Electromagnetic and Light Scattering XIII

26 – 30 September 2011, Hotel Imperiale, Taormina, Italy

Scientific Program with Short Abstracts

Dipartimento di Fisica della Materia e Ingegneria Elettronica
Università di Messina, Italy

Istituto per i Processi Chimico Fisici del CNR
Messina, Italy

ELSXIII

Monday, September 26

Session 1.1 8:45 – 10:30
Session chair: Ferdinando Borghese

8:45-9:00	**Conference Opening**
9:00-9:30	**IT1. Numerically exact modeling of electromagnetic scattering by discrete random media** ***M. I. Mishchenko*** *NASA Goddard Institute for Space Studies, New York, USA* We use the numerically exact superposition T-matrix method to perform extensive computations of electromagnetic scattering by a 3D volume filled with randomly distributed wavelength-sized particles. These computations are used to simulate and analyze the effect of randomness of particle positions as well as the onset and evolution of various multiple-scattering effects with increasing number of particles in a statistically homogeneous volume of discrete random medium. Our exact results illustrate and substantiate the methodology underlying the microphysical theories of radiative transfer and coherent backscattering. Furthermore, we show that even in densely packed media, the light multiply scattered along strings of widely separated particles still provides a significant contribution to the total scattered signal and thereby makes quite pronounced the classical radiative transfer and coherent backscattering effects.
9:30-9:45	**CT1. A T-matrix approach for particles with small-scale surface roughness** ***M. Kahnert***,[a] *T. Rother*[b] *(a) Swedish Meteorological and Hydrological Institute, Norrkoping, Sweden - (b) German Aerospace Center, Neustrelitz, Germany* We combine group theory with a perturbation approach to perform T-matrix computations for particles with small-scale surface roughness up to size parameters of 70. The optical properties of high-order 3D-Chebyshev particles differ substantially from those of spheres. CPU times are reduced by more than 4-5 orders of magnitude by the use of group theory, while the perturbation approach circumvents the notorious ill-conditioning problems of the null-field method, thus allowing the treatment of large size parameters.
9:45-10:00	**CT2. Scattering by closely spaced infinite cylinders in an absorbing medium** ***S.-C. Lee*** *Applied Sciences Laboratory, USA* Scattering by closely spaced parallel infinite cylinders in an absorbing medium is considered in this paper. The source wave is arbitrarily polarized and propagates in a general direction at the cylinders. The formulation utilizes the Hertz potential approach, and the scattering cross section and intensity distribution in the far-field are developed. Numerical results are presented to illustrate the influence of the absorbing medium on the scattering properties of two configurations of closely-spaced cylinders.
10:00-10:15	**CT3. A study of light scattering by wavelength-sized particles covered by much smaller grains using the superposition T-matrix method** ***J. M. Dlugach***[a], *M. I. Mishchenko*[b], *D. W. Mackowski*[c], *I. A. Zinchenko*[a] *(a)Main Astronomical observatory of the National Academy of Sciences of Ukraine, Kyiv, Ukraine - (b) NASA Goddard Institute for Space Studies, New York, USA - (c) Department of Mechanical Engineering, Auburn University, USA* By using the results of a direct, numerically exact solution of the Maxwell equations we analyze the behavior of the light scattering characteristics for polydisperse spherical particles covered with a large number of smaller grains. We show that the effect of the presence of microscopic dust on the surfaces of wavelength-sized particles depends on the particle absorption and the relative size of irregularities. In our computations, a new parallel superposition T-matrix code developed for use on parallel computer clusters is applied.
10:15-10:30	**CT4 The cause of characteristic lengths in scattering curves** ***M. J. Berg*** *Mississippi State University, USA* This work explains the cause of crossovers in the power-law structure of scattering curves for spherical and nonspherical particles. For spheres, the crossovers have been empirically correlated with length scales of the particle, e.g., radius. Here, a technique called phasor analysis will show that destructive interference within the particle causes the crossovers. Nonspherical particles will also be investigated and found to display similar behavior, and several practical implications of the crossovers will be presented.

Coffee Break 10:30 – 11:00

Monday, September 26	
Session 1.2	**11:00 – 12:45** **Session chair: James Hough**
11:00-11:30	**IT2. The nature of interstellar dust as revealed by light scattering** ***D. A. Williams*** *University College London, United Kingdom* Interstellar dust was first identified through the extinction that it causes of optical starlight. Initially, observational and theoretical studies of extinction were made to identify simple ways of removing the effect of extinction. Over the last few decades it has become clear that dust has a number of very important roles in interstellar physics and chemistry, and that through these roles dust affects quite fundamentally the evolution of the Milky Way and other galaxies. However, our detailed knowledge of the actual material of dust remains relatively poor. The use of accurate models for the interaction of electromagnetic radiation with particles of arbitrary shape and composition remains vital, if our description of dust is to improve.
11:30-11:45	**CT5. On the calibration of the polarimetric slope - albedo relation for asteroids: Work in progress** ***A. Cellino***[a], *R. Gil-Hutton*[b] *(a)Osservatorio Astronomico di Torino, INAF, Pino Torinese, Italy - (b)Complejo Astronomico El Leoncito, San Juan, Argentina* Asteroid polarimetry is known to be an excellent tool to derive information on the geometric albedo of these objects. This is made possible by the existence of a relation between the albedo and the morphology of the curve which describes the variation of the degree of linear polarization of asteroid light as a function of the illumination conditions. A major problem is that the calibration of the commonly accepted form of the polarization - albedo relation includes numerical coefficients which are affected by fairly high uncertainties. Following some recommendations issued by IAU Commission 15, we are trying to improve the albedo - polarization relation by taking advantage of new polarimetric data obtained in dedicated observation campaigns. We present here some very preliminary results.
11:45-12:00	**CT6. Composite grains: Application to circumstellar dust** ***D. B. Vaidya***[a], *R. Gupta*[b] *(a) ICCSIR, Ahmedabad,India - (b) IUCAA, Ganeshkhind Pune, India* Using the discrete dipole approximation (DDA) we calculate the absorption efficiency of the composite grain, made up of a host silicate spheroid and inclusions of graphite, in the spectral region 5.0-25.0 μm. We study the absorption as a function of the volume fraction of the inclusions. In particular, we study the variation in the 10 μm and 18.0 μm emission features with the volume fraction of the inclusions. Using the extinction efficiencies, of the composite grains we calculate the infrared fluxes at several dust temperatures and compare the model curves with the observed infrared emission curves (IRAS-LRS), obtained for circumstellar dust shells around oxygen rich M-type stars.
12:00-12:15	**CT7. Linear polarization measurements with clouds of tholins produced by radio-frequency plasma** ***E. Hadamcik***[a], *J.-B. Renard*[b], *N. Carrasco*[c], *G. Cernogora*[c], *C. Szopa*[a], *J. Lasue*[d] *(a) UPMC Univ. Paris 06,CNRS LATMOS, France - (b) LPC2E/CNRS,Orléans Cedex, France – (c) Université de Versailles St-Quentin LATMOS, France – (d) LANL, Space Science and Applications, Los Alamos, USA* The linear polarization of the light scattered by fluffy agglomerates of tholins produced by a RF plasma is correlated to the physical properties of the samples. The results are compared to space observations of Titan's aerosols.
12:15-12:30	**CT8. Conventional clear-sky aerosol retrievals: Do they work for cloudy days?** ***E. Kassianov,*** *M. Ovchinnikov, L. K. Berg, C. Flynn* *Pacific Northwest National Laboratory, Richland, USA* This presentation highlights different approaches to determine the aerosol properties between clouds and covers a broad range of related topics, including the passive aerosol remote sensing from space, in situ observations of aerosol aloft and at surface and numerical modeling of aerosol and cloud properties. Some of these approaches, which are still in research phase, can reduce substantially the impact of cloud-induced contamination on the cloudy-sky aerosol retrievals, while other can reduce uncertainties associated with aerosol hygroscopicity and enhanced relative humidity near cloud edges. The combination of these approaches for addressing outstanding issues of the cloudy-sky aerosol retrievals is also discussed.
12:30-12:45	**CT9. Retrieval of cloud droplet size distribution parameters from polarized reflectance measurements** ***M. Alexandrov***[ab], *B. Cairns*[b], *C. Emde*[c], *B. Van Diedenhoven*[ab], *A. Ackerman*[b]; *(a) Columbia University, Department of Applied Physics and Applied Mathematics, New York, USA – (b) NASA Goddard Institute for Space Studies, New York, USA - (c) Ludwig-Maximilians-Universität, München, Germany* We present an algorithm for retrieval of cloud droplet size distribution parameters (effective radius and variance) from the Research Scanning Polarimeter (RSP) measurements. The RSP is an airborne prototype for the Aerosol Polarimetery Sensor (APS), which is due to be launched as part of the NASA Glory Project. This instrument

	measures both polarized and total reflectances in 9 spectral channels with center wavelengths ranging from 410 to 2250 nm. For cloud droplet size retrievals we utilize the polarized reflectances in the scattering angle range between 140 and 170 degrees where they exhibit rainbow. The shape of the rainbow is determined mainly by single-scattering properties of the cloud particles, that simplifies the inversions and reduces retrieval uncertainties. The retrieval algorithm was tested using realistically simulated cloud radiation fields. Our retrievals of cloud droplet sizes from actual RSP measurements made during two recent field campaigns were compared with the correlative in situ observations.

Lunch Break 12:45 – 15:30

Monday, September 26

Session 1.3 15:30 – 16:45
Session chair: Cesare Cecchi-Pestellini

15:30-16:00	**IT3. Interstellar extinction and polarization with homogeneous and composite grains** ***N. Voshchinnikov*** *St. Petersburg University, St. Petersburg, Russia* We discuss possible ways to solve problems arising due to non-unique interpretation of interstellar extinction and linear polarization.
16:00-16:15	**CT10. Exploring the surface roughness of small ice crystals by measuring high resolution angular scattering patterns** ***M. Schnaiter*** [a], *P. H. Kaye* [b], *E. Hirst* [b], *Z. Ulanowski* [b], *R. Wagner* [a] *(a) Karlsruhe Institute of Technology, Institute for Meteorology and Climate Research, Germany - (b) Centre for Atmospheric and Instrumentation Research, University of Hertfordshire, United Kingdom* Surface roughness of atmospheric ice particles is an important yet poorly investigated microphysical property in the context of the climate impact of cirrus and mixed-phase clouds. Measurements of single particle two-dimensional light scattering patterns have been shown to be a promising method to identify particle roughness in natural clouds. This method was applied in a laboratory study on the surface roughness properties of small ice particles that have been grown under simulated cirrus conditions.
16:15-16:30	**CT11. Retrieving the size of particles with rough surfaces from 2D scattering patterns** ***Z. Ulanowski***, *P. H. Kaye, E. Hirst, R. Greenaway* *Centre for Atmospheric and Instrumentation Research, University of Hertfordshire, United Kingdom* Frequency analysis can be used for the recovery of particle properties such as size from scattering data, but is difficult to apply in practice, as lack of completeness or discontinuities at boundaries can produce artefacts. For 2D scattering patterns image processing, including morphological operations, offers an alternative approach. We test possible techniques on a diverse range of particles. It is found that the average surface area of intensity peaks is inversely proportional to particle size.
16:30-16:45	**CT12. Solving diffraction problems by method of elementary scatterers** *A. G. Kyurkchan,* ***N. I. Smirnova*** *Moscow Technical University of Communications and Informatics, Russia* The method of modeling scattering characteristics of bodies with complex geometry and structure using elementary scatterers, which together reproduce the geometry and structure of initial object, is proposed. The efficiency of this approach is shown by a simple example – the diffraction problem on a strip.

