On the occasion of the 16th International Conference
on Image Analysis and Processing - ICIAP 2011

Alma Mater Studiorum
Università di Bologna

M.V. Keldysh Institute of
Applied Mathematics
Russian Academy of
Sciences, Moscow, Russia

WORKSHOP

First Russian – Italian Joint Seminar on Mathematical and Physical Models Applications to Condensed Matter and Preservation of the Cultural Heritage

Fondazione Flaminia
Ravenna

Casa Matha, Piazza Andrea Costa 3,
Ravenna, Italy, September 12, 2011

Faculty of Preservation of the Cultural Heritage,
Palazzo Corradini, Via Mariani 5, Ravenna,
Italy, September 13, 2011

The appointment of Ravenna is the first in an annual series of workshops (to be held alternately in Italy and in Russia, in Moscow and St Petersburg) among young researchers - students and graduate students, research fellows - and leading Italian and Russian experts, to establish scientific cooperation, internships, common educational activities on issues of frontier of condensed matter, solid state physics and computer science, related to knowledge and conservation of works of art and archaeological artifacts. The initiative of this Seminar appears as a result of many years of collaboration between M.V. Keldysh Institute of applied mathematics of Russian Academy of Sciences, Moscow, Russia, Bologna University, Italy and ENEA Bologna, Italy.

Aim of the workshop is the promotion of scientific collaboration between our countries in the field of development, application and exploitation of mathematical and physical tools for the humanities and particularly for the study of condensed matter and surface physics in order to provide knowledge and preservation of the cultural heritage, image processing at monitoring of damages by time and ecological factors of objects of architecture and paintings, for archaeological and artistic investigations, for development of computer simulation, mathematical-physical methods for diagnostics and transport-diffusion processes of pollutants, deposition of thin films, applications of plasma and radiations in problems of increase of accuracy of diagnostics of an industrial tomography, etc.

This initiative was proposed by prof. Gala Zmievskaya from Russia, Leading Research Fellow of KIAM RAS Moscow, member of ICIAP 2011 Program Committee, and realized by prof. Giuseppe Maino, ENEA and University of Bologna, Ravenna site, Italy, general chairman of ICIAP 2011, 16th edition of the International Conference on Image Analysis and Processing.

We gratefully acknowledge support of Fondazione Flaminia and particularly the organizational help of Carla Rossi. We are also indebted to Ordine della Casa Matha, where the workshop was holded, and to NEREA-Aida and Meduproject spin-offs for continuous scientific, technical and management collaborations.

NEREA network restauro avanzato

AIDA Analisi scientifiche e Informatica Documentale per l'Arte

http:\\www.nerea-aida.it

MEDU PROJECT

http:\\www.meduproject.com

Images of Casa Matha, Ravenna, workshop venue

ICIAP 2011

16th International Conference on Image Analysis and Processing

September 14 - 16, 2011 - Ravenna, Italy

On the occasion of the 16th International Conference on Image Analysis and Processing

WORKSHOP - First Russian - Italian Joint Seminar on Mathematical and Physical Models Applications to Condensed Matter and Preservation of the Cultural Heritage

Ravenna, Italy, September 12 and 13, 2011

The workshop will be devoted to the following problems and subjects:

- New computer simulation technologies/database and information networks for models of cultural heritage science.
- New computer simulation models in nanoscience for development and evaluation of cleaning and conservation materials and methods (coatings, adhesives, consolidants, varnishes/protectives, etc.).
- Studies on ancient materials and production techniques.
- Computer simulation methods of damaging of surfaces and thin film covering.

Scientific Program

Monday, September 12, 2011

10.00 a.m.

