of experimental spectral features.

WA2 • 8:30 a.m.
THz Spectroscopy of Dicyanobenzenes, *Okan Esenturk[1], Edwin J. Heilweil[2]; [1]Univ. of Maryland, USA, [2]NIST, USA.* THz absorption spectra of dicyanobenzene isomers exhibit ~10-fold enhanced absorption cross-sections compared to other measured organic systems. Observed internal and intermolecular features are readily assigned by comparing solid spectra to solution spectra and DFT calculations.

WA3 • 8:45 a.m.
Precise ab-initio Calculation of Terahertz-Frequency Vibrational Modes in Molecular Crystals, *Stewart J. Clark[1], Peter U. Jepsen[2]; [1]Durham Univ., UK, [2]Technical Univ. of Denmark, Denmark.* We use THz time-domain spectroscopy together with ab-initio DFPT methods to accurately predict the terahertz vibrational modes of molecular crystals. We demonstrate that vibrational modes in this region are phonon-like, strongly mixed with molecular modes.

WA4 • 9:00 a.m.
Terahertz-Conductivity of Nano-Structured Gold Films, *Markus Walther[1], Andreas Thoman[1], Craig Sherstan[2], Dave G. Cooke[2], Frank A. Hegmann[2]; [1]Univ. Freiburg, Germany, [2]Univ. of Alberta, Canada.* Terahertz (THz) time-domain spectroscopy is used to measure the complex conductivity of semi-continuous gold films in the spectral region 0.5-2.5 THz. The effects of the characteristic nano-structure of the films on their THz-conductivity are investigated.

WA5 • 9:15 a.m.
Temperature Dependence of Terahertz Emission from InMnAs, *Hui Zhan[1], Jason A. Deibel[1], Jonathan Laib[1], Chanjuan Sun[1], Junichiro Kono[1], Daniel Mittleman[1], Hiro Munekata[2]; [1]Rice Univ., USA, [2]Tokyo Inst. of Technology, Japan.* We observe a temperature-induced polarity reversal of the emitted terahertz field from the dilute magnetic semiconductor InMnAs under femtosecond laser illumination. It is related to the competition between the photo-Dember current and the surface-field-induced current.

WA6 • 9:30 a.m.
Coherent THz Cyclotron Oscillations in a Two-Dimensional Electron Gas, *Xiangfeng Wang[1], David J. Hilton[1], Lei Ren[1], Daniel M. Mittleman[1], Junichiro Kono[1], John L. Reno[2]; [1]Rice Univ., USA, [2]Sandia Natl. Labs, USA.* Time-domain THz spectroscopy of a GaAs two-dimensional electron gas in magnetic fields reveals long-lived coherent cyclotron oscillations. The temperature dependence of extracted decay times shows three pronounced regions where different scattering mechanisms dominate.

WA7 • 9:45 a.m.
Novel Terahertz Electric Metamaterials, *Hou-Tong Chen[1], John F. O'Hara[1], Antoinette J. Taylor[1], Richard D. Averitt[1], Clark Highstrete[2], Mark Lee[2], Willie J. Padilla[3]; [1]Los Alamos Natl. Lab, USA, [2]Sandia Natl. Labs, USA, [3]Dept. of Physics, Boston College, USA.* Planar electric metamaterials and their inverse structures are demonstrated to show complementary electrical resonant behavior in terahertz time-domain spectroscopy. Simulations and measured data agree well and illustrate potential applicability of these materials for terahertz devices.

Salon 5
10:00 a.m.–10:30 a.m.
Coffee Break

WB • Quantum Cascade Lasers and Other THz Sources

Salon 6&7
10:30 a.m.–12:30 p.m.
WB • Quantum Cascade Lasers and Other THz Sources
Benjamin Williams; MIT, USA, Presider

WB1 • 10:30 a.m. **•Invited•**
Progress in Long Wavelength Quantum Cascade Lasers, *Jerome Faist; Univ. of Neuchâtel, Switzerland.* No abstract available.

WB2 • 11:00 a.m.
Generation of Multi-Cycle Terahertz-Pulses in Periodically-Inverted GaAs Structures, *Yun-Shik Lee[1], Walter C. Hurlbut[1], Konstantin L. Vodopyanov[2], Martin M. Fejer[2], Vladimir G. Kozlov[3]; [1]Oregon State Univ., USA, [2]Stanford Univ., USA, [3]Microtech Instruments, Inc., USA.* We demonstrate multi-cycle THz waveforms in optically-contacted multi-layer, diffusion-bonded, and orientation-patterned GaAs, using optical rectification of 2μm, 100-fs pump pulses. THz pulses were characterized by two-color time-domain spectroscopy and Michelson interferometry.

WB3 • 11:15 a.m.
Design Limitations in Terahertz Quantum Cascade Lasers Caused by Thermally Activated Absorption Features, *J. Kröll[1], J. Darmo[1], K. Unterrainer[1], S. S. Dhillon[2,3], C. Sirtori[2,3], X. Marcadet[3], M. Calligaro[3]; [1]Vienna Univ. of Technology, Austria, [2]Univ. Paris 7, France, [3]Thales Group, France.* We present loss characteristics of a terahertz quantum cascade laser based on the bound-to-continuum design. By coupling broadband THz pulses into the laser's waveguide structure the spectrum of thermally activated absorption features is measured.