Coffee Break 16:45 – 17:00

Monday, September 26

Session 1.4 17:00 – 18:15
Session chair: Onofrio M. Maragò

17:00-17:30	**IT4. Engineering with and for light absorption and scattering: A quarter century of experimental research at RTL** ***M. Pinar Mengüç*** *Özyegin University, Istanbul, Turkey* Characterization of particles requires detailed understanding of light interaction with homogeneous/inhomogeneous and regular/irregular shaped particles, or fractal-like structures, within optically thin or thick media. Even after the development of such theoretical understanding, focused experiments need to be

	carried out to measure scattered light intensity profiles and change in the absorption due to particles present in a given medium. Eventually, the data from such experiments are to be processed thoroughly with the help of robust inverse analyses to determine the required properties. This trilogy of particle characterization research was one of the focus areas of the Radiation Transfer Laboratory at the University of Kentucky over the last quarter century. This paper focuses only on the experimental works conducted and highlights a wide number of research papers published at the RTL for characterization purposes.
17:30-17:45	**CT13. Optimization methods for characterization of single particles from light scattering patterns** ***M. A. Yurkin*** [ab], *G. V. Dyatlov* [bc], *K. V. Gilev* [ab], *V. P. Maltsev* [ab] *(a) Institute of Chemical Kinetics and Combustion, Novosibirsk, Russia- (b) Novosibirsk State University, Russia- (c) Sobolev Institute of Mathematics, Novosibirsk, Russia* We address the inverse light-scattering problem for particles described by a several-parameters model, when experimental data are given as an angle-resolved light scattering pattern (LSP). This problem is reformulated as an optimization (nonlinear regression) problem, for which two solution methods are proposed. The first one is based on standard gradient optimization method, but with careful choice of the starting point. The second method is based on precalculated database of theoretical LSPs, from which the closest one to an experimental LSP is selected for characterization. We tested both methods for characterization of polystyrene microspheres using a scanning flow cytometer (SFC).
17:45-18:00	**CT14. Emissive exchange between particles** ***D. Mackowski,*** [a] *M. Mishchenko*[b] *(a) Department of Mechanical Engineering, Auburn University, USA – (b) NASA Goddard Institute for Space Studies, New York, USA* A formulation is developed to predict the exchange of emission between discrete points in a particle and between neighboring particles. The formulation relies on the volume integral equation for time harmonic fields, coupled to a VSWF, T matrix representation.
18:00-18:15	**CT15. Comparative strengths of a pseudo-spectral time domain method in numerical simulation of single particle optical scattering** *R. L. Panetta, C. Liu,* ***P. Yang*** *Dept of Atmospheric Sci., Texas A&M University, USA* We present some results on the relative performance of the pseudo-spectral time domain, finite difference time domain, and DDA methods in calculating single-particle optical scattering properties. Our interest is in particles with size parameters in excess of 10. Using as test case a homogeneous spherical particle we have found that the pseudo-spectral time domain method is generally more efficient (uses less cpu time for a given accuracy) than the finite-difference time domain method. The DDA method appears to be superior to the pseudo-spectral method for indices of refraction less than 1.5, but as the index of refraction increases, the pseudo-spectral method becomes superior. We present here some results for particles with size parameters 10 and 30, and indices of refraction 1.3117 and 1.7.

Tuesday, September 27

Session 2.1 8:45 – 10:30
Session chair: Maria A. Iatì

8:45-9:15	**IT5. Polarization of light backscattered by wavelength-scale particles** ***K. Muinonen*** [ab], *J. Tyynelä,* [a] *E. Zubko*[ac], *H. Lindqvist* [a], *A. Penttilä* [a], *T. Pieniluoma* [a] *and G. Videen* [d] *(a) University of Helsinki, Finland – (b) Finnish Geodetic Institute, Masala, Finland – (c) Kharkov National University, Ukraine – (d) Army Research Laboratory, Adelphi, Maryland, USA.* We analyze angular dependencies of light scattered by wavelength-scale particles into the backscattering regime, that is, into scattering angles $\Theta \geq 90°$. We consider spherical and cubic particles, oblate and prolate spheroidal particles, as well as clusters of spherical particles, all with equal-volume-sphere size parameters $4 \leq x \leq 10$ and real-valued refractive indices $1.1 \leq m \leq 2.0$. We offer interference-based explanations for the angular dependencies of the scattered intensity, degree of linear polarization for unpolarized incident light, and the depolarization ratio.
9:15-9:30	**CT16. Negative polarization of agglomerate particles with various densities** ***E. Zubko*** [ab], *K. Muinonen* [ac], *Y. Shkuratov* [b], *G. Videen* [d] *(a) University of Helsinki, Finland – (b) Kharkov National University, Ukraine – (c) Finnish Geodetic InstituteMasala, Finland – (d) Space Science Institute, Boulder, USA* We study the negative polarization produced by agglomerate particles of various density. We found that all types of agglomerates studied reveal similar dependence of negative polarization minimum P_{min} and its location α_{min} on particle size and refractive index.
9:30-9:45	**CT17. Measurement of aggregates' size distribution by inversion of angular light scattering** ***C. Caumont-Prim,*** *J. Yon, A. Coppalle, K. F. Ren* *UMR 6614 CORIA CNR,Université et INSA de Rouen, France* The aim of this work is to propose a new method for determining the size distribution of submicronic particles by inversion of the measured angular scattering of light. This method relies on the determination of a function R_g* by angular scattering. The variation of this function informs us about the polydispersity of the aggregates size. We show that, by supposing the nature of the size distributions (lognormal), it is possible to determine the governing parameters of these distributions.
9:45-10:00	**CT18. Scaled analog measurements of light scattering by aggregates with merging monomers** ***J.-M. Geffrin*** [a], *R. Vaillon* [b], *C. Eyraud* [a], *B. Lacroix* [b] (*a) Université Aix-Marseille, France – (b) Université de Lyon, CNRS, France* This work reports on the experimental analysis of light scattering by aggregates with merging monomers. For such complex shape particles, scaled targets can be built using a rapid prototyping technique (stereo lithography). Our microwave scattering device provides the amplitude and phase of elements of the amplitude scattering matrix. Assessment of the approximate codes can thus be carried out on an exprimental basis. Sample results for the bi-sphere and a 74 sphere aggregate are presented and discussed.
10:00-10:15	**CT19. Scattering matrix measurements and light-scattering calculations of calcite particles** ***D.D. Dabrowska*** [a], *O. Munõz* [a], *F. Moreno* [a], *T. Nousianen* [b], *E.S. Zubko* [bc], *A.C. Marra* [d] *(a) Instituto de Astrofisica de Andalucia, Spain – (b) University of Helsinki, Finland – (c) Institute of Astronomy Kharkov National University, Ukraine – (d) Institute of Atmospheric Sciences and Climate (ISAC) of the Italian National Research Council (CNR) Lecce,Italy* We present measurements of the complete scattering matrix as a function of the scattering angle of a sample of calcite particles collected near Lecce, Italy. The measurements are done at a wavelength of 647 nm in the scattering angle range 3° - 177°. FESEM and SEM images show that the sample consists largely of flake-like particles. Ten different flake-like geometries are randomly generated and their scattering properties are simulated with DDA for sizes from 0.1 μm to 1 μm. Some preliminary comparisons of the simulations and the measurements are shown.
10:15-10:30	**CT20. Measurement of angular scattering function and degree of linear polarization of bentonite clay particles embedded in cylindrical epoxy matrix** ***A. Gogoi*** [a], *G. Das* [b], *N. Karak* [b], *A. Choudhury* [a], *G. A. Ahmed* [a] *(a) Optoelectronics and Photonics Research Laboratory, Tezpur University, Assam, India – (b) Advanced Polymer and Nanomaterials Laboratory, Tezpur University, India* Scattering properties of bentonite clay particles were investigated at 543.5 nm incident laser wavelength by using a designed and fabricated light scattering setup. The scattering samples were held in front of a laser beam by using a transparent cylindrical thermosetting epoxy matrix.