Giannantonio Mingozzi, Deputy Mayor of Ravenna
Lanfranco Gualtieri, President of Fondazione Flaminia
Paolo Bezzi, Primo Massaro of Casa Matha
Donatella Biagi Maino, President of Corso di Laurea Magistrale in *Storia e Conservazione delle Opere d'Arte*, University of Bologna, Ravenna campus
Welcome addresses and introduction to workshop

10.20 a.m. Galina I. Zmievskaya, *Introductory remarks*

10.40 a.m. Giuseppe Maino, *When Physics and Computer Science meet Art*

11.00 a.m. Coffee break

11.20 a.m. Vadim D. Levchenko, *Full-scale computer simulation in physics on modern and perspective computers*

11.40 a.m. Anna L. Bondareva, *Diagnostics of microporosity into multilayers solids*

12.00 a.m. Galina I. Zmievskaya, *Stochastic simulation method in both problems: Thin film islands, chemical vapor deposition and radiation stimulated damaging*

12.20 a.m. Sergey Khilkov, *Computer simulation of stochastic resonance in systems with Bose and Fermi statistics*

12.40 a.m. Andrey Zakirov, *The effective 3D modeling of electromagnetic waves' evolution in actual problems of nano-optics*

1.00 p.m. Lunch

2.40 p.m. Anna L. Bondareva, *Problems of solid-phase and gas-phase epitaxy of damaged surfaces*

3.00 p.m. Marianna Panebarco, *VirtualLife – an innovative virtual framework for promoting cultural heritage*

3.20 p.m. Roberta Menghi, *Virtual reality models for the preservation of the Unesco historical and artistical heritage*

3.40 p.m. Mariapaola Monti, *Image processing and a virtual restoration hypothesis for mosaics and their cartoons*

4.00 p.m. Andrea Nanetti and Sergej Pavlovic Karpov, *Engineering Historical Memory: The Italian documents and manuscripts of the Likhashev Collection in the Academy of Sciences of St-Petersburg*

4.20 p.m. Lisa Volpe, *Diagnostic investigation of cultural heritage*

4.40 p.m. Coffee break

5.00 p.m. Round table – Discussions and projects' proposals

Tuesday, September 13, 2011

9.00 a.m. Ivan Gorjachev, *The occurrence of the Hall current in a magnetized plasma during the deposition of thin films*

9.20 a.m. Tatjana V. Levchenko, *First order phase transition at fluctuation stage in problem of cluster formation and water condensation into cracks*

9.40 a.m. Elvira O. Manucharyants, *Problem of percolation and protection of cultural monuments*

10.00 a.m. Anastasia Perepelkina, *Fully kinetic 3D model of magnetized plasma*

10.20 a.m. Alexander A. Samylkin, *Weight Monte Carlo study of rarefied gas flows with coagulation*

10.40 a.m. Coffee break

11.00 a.m. Anton V. Ivanov, *Algorithms and realization of high performance recursive grid on sphere*

11.20 a.m. Marco Landi, *Multispectral imaging and digital restoration for paintings documentation*

11.40 a.m. Elena Nencini, *From the physical restoration for preserving to the virtual restoration for enhancing*

12.00 a.m. Maurizio Indirli, *Multidisciplinary assessment of historic centres through remote sensing, direct survey and GIS approach*

12.20 a.m. Conclusions

1.00 p.m. Lunch

List of Russian reports

1. Levchenko Vadim D. (KIAM*)
Full-scale computer simulation in physics on modern and perspective computers

2. Bondareva Anna L. (KIAM*), Zmievskaya Galina I. (KIAM*)
Diagnostics of microporosity into multilayers solids

Mathematical modeling of the physical and chemical processes leading to degradations of materials properties of objects of a cultural heritage under the influence of natural and anthropogenic factors can be considered on a model example of microporosity in thin layers on a substratum and into the multilayered media combining crystal and amorphous layers or layers with properties of porous ceramics.
One of nondestructive method for researching and control of processes in solids is 1/f noise registration. 1/f noise can be used for diagnostics of porosity and roughness in sculptures and paintings films. The solids destruction has fluctuation nature at initial stage and can be studied by 1/f-noise.
The numerical analysis of an arrangement of layers of porosity depending on influence change on the sample is given, and also occurrence conditions of the flaking accompanying by stress computer simulation into layers are analyzed. Numerical stochastic models and methods are considered [1]: They are used earlier in models of updating of properties of a surface by drawing of thin films or as a result of solid-phase and gaseous-phase epytaxies. The comparison of transformation of the silicon porous surface creating strengthening covering in the form of a thin film of carbide of silicon with chemical processes in porous materials of a fresco is performed as for its conservation [2] is concerned.