WB4 • 11:30 a.m.
An External Cavity 4.7 Terahertz Quantum Cascade Laser, *Joel M. Hensley[1], David B. Fenner[1], Mark G. Allen[1], Jihua Xu[2], Richard P. Green[2], Lukas Mahler[2], Alessandro Tredicucci[2], Fabio Beltram[2], Harvey E. Beere[3], David A. Ritchie[3]; [1]Physical Sciences Inc., USA, [2]NEST CNR-INFM and Scuola Normale Superiore, Italy, [3]Cavendish Lab, Univ. of Cambridge, UK.* An anti-reflection coated 4.7 terahertz quantum cascade laser coupled to an external cavity formed by a single moving mirror frequency tunes up to 4 wavenumbers with mode hops and around 0.4 wavenumbers without mode hops.

WB5 • 11:45 a.m.
The Influence of Doping on the Performance of Terahertz Quantum-Cascade-Lasers, *Alexander Benz, Gernot Fasching, Aaron Maxwell Andrews, Karl Unterrainer, Tomas Roch, Werner Schrenk, Gottfried Strasser; Vienna Univ. of Technology, Austria.* We present the effects of the doping concentration on a set of terahertz quantum-cascade-lasers emitting around 2.75 THz. The threshold current density decreases linearly with the doping. The output power drops monotonically.

WB6 • 12:00 p.m.
InGaAs nipnip Superlattice THz Emitters, *Sascha Preu[1], Micah Hanson[2], Tak Ling J. Wilkinson[3], Stefan Malzer[1], Arthur C. Gossard[2], Elliott R. Brown[3], Gottfried H. Döhler[1], Lijun Wang[1]; [1]Max Planck Res. Group, Univ. of Erlangen-Nuremberg, Germany, [2]Materials Dept., Univ. of California at Santa Barbara, USA, [3]Dept. of Electrical and Computer Engineering, Univ. of California at Santa Barbara, USA.* We report on InGaAs nipnip-superlattice photomixers with 1microwatt CW-output at 400 GHz. We show that the RC 3dB frequency can be significantly reduced by increasing the number of periods leaving the transit-time roll-off unaffected.

WB7 • 12:15 p.m.
Tunable Terahertz Generation inside a Synchronously-Pumped Optical Parametric Oscillator Using Quasi-Phasematched GaAs, *Joseph E. Schaar[1], Konstantin L. Vodopyanov[1], Martin M. Fejer[1], Xiaojun Yu[1], James S. Harris[1], Candace Lynch[2], David Bliss[2], Vladimir G. Kozlov[3]; [1]Stanford Univ., USA, [2]AFRL, Hanscom AFB, USA, [3]Microtech Instruments, Inc., USA.* We generated 1 of mW average THz power using quasi-phasematched GaAs as a frequency mixer between an optical parametric oscillator's (OPO) signal and idler waves. The output frequency was tunable from 0.65-3.4 THz.

12:30 p.m.–2:00 p.m.
Lunch Break (on your own)

WC • Guided THz Waves

Salon 6&7
2:00 p.m.–3:30 p.m.
WC • Guided THz Waves
Peter U. Jepsen; Technical Univ. of Denmark, Denmark, Presider

WC1 • 2:00 p.m. **•Invited•**
New Results with Waveguide THz-TDS, *Daniel Grischkowsky; Oklahoma State Univ., USA.* No abstract available.

WC2 • 2:30 p.m.
Radially Polarized THz Source Employing Velocity Mismatched Optical Rectification, *Guoqing Chang[1], Charles J. Divin[1], Chi-Hung Liu[1], Steven L. Williamson[2], Almantas Galvanauskas[1], Theodore B. Norris[1]; [1]Univ. of Michigan, USA, [2]Picometrix LLC, USA.* By exploiting velocity mismatch, we show that optical rectification can generate radially polarized THz pulses. A compact system is implemented using <001> cut ZnTe pumped by an ultrafast Yb-doped parabolic fiber amplifier.

WC3 • 2:45 p.m.
Coupling Multicycle Terahertz Pulses onto a Metal Wire Waveguide Using a Subwavelength Coaxial Aperture, *Amit Agrawal, Ajay Nahata; Univ. of Utah, USA.* We demonstrate a flexible approach for coupling multicycle terahertz pulses onto a metal wire. This is accomplished by inserting the wire into the center of a circular subwavelength aperture fabricated into a free-standing metal foil.

WC4 • 3:00 p.m.
Frequency-Dependent Radiation Patterns Emitted by THz Plasmons on Cylindrical Metal Wires, *Jason A. Deibel[1], Nicholas Berndsen[1], Kanglin Wang[1], Daniel Mittleman[1], Nick C. J. van der Valk[2], Paul C. M. Planken[2]; [1]Rice Univ., USA, [2]Univ. of Technology Delft, The Netherlands.* We report on the emission patterns from THz plasmons propagating along wire waveguides. Experimental results and numerical simulations show frequency-dependent diffraction occurring at the end of the cylindrical waveguide.

WC5 • 3:15 p.m.
Resonantly Enhanced Terahertz Transmission Using Quasiperiodic Arrays of Subwavelength Apertures, *Tatsunosuke Matsui[1], Amit K. Agrawal[2], Ajay Nahata[2], Z. Valy Vardeny[1]; [1]Physics Dept., Univ. of Utah, USA, [2]Dept. of Electrical and Computer Engineering, Univ. of Utah, USA.* We measure terahertz transmission properties of subwavelength apertures arrays with quasicrystalline arrangement such as Penrose and dodecagonal quasicrystals. We observe sharp resonant peaks in the transmission spectra, which agree with the underlying geometrical structure factor.

Key to OTST Authors and Presiders