Coffee Break 10:30 – 11:00

Tuesday, September 27

Session 2.2 11:00 – 12:45
Session chair: Joop Hovenier

11:00-11:30	**IT6. Optical properties of nonspherical atmospheric particles and relevant applications** ***P. Yang*** [a], *L. Bi* [b], *G. Kattawar* [b], *R. L. Panetta* [a] *(a) Dept of Atmospheric Sci., Texas A&M University, USA - (b) Dept of Physics and Astronomy, Texas A&M University, USA* Recent progress in the study of the single-scattering properties of nonspherical ice crystals within cirrus clouds and nonspherical dust particles is reviewed. We have been using the finite-difference time domain (FDTD) method, the discrete dipole approximation (DDA), and an improved geometric optics method (IGOM) to compute the single-scattering properties of nonspherical particles. We have incorporated the so-called edge effect associated with the surface wave into the IGOM extinction and absorption efficiencies. The simulation results in the solar and thermal infrared spectral regimes are presented. Furthermore, the impacts of particle nonsphericity on downstream remote sensing implementations and radiative transfer simulations involving ice clouds and dust aerosols are also summarized.
11:30-11:45	**CT21. Glints from cirrus clouds, snow blankets, and sea surfaces** ***A. Konoshonkin*** [a], *A. Borovoi* [b] *(a) Tomsk State University, Russia – (b) V.E. Zuev Institute of Atmospheric Optics, Tomsk, Russia* Glints are bright spots observed in the case of light specular reflectance. They are used mainly for retrieval of the probability density function of wave slopes in the seas. On the other hand, they are useful for studying particulate media like cirrus clouds. In this paper, a general theory applicable for both media is presented.
11:45-12:00	**CT22. UV-depolarization Lidar remote sensing experiment analysis using scattering matrix formalism** *A. Miffre, G. David, B. Thomas,* ***P. Rairoux*** *Laboratoire de Spectrométrie Ionique et Moléculaire, Université Lyon, France* In this paper, an optical remote sensing method is proposed to retrieve the number concentration of non spherical volcanic ash particles. An UV-polarization sensitive remote sensing experiment is interpreted in the frame of the scattering matrix formalism. It follows that UV-optical scattering and depolarization, when they are used together and in correlation with laboratory measurements on scattering matrix elements, are meaningful to retrieve information on volcanic ash particles such as shape or number concentration.
12:00-12:15	**CT23. Iterative atmospheric correction scheme and the polarization color of alpine snow** ***M. Ottaviani,*** *B. Cairns* *NASA Goddard institute for Space Studies (GISS), New York, USA* Proper characterization of the Earth's surface is crucial to remote sensing, both to map geomorphological features and because subtracting this signal is essential during retrievals of the atmospheric constituents located between the surface and the sensor. Current operational algorithms model the surface total reflectance through a weighted linear combination of geometry-dependent kernels, each devised to describe a particular scattering mechanism. The information content of intensity-only measurements is overwhelmed by instruments with polarization capabilities. Because of their remarkable lack of spectral contrast, the polarized reflectances of land surfaces in the shortwave infrared spectral region (where atmospheric scattering is minimal) can be used to model the surface at shorter wavelengths, where aerosol retrievals are performed.
12:15-12:30	**CT24. Height and thickness of a scattering (aerosol or cloud) layer from space-based oxygen A-band spectroscopy: An analytical approach** ***A. B. Davis*** *Jet Propulsion Laboratory, Pasadena, USA* Simplified radiative transfer modeling is used to show that both altitude and thickness of a scattering layer can be inferred from satellite observations in the O_2 A-band at high-enough spectral resolution, preferably with prior information about optical thickness. For simplicity, the surface is assumed black (water-like). This confirms previous claims but using closed-form analytical methods. For optically thin aerosol, the single-scattering limit is used; for optically thick clouds, a diffusion-type model is invoked.
12:30-12:45	**CT25. Radiative transfer in the oxygen A-band and its application to cloud remote sensing** ***L. Lelli,*** *A.A. Kokhanovsky, V.V. Rozanov, J.P. Burrows* *University of Bremen, Germany* Detection of clouds and retrieval of their properties (top and bottom altitude, optical thickness) with satellite-based spectrometers needs the solution of radiative transfer in the atmosphere. Depending on the application needed for and instrument capabilities, a trade-off choice has to be made between accuracy and speed. This study aims to characterise the range of applicability of analytical asymptotic equations to real scenarios. It has been found that the errors, introduced with approximate parameterisations, are within reasonable ranges both in absolute and relative values.

Lunch Break 12:45 – 15:30

Tuesday, September 27

Session 2.3 15:30 – 16:45
Session chair: Michael Kahnert

15:30-16:00	**IT7. Polarimetric signatures of solar system objects** **P. A. Yanamandra-Fisher** *Space Science Institute, Boulder, Colorado, USA* Polarimetry is currently enjoying a rejuvenation in planetary, astrophysical and exobiology applications from characterization of various solar system objects (planetary atmospheres, comets, satellites, ring systems, asteroids, dust, etc.) to the detection of exoplanets and identification of biological markers. Although ground based observations of the planets and their satellites are restricted to small phase angles, important results have been obtained with polarimetry. Some examples are: the identification of spherical droplets of sulphuric acid in the atmosphere of Venus; dust storms and ice clouds on Mars; variations in hydrocarbon hazes from equator to poles on Jupiter, Saturn, Neptune and Uranus. In Saturn's rings, anisotropic multiple scattering effects are observed and exhibit variations often in few days or weeks, with mutual interactions and gravitational resulting in organized structures. The curves of polarization for atmosphereless Solar System objects (such as the Moon, planetary satellites and asteroids) are diagnostic of the texture of the surface, and demonstrate that most of them have their surfaces covered with a regolith of fine material, a function of particle size and regolith packing density, also properties of the composition of the parent bodies. An example is the recent discovery of a class of large inversion angle asteroids, displaying spinel features in their spectra and indicative of the oldest surfaces in the Solar System. Linear and circular polarization of comets provides information about the composition and wavelength dependence of the dust, indicative of new, active comets vs. older comets. Measuring the degree of linear polarization can diagnose physical conditions of the scattering surface and is complementary to photometry and spectroscopy for the remote analysis of small solar system objects. In addition, measuring the linear polarization of exoplanetary systems can detect exoplanets separate from their parent stars. Biological molecules exhibit an inherent handedness or circular polarization or chirality; search for chiral signatures on exo-Earths would identify astrobiological material. Even as the field of polarimetric observations is maturing as a technique for remote sensing, the modeling of polarimetric observations is not similarly mature. Recent efforts include characterization of light scattering by particles of complex shapes and structures to be calculated; vector radiative transfer equation for optically thick media to be solved; with approximations to model closely packed particulate media or regoliths. The synergy between the new modeling techniques and increased use of polarization as a remote sensing technique provide opportunities to understand our solar system and other planetary systems. I will review the importance of polarimetry both in remote sensing and in the development of physical models.
16:00-16:15	**CT26. Magnetic response from a composite of metal-dielectric particles in the visible range: T-matrix simulation** ***O. Zhuromskyy****, V. Lomanets, U. Peschel* *University of Erlangen-Nürnberg, Erlangen, Germany* The optical response of a particle composed of a dielectric core surrounded by a densely packed shell of small metal spheres is simulated with the superposition T-matrix method for realistic material parameters. In order to compute the electric and magnetic particle polarizabilities, a single expansion T-matrix is derived from a particle centered T-matrix. Finally the permeability of a medium comprising such particles is found to deviate considerable from unity resulting in a noticeable optical response.
16:15-16:30	**CT27. Near field computation of the extinction of electromagnetic waves in multiparticle systems** ***J. Schäfer,*** *A. Kienle* *Institut für Lasertechnologien in der Medizin und Metechnik, Ulm, Germany* In this contribution extinction of electromagnetic waves inside a medium consisting of cylindrical absorbing particles is considered. Near fields are calculated using a numerical solution of Maxwell's equations and compared to results given by Lambert-Beer's law.
16:30-16:45	**CT28. On retrieving shape information from scattering phase matrices using a distribution of spheroids** ***T. Nousianen***[a]*, M. Kahnert*[b]*, H. Lindqvist*[a] *(a) University of Helsinki, Finland - (b) Swedish Meteorological and Hydrological Institute, Norrköping, Sweden* Phase matrices of spheroids are fitted to phase matrices of reference particles with identical sizes and refractive indices to test how well spheroids can be used to retrieve shape information from less symmetric target particles. It is found that shapes of best-fit spheroids do not correlate well with shapes of the reference particles even when the phase matrix is reproduced well by the spheroids.

Coffee Break 16:45 – 17:00

Tuesday, September 27

Session 2.4 17:00 – 18:15
Session chair: Olga Munõz

17:00-17:30	**IT8. Dust busters** ***C. Cecchi-Pestellini*** [a], *G. Mulas* [a], *S. Casu* [a], *M. A. Iatì* [b], *R. Saija* [c], *A. Cacciola* [c], *F. Borghese* [c], *P. Denti* [c] *(a) INAF – Osservatorio Astronomico di Cagliari, Italy – (b) Istituto per i Processi Chimico–Fisici, CNR, Messina, Italy – (c) Università di Messina, Italy* We present a model for interstellar extinction dust, in which we assume a bimodal distribution of extinction carriers, a dispersion of core–mantle grains, supplemented by a collection of PAHs in free molecular form. We use state–of–the–art methods to calculate the extinction due to macroscopic dust particles, and the absorption cross–sections of PAHs in four different charge states. While successful for most of observed Galactic extinction curves, in few cases the model cannot provide reliable results. Paradoxically, these failures appear to be very promising, suggesting that the whole body of dust extinction features might be described within the cycle of carbon in the interstellar medium.
17:30-17:45	**CT29. On the intensity and polarization of radiation emerging from a thick Rayleigh scattering atmosphere** ***V. Natraj*** [a], *J. W. Hovenier* [b] *(a) Jet Propulsion Laboratory, Pasadena, USA – (b) University of Amsterdam, The Netherlands* We compute the intensity and polarization of reflected and transmitted light in optically thick Rayleigh scattering atmospheres. We obtain results accurate to seven decimal places. The results have been validated using a variety of methods.
17:45-18:00	**CT30. Radiative transfer in closely packed realistic regoliths** ***S. Vahidinia*** [ab], *J. Cuzzi* [b], *B. Draine* [c] *and E. Marouf* [d] *(a) ORAU-NASA, USA – (b) NASA AMES Research Center, USA – (c) Princeton University, USA – (d) San Jose State University, USA* We have developed a regolith radiative transfer model (RRT) based on a first-principles approach to regolith modeling that is essential for near-to-far infrared observations of grainy surfaces, and is readily configured to answer fundamental questions about popular models with which all remote observations of all airless solar system bodies with granular surfaces are currently interpreted. Our model accounts for wavelength-size regolith particles which are closely packed and can be heterogeneous in composition and arbitrarily shaped. Here we present preliminary results showing the role of porosity on layer reflectivity.