This study was supported in part by the Russian Foundation for Basic Research (project no. 09-01-00798-a and 11-01-00282-a), the Department of Mathematics of the Russian Academy of Sciences (program no. 3), and the Russian Federal Target Program “Scientific and Educational Personnel of the Innovative Russia” (state contract nos. 02.740.11.0615 and 02.740.11.0475).

[1] Zmievskaya G.I., Bondareva A.L., Levchenko V. D., Levchenko T.V., J. Phys. D: Appl. Phys. 2007. N 40. P. 4842
[2] Baglioni P. and Giorgi R., Soft and Hard Nano-materials for Restoration and Conservation of Cultural Heritage; Soft Matter, 2 (2006), pp.293–303.

3. Zmievskaya Galina I. (KIAM*)
Stochastic simulation method in both problems: Thin film islands chemical vapor deposition and radiation stimulated damaging

Thin film islands, chemical vapor deposition and radiation stimulated damaging are processes leading to degradations of properties of materials of objects of cultural heritage importance. Numerical simulations of the initial non-equilibrium fast (fluctuation) stage, which lasts for less than 1 ms, make it possible to calculate non-equilibrium kinetic distribution functions of nuclear clusters.

In 2009, colloidal germanium crystals in an RF discharge were obtained in the United States and Germany. Application possibility of colloidal crystals for protection and restoration of cultural monuments stimulated us to perform preliminary calculations of the nucleation kinetics of coherent ***Ge*** and ***SiC*** islands in a discharge plasma.
We put forward kinetic model of nano-scale surface modification processes on the basis of computer simulation methods for plasma and plasma-like non-equilibrium media. Collisions and fluctuation processes have produced the nuclei of new phase (islands and blisters); they can be described by Ito Stochastic Differential Equations /SDE/. It is statistically equivalent to equations of Fokker-Planck-Kolmogorov type, and this fact allows us to take the numerical solution of SDE systems as a method for the solution of Mathematical Physics Equations.

This study was supported in part by the Russian Foundation for Basic Research (project no. 09-01-00798-a and 11-01-00282-a), the Department of Mathematics of the Russian Academy of Sciences (program no. 3), and the Russian Federal Target Program “Scientific and Educational Personnel of the Innovative Russia” (state contract nos. 02.740.11.0615 and 02.740.11.0475).

4. Khilkov Sergey (student, MPTI), Ivanov Anton V. (KIAM*)**
Computer simulation of stochastic resonance in systems with Bose and Fermi statistics

Stochastic resonances (non-monotonic dependence of the system response on the temperature) have been attracting attention of scientists in different areas [1], from climatology to creation of new types of detectors and signal filters.
The value of Fourier spectrum on the frequency of driving force is usually referred to as the response. Until recently it was erroneously supposed that stochastic resonance occurs only in double-well potential with coincidence of frequency of the external driving force and the frequency of system transitions from wall to wall. But P.S. Landa and colleagues showed that stochastic resonance is the consequence of potential anharmonicity (dependence of oscillation frequency on the amplitude) and it occurs even in single-wall potential with cubic non-linearity.
Up to now stochastic resonances have been investigated in systems with Boltzmann statistics. In our opinion, it is of noteworthy importance the research of stochastic resonance in systems with Bose statistics (Cooper pairs in superconductors, system of atoms with integer spin) and Fermi statistics (systems of atoms with half-integer spin, electrons in solid matter).
To describe such systems we refers to a Fokker-Plank-like equation with non-linear right part, that provides relaxation system to Bose or Fermi distributions. The equation is solved computationally, with two different methods.
Series of computations were carried out under governance of RACS [3] (results and algorithms control system). System response dependence for the different ratio of initial parameters was obtained.

[1] Landa P.S., Neimark Y.I., McClintock P.V.E, J. Stat. Phys. 2006. V.~125. P.~593.
[2] Zmievskaya, G.I., Mat. modelirovanie, 1996, V.8 N.11. P.3-40
[3] Ivanov A.V., Automation and modern technologies. M.: Mechanical engineering. 2007.