Poster Session 18:00 – 20:00
See poster details at the end of the booklet

Wednesday, September 28

Session 3.1 8:45 – 10:30
Session chair: Elefterios Lidorikis

8:45-9:15	**IT9. Optical trapping and optical binding using cylindrical vector beams** *S. E. Skelton [a], M. Sergides [a], R. Patel [a], E. Karczewska [a], O. M. Maragò [b], **P. H. Jones** [a]* *(a) University College London, United Kingdom – (b) CNR-IPCF, Messina, Italy* We report on the use of cylindrical vector beams for optical manipulation of micron and sub-micron sized particles using the methods of a single-beam gradient force trap (optical tweezers) and an evanescent-field surface trap (optical binding). We have demonstrated a stable interferometric method for the synthesis of cylindrical vector beams (CVBs), and present measurements demonstrating polarization-controlled focal volume shaping using CVBs in an optical tweezers. Furthermore we show how appropriate combinations of CVBs corresponding to superpositions of optical fibre modes can be used for controlled trapping and trafficking of micro- and nanoparticles along a tapered optical fibre.
9:15-9:30	**CT31. Local electric field measurements by optical tweezers** *G. Pesce [a], B. Mandracchia [a], E. Orabona [b], G. Rusciano [a], L. De Stefano [b], **A. Sasso** [a]* *(a) Università di Napoli Federico II, Italy - (b) Institute for Microelectronics and Microsystems Unit of Naples-CNR, Italy* We report a new technique to measure direction and amplitude of electric fields generated by microelectrodes embedded in polar liquid environment, as often used in microfluidic devices. The method is based on optical tweezers which act as sensitive force transducer while a trapped charged microsphere behaves as a probe. When an electric field is applied the particles moves from its equilibrium position and finishes in a new equilibrium position where electric and optical forces are balanced. A trapped bead is moved to explore the electric field in a wide region around the microelectrodes. In such way maps of electric fields with high spatial resolution can be reconstructed even for complex electrode geometries where numerical simulation approaches can fail. Experimental results are compared with calculations based on finite element analysis simulation.
9:30-9:45	**CT32. Electric and magnetic dipolar response of small dielectric particles: Scattering anisotropy and optical forces.** *R. Gomez-Medina [a], B. Garcia-Camara [b], I. Suarez-Lacalle [a], L.S. Froufe-Perez [a], F. Gonzalez [b], F. Moreno [b], M. Nieto-Vesperinas [c], **J.J. Saenz** [a]* *(a) Universidad Autònoma de Madrid, Spain – (b) Universidad Cantabria, Spain – (c) Instituto de Ciencia de Materiales de Madrid, Spain.* We predict that real small dielectric particles made of non-magnetic materials present non-conventional scattering properties similar to those previously reported for somewhat hypothetical magnetodielectric particles.
9:45-10:00	**CT33. Studying the dynamics of colloidal particles with digital holographic microscopy and electromagnetic scattering solutions** ***J. Fung** [a], R. W. Perry [b], D. M. Kaz [a], R. McGorty [a] and V. N. Manoharan [ab]* *(a) Harvard University, Department of Physics, USA – (b) Harvard University, School of Engineering and Applied Sciences, USA* Digital holographic microscopy (DHM) can measure the 3D positions as well as the scattering properties of colloidal particles in a single 2D image. We describe DHM and our analysis of recorded holograms with exact scattering solutions, which permit the measurement of 3D particle positions with ~10 nm precision and millisecond time resolution, and discuss studies of the Brownian dynamics of clusters of spheres with DHM.
10:00-10:15	**CT34. Scattering intensity from Brownian dynamics: Application to Total Internal Reflection Microscopy** ***G. Volpe** [ab], T. Brettschneider [b], L. Helden [b], C. Bechinger [ab]* *(a)Max-Planck-Institut für Intelligente Systeme, Stuttgart, Germany – (b) Universität Stuttgartt, Germany* Total internal reflection microscopy (TIRM) measures the position of a Brownian particle above an interface by using its scattering of an evanescent wave. From the knowledge of the trajectory it is possible to reconstruct the interaction potential between the Brownian particle and the wall with nanometer and femtonewton resolution. TIRM relies on the a priori knowledge of the relation I(z) between the particle position and the scattering intensity. We introduced a method to determine experimentally I(z). Such method largely extends the conditions accessible with TIRM.
10:15-10:30	**CT35. Optical trapping of carbon nanotubes and graphene** *S. Vasi [ab], M.A. Monaca [ab], M. G. Donato [a], F. Bonaccorso [c], G. Privitera [c], O.Trushkevych [c], G. Calogero [a], B. Fazio [a], A. Irrera [a], M. A. Iatì [a], R. Saija [a], P. Denti [b], F. Borghese [b], P.H. Jones [d], A.C. Ferrari [c], P. G. Gucciardi [a], **O. M. Maragò** [a]* *(a) CNR-IPCF Messina, Italy – (b) Università di Messina, Italy – (c) University of Cambridge, United Kingdom – (d) University College London, United Kingdom* We study optical trapping of nanotubes and graphene. We extract the distribution of both centre-of-mass and angular fluctuations from three-dimensional tracking of these optically trapped carbon nanostructures. The optical force and torque constants are measured from auto and cross-correlation of the tracking signals. We demonstrate that nanotubes enable nanometer spatial, and femto-Newton force resolution in photonic force microscopy by accurately measuring the radiation pressure in a double frequency optical tweezers. Finally, we integrate optical

	trapping with Raman and photoluminescence spectroscopy demonstrating the use of a Raman and photoluminescence tweezers by investigating the spectroscopy of nanotubes and graphene flakes in solution. Experimental results are compared with calculations based on electromagnetic scattering theory.

Coffee Break 10:30 – 11:00

Wednesday, September 28

Session 3.2 11:00 – 12:45
Session chair: Gorden Videen

11:00-11:30	**IT10. Physical properties of cometary dust from Monte Carlo analysis of tail and coma images** ***F. Moreno*** *Instituto de Astrofisica de Andalucìa, Granada, Spain* Forward and inverse Monte Carlo modeling of cometary dust tail and coma images has provided one of the best approaches to infer the basic physical dust parameters and their time dependence: mass loss rates, ejection velocities, and size distribution functions. These methods attempt to fit the brightness distribution found in cometary astronomical images at a variety of wavelengths. The trajectories and the light scattered by the dust particles are functions of the size parameter, shape, and refractive index. In this paper we describe briefly the Monte Carlo technique, and present some applications.
11:30-11:45	**CT36. Modeling comet dust: Photopolarimetric properties of large aggregates** ***L. Kolokolova*** [a], *D. Mackowski* [b] *(a)University of Maryland, USA – (b) Auburn University, USA* Photopolarimetric and in situ data on comet dust are consistent with the idea that large fluffy aggregates dominate in the light scattering by the comet dust. Recent development of the multisphere T-matrix method (MSTM) for parallel computing allowed efficient computations of those aggregates. We present results of such computations emphasizing how they reproduce phase and spectral dependence of the comet polarization.
11:45-12:00	**CT37. Influence of absorption on the time of flight of the light going through a complex medium** ***M. Kervella*** [a], *F.-X. D'Abzac* [a], *F. Hache* [b], *L. Hespel* [a], *T. Dartigalongue* [a] *(a) Office National d'Etude et de Recherche en Aerospatiale, France – (b) Ecole Polytechnique Palaiseau, France* The aim of this work is to evaluate the influence of absorption processes on the time of flight of light going through an absorbing and scattering thick medium (clouds, paints, gas cell, etc). In order to study statistical scattering and absorbing processes, we use a Monte-Carlo simulation code with temporal phase function and Debye modes. The main result is that absorption inside particles induces a decrease of the global time delay.
12:00-12:15	**CT38. Angularly resolved reflectance from random and aligned semi-infinite media** ***A. Kienle****, F. Foschum* *Institut für Lasertechnologien in der Medizin und Meßtechnik, Ulm, Germany* The angularly resolved reflectance from semi-infinite turbid media is investigated using the Monte Carlo method. Turbid media with random and aligned microstructures are considered. It is shown that in the case of random media the Lambert law is valid for one special configuration of the optical and geometrical properties. For random media having an aligned microstructure the angularly resolved total reflectance is completely different from a Lambertian characteristic.
(Cancelled)	**CT39. Slow and fast magneto-optical response of magnetite nanoparticles suspension** *N.L. Dmitruk, I.E. Moroz,* ***S. Z. Malynych*** *(a) V.E Lashkaryov Institute of Semiconductor Physics NAS of Ukraine,Ukraine – (b) National University "Lviv Polytechnica", Ukraine* DC magnetic field applied to Fe_3O_4 nanoparticle suspension affects its light scattering. Time dependent variations in the light intensity transmitted through a suspension are observed after the magnetic field is switched-on. Two types of variations can be distinguished. Fast response takes less than millisecond while slow variations occur at the time interval from seconds to hundreds of minutes. Possible mechanisms of these variations are discussed.
12:15-12:30	**CT40. Application of the Vectorial Complex Ray Model to the scattering of an ellipsoid particle** ***K. F. Ren****, C. Roze, T. Girasole* *UMR 6614 /CORIA, CNRS - Université & INSA de Rouen, St-Etienne du Rouvray, France* We have developed a novel model -- Vectorial Complex Ray Model (VCRM) -- for the scattering of a smooth surface object of arbitrary shape. In this model, the wave is described by bundles of rays, and a ray is characterized not only by its direction and amplitude, but also by the curvature and the phase of the wave. These new properties allow to take into account the phase shift due to the focal lines of an arbitrary shaped wave and the amplitude due to the divergence of the wave. The interferences can therefore be calculated correctly for an arbitrarily shaped particle of smooth surface. In this communication, we present an application of the VCRM in the 2D scattering of a plane wave by a homogeneous ellipsoid at oblique incidence. The transversal convergence effect of the wave will be discussed.

Lunch Break 12:30 – 14:30

Visit to Siracusa, departure 14:30

Conference Dinner & Elsevier-JQSRT Awards Ceremony, restaurant "Da Nino" (Letojanni) 20:30

Thursday, September 29

Session 4.1 8:45 – 10:30
Session chair: Michael Mishchenko

8:45-9:45	**Introduction to the *Van de Hulst Award* by Michael Mishchenko** **Memorial Lecture, Prof. Joop Hovenier**
9:45-10:00	**CT41. Size effects on the scattering matrices of clay particles. An experimental study** ***O. Munõz*** [a], *F. Moreno* [a], *D.D. Dabrowska* [a], *H. Volten* [b], *J.W. Hovenier* [c] *(a) Instituto de Astrofisica de Andalucìa, Granada, Spain – (b) Netherlands National Institute for Public Health and the Environment, Bilthoven, The Netherlands – (c) University of Amsterdam, The Netherlands* We present experimental scattering matrix elements as functions of the scattering angle of two sets of three samples of clays (yellow, green, and white). The measurements were performed in Amsterdam at a wavelength of 633 nm, and at the IAA cosmic dust laboratory in Granada at 647 nm. We study the impact of different sizes on the measured scattering matrix elements.
10:00-10:15	**CT42. On the polarization angle of skylight reflected by natural surfaces: Properties and application for remote sensing of planetary atmospheres** ***J. Chowdhary*** [ab], *B. Cairns* [ab] *and M. Mishchenko* [b] *(a) Columbia University, New York, USA – (b) NASA Goddard institute for Space Studies, New York, USA* In this study, we focus on the polarization angle of light scattered by terrestrial atmosphere-surface systems. The polarization angle describes the orientation of the plane in which the linearly polarized portion of light propagates. We show for skylight how this angle varies with the solar zenith angle and that, for skylight reflected by natural surfaces, these variations remain the same for wide ranges of atmospheric conditions and surface properties. This provides a tool for extracting scattering properties of the atmosphere from remote sensing observations of the Earth without any knowledge of the underlying surface. We demonstrate this principle for simulated data, and apply it to observations obtained by an airborne polarimeter over open oceans.
10:15-10:30	**CT43. Systematic simulations of aerosol optical property retrieval uncertainty for scanning polarimeters** *K. Knobelspiesse, B. Cairns (presented by **M. Alexandrov**)* *NASA Goddard Institute for Space Studies, New York, USA* Scanning polarimeters, which utilize multi-angle, multispectral polarimetric observations from aircraft and orbit, represent the next generation of instruments capable of determining aerosol and cloud properties remotely. Retrieval of these properties from observations, however, are not straightforward. Iterative minimization techniques are often used to match radiative transfer simulations to the observations, where the aerosol and cloud parameters of the optimal model match are considered the best estimate of what is physically present in the scene. If the radiative transfer model perturbation sensitivity, expressed as a Jacobian matrix, can be assessed at the solution, then the observation uncertainty can be projected into the domain of the retrieved parameters. These parameter uncertainties provide are an extremely useful means to assess retrieval success. Another aspect of our iterative minimization techniques is the need for a reasonable initial estimate of optical properties. This estimate is provided by matching observations to a Lookup Table (LUT) of pre-computed radiative transfer scenes. This LUT spans a wide range of aerosol and cloud optical properties, and also includes numerical estimates of the Jacobian matrix at each element in the LUT. Using the Jacobians, we can estimate the retrieval uncertainty for all elements of the LUT, and therefore build a table of expected uncertainty. This paper presents how this approach is used in a systematic manner, and how it can be used to test retrieval capability for various combinations of polarized, multi-angle and multispectral observations.

Coffee Break 10:30 – 11:00

Thursday, September 29

Session 4.2 11:00 – 12:45
Session chair: Maxim Yurkin

11:00-11:30	**IT11. Electromagnetic scattering by a polydispersion of small charged cosmic dust particles** *M. Kocifaj* [a], *J. Klacka* [b], ***G. Videen*** [c] *(a) Slovak Academy of Sciences, Bratislava, Slovakia – (b) Comenius University, Bratislava, Slovakia – (c) US Army Research Laboratory AMSRD-ARL-CI-ES, Adelphi, USA* Some recent studies on extended red emissions suggest the presence of very small dust particles in the Universe.

	The sizes of these particles vary from ~1 nm to some tens of nanometers, thus situating them deeply in the Rayleigh region if computations are made for visible or near infrared. The optical response of such particles can be a function of the surface charge. In this study we analyse the effect of surface electric potential on the total optical thickness and scattering phase function of the cosmic dust particles. The results are compared with those obtained for electrically neutral dust.
11:30-11:45	**CT44. Aerosol agent detection using spectroscopic characterization** *Vasanthi Sivaprakasam [a], Marc Currie [a], Janet Lou [b], Jozsef Czege [b],* ***Jay Eversole*** *[a]* *(a) Naval Research Laboratory,Washington, USA – (b) Global Defense Technology & Systems Inc., McLean, USA* We present here a brief description of our efforts to develop optical spectroscopic characterization and classification methods for air-borne biological particles. While the bulk of our experimental investigation has used laser-induced fluorescence in conjunction with incident laser elastic scattering, we have also developed novel methods for generating, handling, interrogating and collecting aerosol particles. A method known as a Structured Trigger Beam (STB) for obtaining optical measurements from individual aerosol particles that are normalized with respect to the instrument response function is described here. Our latest results will be included in our presentation.
11:45-12:00	**CT45. Photo-polarimetric sensitivities to layering and mixing of absorbing aerosols** ***O. V. Kalashnikova*** *[a], M. J. Garay [ab], A. B. Davis [a], D. J. Diner [a], J. V. Martonchik [a]* *(a) Jet Propulsion Laboratory, Pasadena, USA – (b) Raytheon Company Pasadena, USA* We investigate to what extent multi-angle polarimetric measurements are sensitive to vertical mixing/layering of absorbing aerosols, adopting calibration uncertainty of 1.5% in intensity and 0.5% in the degree of linear polarization of Multiangle Spectro-Polarimetric Imager (MSPI). Employing both deterministic and Monte Carlo radiative transfer codes with polarization, we conduct modeling experiments to determine how the measured Stokes vector elements are affected at UV and short visible wavelengths by the vertical distribution, mixing and layering of smoke and dust aerosols for variety of microphysical parameters. We find that multi-angular polarimetry holds the potential to infer dust-layer heights and thicknesses at blue visible channel due to its lesser sensitivity to changes in dust coarse mode optical properties, but higher sensitivity to the dust vertical profiles. Our studies quantify requirements for obtaining simultaneous information on aerosol layer height and absorption under MSPI measurement uncertainties.
12:00-12:15	**CT46. Spectral simulation approach of light scattering by biological microstructures** ***F. Voit****, J. Schafer, A. Kienle* *Institut fur Lasertechnologien in der Medizin und Messtechnik an der Universitat Ulm, Germany* A light scattering simulation method for characterization of spectrally resolved microscopic images is presented. Based on the discrete dipole approximation, this method can be applied to analyze complex biological microstructures. In this contribution, spectral scattering features are compared to Fraunhofer diffraction for cuboidal models.
12:15-12:30	**CT47. Light scattering study of ZnO nanoparticles for the application of its anti-bacterial property** ***S. Roy*** *[a], N. Barua [b], A. K. Buragohain [b], G. A. Ahmed [a]* *(a) Optoelectr. and Phot. Lab., Tezpur Univ., Assam, India – (b) Dep. of Molecular Biology and Biotech., Tezpur Univ., Assam, India* Investigations on the anti-bacterial activity of ZnO nanoparticles on *Staphylococcus aureus* were made by using bio-technical method. Light scattering properties of these particles were studied as a function of scattering angle by using a versatile laboratory light scattering setup in order to find the scattering profile of ZnO nanoparticles and also the mode of action of these particles on bacterial property.
12:30-12:45	**CT48. Analysis of laser beam scattering by an ensemble of particles modeling red blood cells in ektacytometer** ***A. Priezzhev****, S. Nikitin, A. Lugovtsov* *M.V. Lomonosov Moscow State University, Russia* Using a simple theoretical model, we have obtained approximate relations between the characteristics of particles, modeling red blood cells, and the parameters of the diffraction pattern, produced by a laser beam diffracted in the ektacytometer. We have estimated, in particular, the effect of the particles size dispersion on the diffraction pattern visibility. The estimate shows, that relation of light intensities in the first minimum and the first maximum in the diffraction pattern is a parameter, which is rather sensitive to the particles size dispersion.

Lunch Break 12:45 – 15:30

Thursday, September 29

Session 4.3 15:30 – 16:45
Session chair: Giovanni Volpe

15:30-16:00	**IT12. Not just energy, but momentum and angular momentum too: mechanical effects in scattering** ***T. A. Nieminen***, *A. B. Stilgoe, N. R. Heckenberg, H. Rubinsztein-Dunlop* *The University of Queensland, Brisbane, Australia* We review the transport and transfer of momentum and angular momentum by electromagnetic waves, and applications of the mechanical effects of scattering.
16:00-16:15	**CT49. Propagation of diffraction-free and accelerating laser beams in turbid media** *T. Ersoy [a], B. Yalizay [a], I. Cilesiz [b],* ***S. Akturk*** *[a]* *(a) Istanbul Technical University, Department of Physics, Turkey – (b) Istanbul Technical University, Department of Electronics and Communication Engineering, Turkey* We experimentally investigate propagation of laser beams with Gaussian, Bessel and Airy transverse profiles in turbid media. We evaluate and compare the self-healing properties of these beams.
16:15-16:30	**CT50. Solutions of the electrostatic problem for highly eccentric particles with axial symmetry** ***A. Vinokurov*** *[a], V. Farafonov [b], S. Barkanov [b]* *(a) Main (Pulkovo) Astronomical Observatory of the Russian Academy of Sciences,Saint-Petersburg, Russia – (b) State University of Aerospace Instrumentation,Saint-Petersburg, Russia* The problem of interaction between the electrostatic field and an axisymmetric particle with analytical shape in the spheroidal coordinates is considered. The proposed solutions are based on two of the light scattering methods having different numerical properties, namely the separation of variables and extended boundary condition methods. The relation between the electrostatic fields and electromagnetic radiation in the far-field zone is revealed.
16:30-16:45	**CT51. Polarization analysis of the scattered radiation by silicon nanoparticles in the infrared** ***B. García-Cámara***, *R. Gomez-Medina, F. González, J. J. Saenz, M. Nieto-Vesperinas, F. Moreno* *(a) Universidad de Cantabria, Santander, Spain – (b) Universidad Autonoma de Madrid, Spain – (c) Instituto de Ciencia de los Materiales de Madrid (CSIC), Madrid, Spain* In this work we have studied the spectral dependence of the linear polarization degree at a right-angle scattering configuration (RASC) for silicon (R ~200nm) in the IR (1-2μm). For isolated and isotropic particles smaller than the incident wavelength, this parameter is complementary to the conventional spectral analysis for showing deviations from the pure electric dipole-like response due to either magnetic dipole-like or higher-order contributions.

Coffee Break 16:45 – 17:00

Thursday, September 29

Session 4.4 17:00 – 18:15
Session chair: Achim Hartschuh

17:00-17:30	**IT13. Nanostructures for single molecule detection** ***E. Di Fabrizio*** *IIT, Italian Institute of Technology, Genova , Italy* In recent years, there was an increasing interest on design and fabrication of nanostructures devoted to photonic applications such as photonic crystals fabrication, spectroscopy analysis, detection of single molecules and fundamental studies on well confined electromagnetic field. Different materials, fabrication techniques and applications were especially devoted to the use of plasmonic enhancement to the study of molecules of biological interest. The main task was the control of the enhancement of the local electrical field, in order to overcome the low scattering cross section of the Raman effect, when single molecule has to be detected. In this work we present the fabrication of a novel plasmonic nanostructure for Surface Enhanced Raman Scattering for single molecule detection. High sensitivity measurements of a few tens of molecules will be presented. The choice of nanolithography as fabrication techniques is due to the fact that it is now necessary to investigate, in a controllable and reproducible way the effect of 3D geometry on the generation of plasmon-polaritons on such material and devices. The structures were tested optically with different set up, and we found significant improvement in the spectra quality and in the detection sensitivity, down to a few molecules.
17:30-17:45	**CT52. Surface Enhanced Raman Scattering optimization of gold nanocylinder arrays : Influence of the Localized Surface Plasmon Resonance and excitation wavelength** ***N. Guillot*** *[a], B. Fremaux [a], H. Shen [b], O. Péron [b], E. Rinnert [b], T. Toury [c], M. Lamy de la Chapelle [a]* *(a) Laboratoire CSPBAT (UMR 7244), Université Paris XIII, France – (b) Service Interfaces et Capteurs* *Département Recherches et Developpements Technologiques, Plouzané, France – (c) Université de Technologie de Troyes, France* We here emphasize that the Surface Enhanced Raman Scattering (SERS) intensity has to be optimized by choosing the appropriate gold nanoparticles size for two excitation wavelengths: 632.8 and 785 nm. We discuss the role of