5. Zakirov Andrey (postgraduate studies, MPTI), Levchenko Vadim D. (KIAM*)**
The effective 3D modeling of electromagnetic waves' evolution in actual problems of nano-optics

We present the extensive program code for modeling up-to-date artificial optical and electro-magnetical devices and materials such as photonic crystals, metamaterials (Left-Handed Materials), streamlined surfaces and other different nanoscale structures. The code is based on the Local-recursive nonlocal-anisochronous algorithm (LRnLA), which makes possible to reach the high rate of program's effectiveness. "Effective" algorithm means such one, that has real rate coming up to theoretical approach. In this work the implementation of this algorithm is offered for Maxwell's equations modeling. In the capacity of difference scheme the finite-difference time-domain method (FDTD) is used. One may set different boundary conditions, including Perfectly Matched Layer (PML). By means of material equations the following media are modeled:
• The simple undispersion materials with real permittivity, ε, and magnetic permeability, μ, which depend only on the position in space.
• The media with dispersion described by Drude model. Conductors and the Negative Index Media (NIM, same as LHM) are within this model too.
• Anisotropic media for model of cloacking surface.
• Nonlinear media.

[1] Levchenko V.D., Information technology and computing systems. 2005. 1. 68.
[2] Allen Taflove. Advances in Computational Electrodynamics: The Finite-Difference Time-Domain Method, 1998.
[3] Berenger J.-P., Three-Dimensional Perfectly Matched Layer for the Absorption of Electromagnetic Waves, Journal of Computational Physics, 127, pp.363-379 (1996).
[4] J. Sleter, Dielectrics, semiconductors, metals, 1969.
[5] V.G. Veselago, Electrodynamics of substances with simultaneously negative values of ε and μ, Advances in Physical Sciences, volume 92, 3, pp.517-526 (1967)

6. Bondareva Anna L. (KIAM*), Zmievskaya Galina I. (KIAM*)
Problems of solid-phase and gas-phase epitaxy of damaged surfaces

Applications of the mono- and poly-crystal materials based on silicon carbide receive a great attention due to its high strength, corrosion stability as well optical characteristics, etc. Materials based on silicon carbide can also used for protection of cultural monuments.
This paper deals with computer simulation of SiC solid-state epitaxy and gas-phase epitaxy. Initial stage of

solid-phase epitaxy related with blistering (vacancies gases bubbles formation) into substrate lattice which is preceded to epitaxy of SiC into lattice. Solid-phase and gas-phase epitaxy of damaged surfaces are numerically examined using kinetic theory, Brownian motion model and stochastic analog method. Using the kinetic distribution function of pores versus both the sizes and coordinates into sample, it is possible to estimate roughness at an interface between layers in bilayer model, which appears because blisters come to the layers boundary. Crater of cone shape appears after Si lattice mono-layer destruction which it is raised by blisters accumulation at the top of sample during its motion into thin layer of substrate in case of CO gas penetration into Si lattice. Chemical reactions leading to SiC formation can happen on interface between layers and on wall of cone shape craters.

This study was supported in part by the Russian Foundation for Basic Research (project no. 09-01-00798-a and 11-01-00282-a), the Department of Mathematics of the Russian Academy of Sciences (program no. 3), and the Russian Federal Target Program “Scientific and Educational Personnel of the Innovative Russia” (state contract nos. 02.740.11.0615 and 02.740.11.0475).

7. Gorjachev Ivan (postgraduated, KIAM*) and Levchenko Vadim D. (KIAM*)

The occurrence of the Hall current in a magnetized plasma during the deposition of thin films