	the position and of the order of the Localized Surface Plasmon Resonance (LSPR) in such optimization for both wavelengths. At 632.8 nm, the best SERS intensity is reached for a LSPR located between the excitation and Raman wavelengths whereas at 785 nm, the LSPR should be placed outside this range. The third order of LSPR is shown to have no influence on the SERS intensity.
17:45-18:00	**CT53. NanoPlasmonics: from biochemical sensors to surface enhanced spectroscopies** **P.-M. Adam** *CNRS FRE 2848, Laboratoire de Nanotechnologie et d'Instrumentation Optique, Troyes Cedex, France* Plasmonics is a field connected to optics dealing with the properties and applications of surface plasmons which are modes of metal dielectric interfaces. Nanoplasmonics concerns the excitation, manipulation and detection of the surface plasmons at the nanometric scale. It has highly potential applications for ultrasensitive biochemical sensing. Surface enhanced spectroscopies are the ultimate sensor tools as they can reach single molecule sensitivity. We will present in this paper our results towards the realization of highly controllable and reproducible nanoplasmonics substrates.
18:00-18:15	**CT54. Light depolarization effects in tip enhanced Raman spectroscopy of Si(001) and GaAs(001)** ***P. G. Gucciardi*** [a], *J. C. Valmalette* [b], *M. Lopes* [c], *R. Deturche* [c], *M. Lamy de la Chapelle* [d], *D. Barchiesi* [c], *F. Bonaccorso*[ab], *C. D'Andrea* [a], *M. Chaigneau* [e], *G. Picardi* [e], *R. Ossikovski* [e] *(a) CNR-IPCF, Messina, Italy – (b) Universitè du Sud Toulon Var, La Garde Cedex, France – (c) Universitè de Technologie de Troyes, France – (d) Universitè Paris 13, Bobigny, France – (e) LPICM, Ecole Polytechnique, CNRS Palaiseau, France* We report on the effects of light depolarization induced by sharp metallic tips in Tip-Enhanced Raman Spectroscopy (TERS). Experiments on Si(001) and GaAs(001) crystals show that the excitation field depolarization induces a selective enhancement of specific Raman modes, depending on their Raman tensor symmetry. A complete polarization analysis of the light backscattered from the tip confirms the TERS findings. The spatial confinement of the depolarization field is studied and its dependence on the excitation wavelength and power are explored.

Friday, September 30

Session 5.1 8:45 – 10:30
Session chair: Timo Nieminen

8:45-9:15	**IT14. Enhancing and localizing light-matter interactions using surface plasmons** *M. Bohmler, N. Hartmann, C. Georgi, G. Piredda, J. Berteloth, A. Bouhelier,* ***A. Hartschuh*** *(a) Ludwig-Maximilians-Universität München, Germany – (b) Universitè de Bourgogne, Dijon, France* The enhancement of light-matter interactions using the strong fields associated with surface plasmons in metallic structures is a powerful concept used for example in surface enhanced Raman scattering and plasmonic sensing. We investigated the coupling between nanoscale emitters and surface plasmons in sharp metal tips and smooth metal films by detecting the angular distribution of the emitted radiation. The localized nature of the interaction is utilized in a scanning-probe approach for high-resolution Raman and photoluminescence microscopy of one-dimensional nanostructures.
9:15-9:30	**CT55. Plasmonic near-field enhanced absorption and scattering** ***E. Lidorikis*** *University of Ioannina, Greece* An important effect when metallic nanoparticles are irradiated by light at the proper frequency is the surface plasmon resonance (SPR), a collective resonant excitation of the nanoparticle's conduction electrons, resulting into enhanced absorption, scattering, and large near-fields close to the nanoparticle surface. We derive analytic closed-form expressions within the framework of a discrete dipole approximation, for two applications involving such nanoparticles: (i) enhancement of semiconductor absorption and (ii) enhancement of Raman scattering, and explore their dependence on nanoparticle shape, distribution and environment. Comparisons with accurate finite-difference time-domain (FDTD) simulations show excellent agreement.
9:30-9:45	**CT56. Light scattering calculations in planar non-homogeneous dielectric media by means of the light diffraction calculation on gratings** ***A. Shcherbakov*** [ab], *A.V. Tishchenko* [b] *(a) Moscow institute of physics and technology, Russia – (b) University Jean Monnet of Saint-Etienne, France* The generalized source method previously developed for the light diffraction calculation on periodic structures is applied for the light scattering calculation in non-periodic media. This greatly enlarges the domain of applicability of two-dimensional Fourier-methods in light scattering applications since the generalized source method has much less numerical complexity than widely used Fourier modal method. It is also demonstrated on numerical examples that for pure dielectric structures the use of lossy perfectly matching layers is not necessary for removing the effects of periodicity and taking of a large grating period is sufficient.
9:45-10:00	**CT57. Plasmonic nanostructure enhanced graphene-based photodetectors** ***T. J. Echtermeyer*** [a], *L. Britnell* [b], *S. Milana* [a], *A. Lombardo* [a], *R. V. Gorbachev* [b], *A.N. Grigorenko* [b], *A. K. Geim* [b], *K.S. Novoselov* [b], *A.C. Ferrari* [a] *(a) University of Cambridge, UK – (b) University of Manchester, UK* Graphene exhibits electrical and optical properties promising for future applications in ultra-fast photonics. High carrier mobility and Fermi velocity combined with its constant absorption over the visible wavelength range to the near-infrared potentially allow its application for photodetection over a broad wavelength spectrum, operating at high frequencies. However, absorption being 2.3% per monolayer, responsivity of these devices is rather low. Here we show that by combining graphene-based photodetectors with metal-nanostructures, plasmonic effects lead to an increased responsivity.
10:00-10:15	**CT58. Discrete dipole approximation of gold nanospheres on substrates: Considerations and comparison with other discretization methods** ***V. L.Y. Loke*** [a], *E. U. Donev* [b], *G. M. Huda* [b], *J. Todd Hastings* [b], *M. Pinar Menguc* [c], *T. Wriedt* [a] *(a) University of Bremen, Germany – (b) University of Kentucky, Lexington, USA – (c) Özyeğin University, Istanbul, Turkey* We embark on this preliminary study of the suitability of the discrete dipole approximation with surface interaction (DDA-SI) method to model electric field scattering from noble metal nano-structures on dielectric substrates. The refractive index of noble metals, particularly due to their high imaginary components, require smaller lattice spacings and are especially sensitive to the shape integrity and the volume of the dipole model. The results of DDA-SI method are validated against those of the well-established finite element method (FEM) and the finite difference time domain (FDTD) method.
10:15-10:30	**CT59. Light scattering and photon statistics of quantum emitters coupled to metallic nanoparticles** *O. Di Stefano, A. Ridolfo, R. Saija,* ***S. Savasta*** *Università di Messina, Italy* We study theoretically the quantum optical properties of hybrid artificial molecules composed of an individual quantum emitter and a metallic nanoparticle. The coupling between the two systems can give rise to a Fano interference effect which strongly influences the quantum statistical properties of the scattered photons: a small

	frequency shift of the incident light field may cause changes in the intensity correlation function of the scattered field of orders of magnitude. The system opens a good perspective for applications in active metamaterials and ultracompact single-photon devices. We also demonstrate with accurate scattering calculations that a system constituted by a single quantum emitter (a semiconductor quantum dot) placed in the gap between two metallic nanoparticles can display the vacuum Rabi splitting.

Coffee Break 10:30 – 11:00

Session 5.2 11:00 – 12:45 **Session chair: Enzo Di Fabrizio**	**Friday, September 30**
11:00-11:30	**IT15. Optical properties of gold nanostructures: Application to the Surface Enhanced Raman Scattering and to the development of a nanobiosensor** ***M. Lamy De La Chapelle*** *Université Paris XIII, Bobigny, France* The application of Surface Enhanced Raman Spectroscopy (SERS) for detection of biomolecules is a subject of intense current research worldwide. In this article the observation of the dependence of the Raman enhancement versus the nanoparticle size is clearly demonstrated on nanocylinders and nanowires. Remarkably the enhancement is observed to be maximum for a specific diameter or length. We finally show that the SERS signal depends on the molecule used and that the SERS active substrates should be actually optimized for each targeted protein.
11:30-11:45	**CT60. Nanoantennas for surface enhanced infrared spectroscopy: Effects of interaction and higher order resonant excitations** ***P. Albella*** [a], *F. Neubrech* [b], *D. Weber* [b], *G. Han* [c], *T. Nagao* [c], *A. Pucci* [b], *J. Aizpurua* [a] *(a) Material Physics Center CSIC-UPV/EHU and Donostia International Physics Center, Donostia-San Sebastian, Spain – (b Kirchhoff-Institute for Physics, Heidelberg, Germany – (c) World Premier International (WPI) Research Center for Materials Nanoarchitectonics (MANA)National Institute for Materials Science (NIMS), Ibaraki, Japan* The sensitivity in surface enhanced infrared spectroscopy (SEIRS) strongly depends on where the resonant excitation is spectrally located compared to the molecular vibration that is to be enhanced. In this contribution, we study the effect of coupling in the electromagnetic properties of 2D gold nanorod arrays in the IR. We also study the SEIRS activity of higher order resonant excitations in long nanoantennas to identify polaritonic signals of a supporting SiO_2 layer with nanometer thickness (3 nm) on a silicon substrate.
11:45-12:00	**CT61. Decomposition of Mueller matrices of scattering media: Theory and experiment** ***R. Ossikovski*** *LPICM, Ecole Polytechnique, CNRS, Palaiseau, France* Algebraic decomposition of Mueller matrices is a particularly promising approach to the retrieval of the optical properties of the medium investigated in a polarized light scattering experiment. Various decompositions of generally depolarizing Mueller matrices are revisited and discussed. Both classic as well as recently proposed approaches are reviewed. Physical and mathematical aspects such as depolarization and limits of applicability are comparatively addressed. Experimental matrices of scattering media are decomposed by different methodologies and physically interpreted.
12:00-12:15	**CT62. Optical response of noble metal nanoparticles** ***V. Myroshnychenko,*** *F. J. Garcia de Abajo* *Instituto de Óptica – CSIC, Madrid, Spain* The rich structure of surface plasmon modes localized in noble metal nanoparticles is explored by optical spectroscopy, spatially resolved electron energy-loss spectroscopy, and by electron beam-induced radiation emission. Spectral features and spatially-resolved maps of surface plasmon modes are calculated by using the boundary element method. Our results show the unmatched capability of electron beams for spectrally and spatially probing plasmon modes in metal nanoparticles.
12:15-12:30	**CT63. Application of the discontinuous Galerkin time domain method to the optics of metallic nanostructures** ***Y. Grynko****, J. Förstner, T. Meier* *University of Paderborn, Germany* A simulation environment for metallic nanostructures based on the Discontinuous Galerkin Time Domain method is presented. The model is used to compute the linear and nonlinear optical response of split ring resonators and to study physical mechanisms that contribute to second harmonic generation.