Some of the modern tools of art restoration and conservation are based on the methods and apparatus for forming thin film materials, which have a low density of defects. The structure of these thin films are created inside deposition chamber via a plasma deposition process in the presence of a magnetic field. The plasma includes positive and negative species of particles injected from the source and the magnetic field manipulates the plasma to effect a generation of directed charged beam for further development of the resulting deposition medium.
It is known that in the magnetic field under the influence of potential difference the charged particles begin to drift along [E x B] vector direction. The velocity of such a movement named Hall current in classical literature is proportional to the relation E/B and is widely investigated in modern
works, because this non-linear effect can lead to turbulence and instabilities, which play a negative role in the deposition of thin films.
Fully kinetic model in conjunction with Vlasov-Maxwell equations is proposed for description of the occurring processes in a magnetized plasma. As the computational 3D-domain, parallelogram with crossed self-consistent electromagnetic fields is chosen (Table 1). The boundary conditions for two side faces are periodical, for other two symmectric boundary is used, and two planes are perfect
conductors. Initial condition is statistic equilibrium.

$$\frac{\partial f_\alpha}{\partial t}+(\vec{V}_\alpha\cdot\vec{\nabla})f_\alpha+e_\alpha\left(\vec{E}+\frac{1}{c}\left[\vec{V}_\alpha\times\vec{B}\right]\right)\frac{\partial f_\alpha}{\partial \vec{p}_\alpha}=0,$$

$$\frac{1}{c}\frac{\partial \vec{E}}{\partial t}=\vec{\nabla}\times\vec{B}-\frac{4\pi}{c}\sum_\alpha e_\alpha\int\vec{V}_\alpha f_\alpha d^3p_\alpha,$$

$$\frac{1}{c}\frac{\partial \vec{B}}{\partial t}=-\vec{\nabla}\times\vec{E},\qquad \vec{\nabla}\cdot\vec{B}=0,$$

$$\vec{\nabla}\cdot\vec{E}=-4\pi\sum_\alpha e_\alpha\int f_\alpha d^3p_\alpha$$

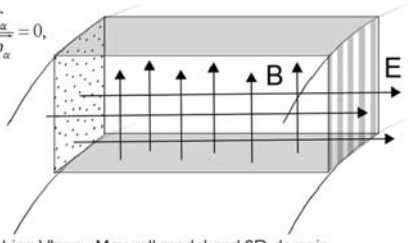

Table 1. Reseaching Vlasov-Maxwell model and 3D-domain.

Numerical realization of the reseach model is possible due to a developed algorithm, ConeFold, and PIC scheme. Substantial optimization and acceleration of computing time using ConeFold yielded several important results in description of the physical processes that occur during the deposition of thin films.
With this algorithm, there is no need to use approximations to speed up the calculations such as an artificial change in the dielectric constant and the mass ratio of ions and electrons, without which modern codes for modeling plasma could not exist. The solution of Maxwell’s equations is performed without simplifications such as electro- and magneto-statics, so more accurate dynamic tracks of charged particles in the plasma can be investigated.
Obtained numerical results reveal the realization of Hall current and electromagnetic fields as E·B, that was confirmed by theoretical analysis. At certain stages of the time there is an origin of non-linear instabilities leading to unpredictable behavior of particle’s trajectories.
As expected this phenomenon breaks plasma beam and makes inhomogenities in resulting deposition of thin films.

8. Levchenko Tatjana V. and Manucharyants Elvira O. (VNI Geosystem Russian Federal Center)
First order phase transition at fluctuation stage in problem of cluster formation and water condensation into cracks

Condensation - the process that determines the creation of aerosols, clouds, fog in the atmosphere - has been well studied in the case where the simulation of gas-vapor medium is in equilibrium, but very little in the situation of non-equilibrium [1, 2].
For the simulation of the fluctuations of the phase transitions of the first type has been proposed [3] a physical-probabilistic analogue of the process of nucleation of steam, using stochastic differential equations (SDE) for the dissemination of Markov processes. The numerical results of experiments [3] have made the model for the [1, 2] non-equilibrium phase formation of clusters of water (and later metal) more reliable.
The behavior of supersaturated water vapor in the cracks, microcracks, pores is still insufficiently studied. Existing models describing these environments, virtually ignore the hydrodynamic and the phase fluctuation of the condensation process. Meanwhile, the mechanism of fracture requires the consideration of physical and chemical processes within them and on their inner surface. They must take into account the reduction of the adsorption strength of solids (Rehbinder effect), which plays a significant role in causing the deformation and fracture. In this special role there are surfactants: The molecules of these substances are absorbed on solid surfaces leading to a decrease in surface free energy, which facilitates the development of microcracks, and then redistribute them to the macroscopic fracture crack. They are active agents on wall surfaces and in water. The minimal thickness of the adsorbed layer, which begins destruction, is not exactly known.
Apparently, the process should be very active when the water is unstable, unbalanced, as then it can reach its maximum penetration into the mouth of the breaks. In this case, using non-stationary fluctuation model of the steam condensate is possible to determine the size of the nuclei in a given field, temperature and pressure, which leads to the formation of adsorption films, and to examine their impact on the energy surface.