12:30-12:45	**CT64. Strongly polarized scattering in surface enhanced raman spectroscopy of randomly distributed molecules on gold nanowires** ***B. Fazio*** [a], *P. G. Gucciardi* [a], *C. D'Andrea* [a], *A. Irrera* [a], *F. Bonaccorso* [a], *G. Calogero* [a], *C. Vasi* [a], *M. Allegrini* [b], *A. Toma* [c], *D. Chiappe* [c], *C. Martella* [c], *F. Buatier de Mongeot* [c] *(a) CNR-IPCF,Messina, Italy – (b) Università di Pisa and INO-CNR, Italy – (c) Università di Genova and CNISM, Italy* We study the polarized Surface Enhanced Raman Scattering from randomly oriented molecules adsorbed on near-field coupled gold nanowires. We show that the scattering is polarized always along the wire-to-wire nanocavities. We find the exact angular dependence for the polarized, unpolarized, parallel- and cross-polarized SERS intensity. Finally we develop a model that fits the experimental data and allows to measure the field enhancement and the re-radiation enhancement factors, independently, and retrieve the depolarization ratio of the probe molecules.

Conference Closure

Poster Session 18:00 – 20:00

Tuesday, September 27

P1. Model of the effective-medium approximation for nano-structured layers with the account of interparticle interactions and its ellipsometric registration

E. G. Bortchagovsky [a], *A. Dejneka* [b], *L, Jastrabik* [b], *V. Z. Lozovski* [c], *T. O. Mishakova* [c]

(a) Institute of Semiconductor Physics of NASU, Kiev, Ukraine-(b) Institute of Physics of the ASCR, Praha, Czech Republic-(c) Taras Shevchenko National University of Kyiv, Ukraine

Here we discuss the deficiencies of standard Effective-Medium Approximation in the application to thin layers and propose the model, which overcomes those problems for 2-dimensional case. Ellipsometry of layers of gold nanoparticles reveals the discussed interparticle interactions in such layers.

P2. Modeling of the particle scattering structure factor for branched bio-polymers in solution: A X-ray scattering study

P. Calandra [a], *M. A. Kiselev* [b], *D. Lombardo* [a]

(a) CNR-IPCF, Messina, Italy - (b) FLNP, Joint Institute for Nuclear Research,Russia

We present a study which illustrates the modeling of the Particle Scattering Structure Factor from Small Angle X-ray Scattering (SAXS) data. The studied sample was a poly(amidoamine) Pamam dendrimers in water solution. The intra-particle form factor *P(q)* has been analyzed employing an inverse Fourier transformation which allows to obtain the particle pair distance distribution function and to gain information about dendrimer shape. The experimental inter-dendrimer structure factor *S(q)* has been analysed in the framework of liquid integral equation theory for charged systems in solution. From that, we derive an effective interparticle interaction composed of a screened Coulombic plus hard-sphere repulsion potential, which allow the estimation of the dendrimer effective surface charge Z_{eff}. The present analysis, applied to a Pamam dendrimers in water solution, strongly supports the finding that structures and interaction of dendrimer is strongly influenced by charge effects. As a result, this quantity can be considered as a crucial parameters for the modulation of the degree of structural organization in solution, suitable for a number of potential applications.

P3. Spectral dependence of the amplification factor in Surface Enhanced Raman Scattering

C. D'Andrea [a], *B. Fazio* [a], *A. Irrera* [a], *P. Artoni* [b], *O. M. Maragò* [a], *G. Calogero* [a], *P. G. Gucciardi* [a]

(a) CNR-IPCF, Messina, Italy - (b) CNR-Matis, Catania, Italy

Multi-wavelength SERS measurements on dyes molecules adsorbed on gold evaporated nanoparticles substrates are presented. The spectra are correlated with the Localized Surface Plasmon Resonance (LSPR) profile of the nanostructured substrate before and after the adsorption process. The enhancement of the typical vibrational modes of the methylene blue is investigated for the different excitation wavelengths and we show that its behavior follows properly the LSPR profile of nanoparticles "dressed" with the dye molecules.

P4. Raman scattering in heavily boron-doped single-crystal diamond

G. Faggio [a], *G.Messina* [a], *S. Santangelo* [a], *D. Alfieri* [b], *G. Prestopino* [b], *I. Ciancaglioni* [b], *M.Marinelli* [b]

(a) Università "Mediterranea" di Reggio Calabria, Italy – (b) Università di Roma "Tor Vergata", Italy

A series of boron-doped homoepitaxial diamond films grown by Microwave Plasma Enhanced Chemical Vapor Deposition at the University of Rome "Tor Vergata" have been investigated with Raman spectroscopy. As the boron content increases, we observed systematic modifications in the Raman spectra of single-crystal diamonds. A significant change in the lineshape of the first-order Raman peak as well as a wide and structured signal at lower wavenumbers appeared simultaneously in samples grown at higher boron content.

P5. Surface Enhanced Raman Spectroscopy of biomolecules in buffer solution

B. Fazio, *C. D'Andrea, V. Villari, N. Micali, O.M. Maragò, G. Calogero, P.G. Gucciardi*

CNR-IPCF, Messina, Italy

Controlled creation of SERS-active hot spots in liquid is a challenge in which optical forces can play an important role by promoting the aggregation of metal nanoparticles by optical trapping or by exploiting the radiation pressure. Here we show that laser induced aggregation of gold nanorods in a buffered solution of Bovine Serum Albumin (BSA) leads to the formation of SERS-active agglomerates capable to enhance the Raman scattering of BSA by 5 orders of magnitude, thus allowing the detection of BSA at concentrations as low as 10^{-6} M. This occurrence involves optical, mechanical and thermal effects.

P6. Optical sizing of irregular snow grains

A. Kokhanovsky

University of Bremen, Germany

We discuss a possibility of snow grain size determination using spectral reflectance measurements in the near-infrared part of the electromagnetic spectrum. Errors related to often made assumption of the sphericity of grains are studied. Also we introduce a new method for the snow albedo and snow pollution monitoring using measurements in the visible part of the electromagnetic theory. Both exact and approximate methods of the radiative transfer are used for the solution of corresponding inverse problem. It is assumed that snow grains can be presented as randomly distributed irregular fractal particles. The developed techniques are applied to both ground and satellite data.

P7. Wide-bandwidth photon time of flight spectroscopy of the turbid media

D. Khoptyar*, A. A. Subash, E. Alerstam, S. A. Engels*

Lund University, Sweden

We report on current state of the art and performance characteristics of ultra-wide bandwidth time of flight spectrometer for biomedical and pharmaceutical applications developed in the Group of Biophotonics Lund University. The unique spectrometer is capable to deliver

absorption/scattering spectra of turbid media in the range from 650nm up to 1400nm. We illustrate outstanding performance of the instrument by reviewing number of applications in precise analysis of pharmaceuticals and in biomedical diagnostics. Furthermore we discuss current challenges in the modeling of turbid light propagation hindering further progress of the optical diagnostics and industrial analytical techniques.

P8. Diffraction of a plane wave on a multilayered grating

A. G. Kyurkchan, *S.A. Manenkov*

Moscow Technical University of Communications and Informatics, Russia

The two-dimensional problem of wave scattering on a multilayered grating consisting of dielectric infinite cylindrical bodies with arbitrary cross-section is considered. The system of integral equations to which the initial problem is reduced is derived. The efficient algorithm for calculation of periodic Green's function is offered. The dependencies for reflected and transmitted field are obtained.

P9. Modelling mineral dust using stereophotogrammetry

H. Lindqvist[a], *O. Jokinen*[b], *K. Kandler*[c], *T. Nousiainen*[a]

(a) University of Helsinki, Finland – (b) Aalto University School of Engineering, Finland – (c) Technische Universität Darmstadt, Germany

The real, three-dimensional shape of a dust particle is derived from a pair of scanning-electron microscope images by means of stereophotogrammetry. The resulting shape is discretized, and preliminary discrete-dipole-approximation computations for the single dust particle reveal that scattering by such an irregular shape differs notably from scattering by a sphere or a Gaussian random sphere which both are frequently used shape models for dust particles.

P10. Small-angle light scattering by monolayer of liquid crystal droplets in polymer matrix

V. A. Loiko[a], *V. Ya. Zyryanov*[b], *U. Maschke*[c], *A. V. Konkolovich*[a], *A. A. Miskevich*[a]

(a) Stepanov Institute of Physics, Minsk, Belarus - (b) Kirenski Institute of Physics, Krasnoyarsk, Russia – (c) Universitè des Sciences et Technologies de Lille, Villeneuve dAscq Cedex, France

A method for modeling the angular distribution of light scattered by a monolayer of liquid crystal droplets dispersed in polymer matrix is developed. It is based on the anomalous diffraction and interference approximations.

P11. Analysis of MAIAC dust aerosol retrievals from MODIS over North Africa

A. Lyapustin[a], *Y. Wang*[b], *C. Hsu*[a], *O. Torres*[a], *G. Leptoukh*[c], *O. Kalashnikova*[d], *S. Korkin*

(a) NASA Goddard Space Flight Center, Greenbelt, USA - (b) University of Maryland, Baltimore, USA – (c) NASA Goddard Space Flight Center code 610.2, Greenbelt, USA – (d) NASA Jet Propulsion Laboratory, Pasadena, USA – (e) Universities Space Research Association, Columbia, USA.

An initial comparison of aerosol optical thickness over North Africa for year 2007 was performed between the Deep Blue (DB) and Multi-Angle Implementation of Atmospheric Correction (MAIAC) algorithms complimeted with MISR and OMI data. The dust retrievals are performed using the model of spheroids. The new MAIAC algorithm has a better sensitivity to the small dust storms than the DB algorithm, but it also has biases in the brightest desert regions indicating the need for improvement. The quarterly averaged AOT values in the Bodele depression and western downwind transport region show a good agreement among MAIAC, MISR and OMI data, while the DB algorithm shows a somewhat different seasonality.

P12. A Fortran-90 multiple sphere code for use on parallel computer clusters

D. Mackowski[a], *L. Kolokolova*[b], *M. Mishchenko*[c]

(a) Auburn University, USA - (b) University of Maryland, College Park, USA – (c) NASA Goddard Institute for Space Studies, New York, USA

A public domain, fortran–90 code for predicting the electromagnetic scattering and absorption properties of sphere clusters is described. The code can calculate the efficiency factors and scattering matrix elements of the cluster for either fixed or random orientation with respect to the incident beam and for plane wave or localized–approximation Gaussian incident fields. In addition, the code can calculate maps of the electric field both interior and exterior to the spheres. The code is written with message passing interface instructions to enable use on distributed memory compute clusters, and for such platforms the code can make feasible the calculation of absorption, scattering, and general EM characteristics of systems containing several thousand spheres.