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[2] Leontovich M. A., Introduction in thermodynamics. The statistical physics. M.:NAUKA, 1983, p.416.
[3] Zinkovskaya (Lavchenk) T.B and Zmievskaya G.I., Numerical stochastic model of clusters formation, Doklady SSSR, 1989, vol.309, N2, pp. 301-305.

9. Manucharyants Elvira O. (VNI Geosystem Russian Federal Center)
Problem of percolation and protection of cultural monuments

Percolation concerns the movement and filtering of fluids through porous materials. Percolation theory describes the behavior of connected clusters in a substrate. Situation where large clusters and long-range connectivity first appear, is called the percolation threshold.
Percolation process can be used for filling of cracks in cultural monuments by means of restoring solution or paints.

10. Perepelkina Anastasia (postgraduate, KIAM*) and Levchenko Vadim D. (KIAM*)
Fully kinetic 3D model of magnetized plasma

Numerical modeling of nonlinear plasma effects is essential for a wide range of relevant physical problems. As a solution for these problems Particle-in-Cell (PIC) method is commonly used. However, its application is difficult and limited due to high computational complexity of this method.
The goal of this study is to develop a novel multipurpose computationally effective fully kinetic 3D3V PIC code as a solution for previously insoluble problems. A plasma engine, namely, Hall Thruster, was a reason for this study.
As a first step we choose a fully kinetic model without collisions that would take into account all essential nonlinear self-consistent plasma processes. It also should allow effective parallel implementation and will be expandable for simulation of any other necessary effect.
Secondly, we choose instruments to maximize computation effectiveness, with latest version of LRnLA algorithm - ConeFold - on the basis [1]. The second tool for accelerating computation several times is vectorization [2]. For implementation of the complex PIC method into the program a source generation code was created.
During the gradual development of the code various tests were carried out. The archived computation effectiveness with ConeFold and further acceleration by vectorization were proved enough to use the developed model for previously impossible relevant physics studies.

[1] Levchenko V.D., Asynchronous parallel algorithms as a method of reaching maximal computation effectiveness

(in Russian), Journal of information technologies and computational systems, 1:68, 2005.
[2] Levchenko V.D., Zakirov A., Effective algorithm for 3d modeling of electromagnetic wave propagation in photonic crystals (in Russian), preprint KIAM, 2005.

11. Samylkin Alexander A. (postgraduate MePhI*, KIAM*) and Korolev Alexander E. (KIAM)**
Weight Monte Carlo study of rarefied gas flows with coagulation

Chemical reactions on solid surface make it possible to change surface material and as result of it restoration of artworks. Modern schemes of Monte Carlo numerical simulations using the method of variable weighting factors are applied. As examples, we consider some of the possibilities of the suggested approach as applied to the problems of modeling jets (jet flows) and, by analogy with them, the problem of modeling the collisions of large porous bodies provisionally associated with massive particles.

[1] Bird G. A., Molecular Gas Dynamics and the Direct Simulation of Gas Flows, Clarendon, Oxford 1994
[2] Marov M.Ya., Korolev A.E., Osipov V.P., Samylkin A.A., Doklady Physics, 2010, Vol. 55, N. 6

12. Khilkov Sergey (student, MPTI) and Ivanov Anton V. (KIAM)**
Algorithms and realization of high performance recursive grid on sphere

Locality is one of the most important features that affects the performances of a program. On the other hand, recursive grids are required for wide variety of computational problems. We offer algorithm that describe such a grid on a sphere.