P13. Light scattering by silver and gold nanoparticles in colloid solutions and monolayers

I.M. Dmitruk[a], *E.S. Grabovskyi*[a], *A.M. Dmytruk*[b], ***S. Z. Malynych***[c], *N.L. Dmitruk*[c]

(a)Taras Shevchenko University, Kyiv, Ukraine - (b) Institute of Physics of National Academy of Sciences of Ukraine, Kyiv, Ukraine - (c) V.E Lashkaryov Institute for Physics of Semiconductors, Kyiv, Ukraine

Scattering diagrams and spectra of scattered light for different directions are studied with custom-assembled automated experimental setups. It is found that Ag and Au nanoparticles of the size in the range 75-200 nm demonstrate efficient wide-angle light scattering due to excitation of multi-pole resonances, which manifest themselves as side lobes in the scattering diagrams. A red shift of light scattering efficiency maximum comparing to extinction maximum is studied aiming its application for efficient trapping of long-wavelength radiation in photovoltaic cells.

P14. Tuning the structural and optical properties of Gold/Silver nanoalloys prepared by laser ablation in liquids for ultra-sensitive spectroscopy and optical trapping

E. Messina, *L. D'Urso, C. Satriano, E. Fazio, M. G. Donato, B. Fazio, C. D'Andrea, O. M. Maragò, P. G. Gucciardi, G. Compagnini, F. Neri*

(a) Università degli Studi di Catania, Italy – (b) Università degli Studi di Messina, Italy – (c) CNR-IPCF,Messina, Italy

The plasmon resonance of metallic Au/Ag alloys in the colloidal state was tuned from 400 nm to 500 nm using a laser irradiated technique, performed directly in the liquid state. Interesting optical nonlinearities, trapping effects and spectroscopic enhancements were detected as function of gold concentration in the nanoalloys. In particular a reduction of the limiting threshold was observed by increasing the gold amount. The SERS activity of the Au/Ag alloys was tested in liquid and in solid state in presence of linear carbon chains as probe molecules. The dependence of the increased Raman signals on the nanoparticle Au/Ag atomic ratio is presented

and discussed. Finally preliminary studies and prospects for optical and Raman tweezers experiments are discussed.

P15. Asteroid phase curves from Lowell Observatory photometric database

*D. A. Oszkiewicz[abc], **K. Muinonen**[ad], E. Bowell[b], D. Trilling[c], L.H. Wasserman[b], A. Penttila[a], T. Pieniluoma[a]*

(a) University of Helsinki, Finland - (b) Lowell observatory, Flagstaff, USA - (c) Northern Arizona University, Flagstaff, USA – (d) Finnish Geodetic Institute, Masala, Finland.

We present results obtained from processing large photometric data base. We make use of low-precision (generally rounded to 0.1 mag) and low-accuracy (rms magnitude uncertainties of ±0.2 to 0.3 mag) data obtained from the Minor Planet Center and modified at Lowell Observatory. We explore first correlations between slope parameter(s) and albedo, and second distributions of slope parameter(s) in asteroid families and taxa.

P16. Super Continuum Light for Measuring Scattering and Absorption of Turbid Media.

O. H. A. Nielsen

Technical University of Denmark, Lyngby, Denmark

The desire to improved quality and minimise waist during food production motivates new methods to characterise the food matrix during production. Furthermore the conventional methods are invasive and labour intensive, samples have to be extracted an analysed, making them inefficient for online monitoring. Optical methods may prove as a valuable tool since the light dos not affect the sample and the measurement can be performed remote. For this application absorption spectroscopy have been developed, however many organic food products exhibit more scattering than absorption in the visible regime making the absorption harder to measure. To overcome this we present a vision system working in the visible/NIR regime usable for monitoring change in particle size distribution. The particle size in dairy production is in the range of ~350 nm and thus the most dominant effects of scattering are exhibited in the visible part of the spectrum. Monitoring the scattering coefficient may give a valuable input for correcting the longer wavelength part of the spectrum and give an indication of the average particle. In the poster we present our latest results in applying oblique incident spectroscopy for characterising food samples using acousto-optical filtering of a super continuum light source.

P17. The difficulty of measuring orbital angular momentum

*D. Preece, **T. A. Nieminen**, T. Asavei, N. R. Heckenberg, H. Rubinsztein-Dunlop*

The University of Queensland, School of Mathematics and Physics, Brisbane, Australia

Light can carry angular momentum as well as energy and momentum; the transfer of this angular momentum to an object results in an optical torque. The development of a rotational analogue to the force measurement capability of optical tweezers is hampered by the difficulty of optical measurement of orbital angular momentum. We present an experiment with encouraging results, but emphasise the difficulty of the task.

P18. Sensitivity of radiative impact of dust to particle shape: comparison of spheres and spheroids

*P. Mauno[a], M. Kahnert[b], P. Raisanen[c], **T. Nousiainen**[a]*

(a) University of Helsinki, Finland – (b) Swedish Meteorological and Hydrological Institute, Norrköping, Sweden – (c) Finnish Meteorological Institute, Helsinki, Finland

The shortwave radiative impacts of dust based on spherical and spheroidal dust particles are compared. For spheroids, two different shape distributions are considered. The size distribution, optical thickness, and the solar zenith angle are varied and the dust is assumed to reside over an ocean. At the top of the atmosphere the radiative impact computed with spheres and spheroids differs by up to 12%.

P19. Separation of fine and coarse aerosol contributions to the total aerosol light scattering: An AERONET assessment

***A. Quirantes**[a], F.J. Olmo[ab], H. Lyamani[ab], A. Valenzuela[ab], L. Alados-Arboledas[ab]*

(a)University of Granada, Spain – (b) Centro Andaluz de Medio Ambiente (CEAMA), Granada, Spain

The contribution of each mode to total light scattering in a bimodal aerosol population is studied. The dependence of some backscattering-related light properties on particle shape, and concentration, are simulated. Results will help us determine whether any of those parameters will be useful in separating the optical properties of each particle mode, and therefore in determining mode concentration.

P20. Mueller matrix characterization of porous media in visible

***S. Savenkov**, A. Priezzhev, Ye. Oberemok, P. Silfsten, T. Ervasti, J. Ketolainen, and K.-E. Peiponen*

(a) Kiev Taras Shevchenko University, Kiev, Ukraine – (b) Lomonosov Moscow State University, Moscow, Russia – (c) University of Eastern Finland, Joensuu, Finland – (d) University of Eastern Finland School of Pharmacy, Kuopio, Finland

In this paper, we apply Mueller polarimetry to study different samples of porous media compacted as tablets from a pharmaceutical excipient microcrystalline cellulose. We measured the Mueller matrices of the samples with the home made polarimeter using a He-Ne laser (0.63 μm). We show that polarization entropy manifests the highest sensitivity to the porosity allowing to identify the tablets of different porosities.

P21. Dominant type of deterministic polarization transformation for inhomogeneous elliptic birefringent medium

***S. Savenkov**[a], Ye. Oberemok[a], I. Kolomiets[a], V. Yakubchak[a], R. Muttiah[b]*

(a) Kiev Taras Shevchenko University, Kiev, Ukraine – (b) University of Texas, Arlington, U.S.A.

The features of spectral properties of the Jones matrix model of the dominant deterministic polarization transformation for inhomogeneous elliptic birefringent medium have been studied.

P22. Modified refractive index of ZnS nanoparticles doped glasses

*M. Moussaoui,R. Saoudi, S. Tonchev, S. Palle, **A. V. Tishchenko***

(a) Université de Lyon, Saint-Etienne, France – (b) The Institute of Solid State Physics, Sofia, Bulgaria – (c) Centre de Microscopie Confocale Multiphotonique, Saint-Etienne, France

ZnS nanoparticles (NPs) embedded in an oxide glass have been achieved in the present work by melting process. The

UV-visible absorption and fluorescence properties of these doped and undoped glasses have been evaluated and compared. Studies on absorption spectra showed that the size of the ZnS NPs was near to 2 nm. Doped glass fluorescence characterized by laser confocale microscopy is centered at about 620 nm. We measured also the refractive index of ZnS doped glasses. The maximum refractive index difference between the undoped and ZnS doped glasses was found about 0.1 (λ = 632.8 nm).

P23. On Rayleigh approximation for non-ellipsoids

V. G. Farafonov[a], V. B. Il'in[abc], M. S. Prokopjeva[b], S. V. Barkanov[a], ***A. A. Vinokurov***[ac]*, T. N. Khoudyakova[b]*

(a) University of Aerospace Instrumentation, St.Petersburg, Russia – (b) St.Petersburg State University, Russia – (c) Pulkovo Observatory of RAS, St.Petersburg, Russia

We consider polarizability of a small arbitrary shaped particle that is obtained from the electrostatic theory under the assumption of the uniform internal field. For ellipsoids, this assumption is known to be always correct and such a polarizability leads to the standard Rayleigh approximation. We show that application of our approximate polarizability provides acceptable results not only for particles close to ellipsoids, but also for scatterers of essentially different shapes.

P24. Shape dependency of the extinction and absorption cross sections of dust aerosols modeled as randomly oriented spheroids

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We present computational results on the shape dependency of the extinction and absorption cross sections of dustlike aerosol particles that were modelled as randomly oriented spheroids. Shape dependent variations in the extinction cross sections are largest in the size regime that is governed by the interference structure. Elongated spheroids best fitted measured extinction spectra of re-dispersed Saharan dust samples. For dust particles smaller than 1.5μm in diameter and low absorption potential, shape effects on the absorption cross sections are very small.

P25. Remote sensing of aerosols above cloud using polarization measurements from POLDER/PARASOL - Comparison with lidar CALIOP -

F. Waquet *, J. Riedi, L. Labonnotte, F. Thieuleux , F. Ducos, P. Goloub, D. Tanré*

Laboratoire d'Optique Atmosphérique, Université Lille, France

Most of the current aerosol retrievals from passive sensors are restricted to cloud-free scenes, which strongly reduces our ability to monitor the aerosol properties at a global scale. The presence of aerosols above clouds affect the polarized radiation reflected by the clouds, as shown by the measurements provided by the POlarization and Directionality of Earth Reflectances (POLDER) instrument. An approximate model of the polarized signal was developed and used to retrieve the Aerosol Optical Thickness (AOT) above clouds. Results obtained with this method in various regions of the world are presented. In the second part, we present additional results obtained with an improved method that allows the retrieval of a detailed microphysical model of the observed particles. The retrieved POLDER AOTs are compared to AOTs retrieved by a space-borne lidar in the case of a dust layer transported above clouds. The advantages and limitations of the different methods are discussed.