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**) Moscow Institute of Physics and Technology (SU), Dolgoprudnyi, Russia
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List of Italian reports

1. Maino Giuseppe
When Physics and Computer Science meet Art

Atomic and nuclear techniques are mainly used in archaeology and history of art for dating and determining the composition ad modifications of materials used in the production of artifacts of particular interest. A close relationship exists between non-destructive multispectral techniques, digital imagery and digital picture processing; in particular, the digital image processing is shown to naturally complete traditional analysis techniques for non-destructive diagnostics of paintings such as radiography and reflectography in identifying the archaeological or artistic objects and the materials from which they are made, their state of repair, technical construction and decoration as well as datation. In particular, physical methods are often used assess fakes or late copies from a lost original.
As Edward V. Sayre remarked in his opening lecture of the seminal 1973 International Conference on Applications of nuclear methods in the field of works of art, The development of nuclear methods for the study of works of art: "Nuclear methods have been applied to the study of works of art with three general objectives: The determination of their compositions, the revelation of their structures and the dating of their times of fabrication". We can simply add the discovery of forgeries, as the recently reopened controversy about the authenticity of the Yale Vinland Map has shown.
Therefore, fundamental and applied physics, and namely condensed-matter and nuclear physics together, can make noteworthy contributions to conservation education and research, in order to:
• Assess stronger foundations for the scientific approach to conservation;
• define a framework for a possible scientific theory for conservation;
• understand and measure many natural phenomena and conservation induced effects;

• apply the existing physical techniques in the humanities field and develop new physical methods and instruments specifically for conservation;
• improve conservation methods and strategies.

2. Panebarco Marianna
VirtualLife – an innovative virtual framework for promoting cultural heritage

Presented by Nergal Srl (Project Coordinator of VirtualLife) and Panebarco di D. Panebarco & C. sas (Exploitation Partner within VirtualLife Consortium)

VirtualLife is an experimental and innovative framework developed within a project co-funded by EC under FP7-ICT Networked Media (the full project name is VirtualLife - Secure, Trusted and Legally Ruled Collaboration Environment in VirtualLife FP7-216064). VirtualLife framework contains advanced tools and options for creating 3d immersive and collaborative on line applications. VirtualLife is not solely a virtual world, nor a stand-alone application, it is a scalable and customizable platform containing some basic modules and based on some fundamental innovative pillars (peer-to-peer architecture, expandable and sophisticated scripting language, legal framework, secure communication infrastructure and finally the concept of virtual identity bound to the real one); thanks to its extreme flexibility, additional modules can be built on top of it on demand.
The presentation will include a detailed overview of the platform and a live demo session of it.

3. Menghi Roberta (postgraduated, guest researcher, Faculty of Preservation of the cultural Heritage, University of Bologna, Ravenna site , 5, via Mariani, Ravenna, Italy)
Virtual reality models for the preservation of the Unesco historical and artistical heritage

More than 30 armed conflicts are currently ongoing around the world. Alongside the loss in human lives, more and more valuable heritage sites are turned into battlefield within the war theatres. More historic and archeological patrimony is being vandalized, looted, illicitly traded spoiling UNESCO World Heritage Listed (WHL) historic city cores.
The War Free World Heritage Listed Cities (WFWHLC) project is aimed to set a very concrete model and plan for preservation cultural heritage at risk in Byblos and Mtskheta, two cities that are Unesco patrimony of the humanity and were recently threatened by war.
The preliminary plan of 3d processing of historical and artistic heritage of the city of Mtskheta, has been developed in collaboration with the Panebarco & C. firm .
The methods of virtual reality considered in this work in order to take advantage of multimedia planning and to create a rich calendar of events parallel to the normal activities in the physical world, are basic components of a broader approach to preservation and enhancement of artistic monuments and objects, declined in contexts where the " virtual" dimension protects and preserves heritage eventually at risk .
The main tool to achive these results is the implementation of a multimedia database where an open source geographical information system (GIS) is coupled to a digital platform for 3D interactive simulation of real world, freely available to the concerned and interested people.
New perspectives of knowledge, using a multi-dimensional dynamic management for Mtskheta and its heritage, can be then developed for each archaeological site.
For both project we have opted to use VirtualLife platform for several reasons:
• the identity and security level which can ensure a system of the diversified accesses with a strong attention to security;
• the peer-to-peer network for reducing server costs;
• the sophisticated scripting language which can allow us to build rich interactive cultural and historical models.

4. Monti Mariapaola (postgraduated, guest researcher, Faculty of Preservation of the cultural Heritage, University of Bologna, Ravenna site , 5, via Mariani, Ravenna, Italy)
Image processing and a virtual restoration hypothesis for mosaics and their cartoons

Mosaic cartoons are tempera paintings which reproduce ancient mosaics, traced tile by tile, in order to document and make copies of the mosaics themselves. Many of these cartoons were created by leading Mosaic Masters and Restorers of Ravenna, such as Alessandro Azzaroni, Zelo Molducci and Libera Musiani (between 1900 and 1975 ca).
In developing a project for the conservation and enhancement of these cartoons, I created the Virtual Restoration

of some of the most important mosaic cartoons belonging to the Institute of Mosaic Art "Gino Severini" in Ravenna.
In this case the Virtual Restoration does not aim at foreshadowing a real restoration intervention (which is often not necessary, as a conservative intervention may be enough), but at replacing the lacunose paintings with digital images reconstructing their missing parts, in order both to facilitate their use for educational purposes and to protect the original ones from everyday use.
The Virtual Restoration of mosaic cartoons was achieved by means of Adobe Photoshop CS.
First of all, the image – after being captured by a digital camera – is subjected to perspective rectification, then to a balancing of brightness, contrast and dominant colors, by using the "Curves" tool in Photoshop in order to make the picture as similar as possible to the original one, since each acquisition inevitably causes overexposure or underexposure and color toning, due to lighting conditions and the characteristics of the sensors used.
In this way it is possible to correct not only the imperfections due to image acquisition, but also the changes of color of the tesserae, due to alterations of paper color (photochromic degradation) over time. Afterwards, missing parts are reconstructed using the whole parts of the image in order to recreate the shape of the lost areas, by applying Photoshop tools such as “Clone stamp”, “Healing brush” and “Patch”. The final image thus obtained reproduces the mosaic cartoon as it presumably could look like originally.

5. Nanetti Andrea (Faculty Member, College Year in Athens, Greece)
Engineering Historical Memory: the Italian documents and manuscripts of the Likhashev Collection in the Academy of Sciences of St-Petersburg

Project of indexing the Italian documents and manuscripts of the Likhashev Collection in the Academy of Sciences of St-Petersburg in order to get them ready to be searchable together with the documents of the "Archivio di Stato" in Venice.

6. Volpe Lisa (Ph.D. Student, 1 and 3), Bruni Stefania (1), Maino Giuseppe (1 and 2) and Vaccaro Carmela (3)
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Diagnostic Investigation of Cultural Heritage

Many applications of SEM analysis, combined with an EDXRS system, are performed on paintings and frescoes, stained glasses, sculptures as well as archaeological objects and extensively and successfully applied to the investigation of many different types of artistic and historical assets.This and other characteristics have allowed identifying many features, thus providing important information to identify the artistic technique of many different types of works.The electron microscopy laboratory ENEA-UTSISM in Bologna has carried out numerous projects in the cultural heritage domain applying the SEM/EDXRS for restoration and conservation of artworks. Recently, the laboratory has developed its instrumentation by implementing an advanced Scanning Electron Microscopy (SEM).In addition to traditional SEMs, allows:
1. Observation and analysis directly of large samples (up to 10cm) without preparation treatments (direct observation and microanalysis). That is, the samples are not destroyed and can be used accordingly;
2. High magnification capabilities with resulting resolution of the order of 3 nanometres;
3. Integration of observation and microanalysis procedures within the same system.

7. Landi Marco (postgraduated, guest researcher, Faculty of Preservation of the Cultural Heritage, University of Bologna, Ravenna site, 5, via Mariani, Ravenna, Italy)
Multispectral imaging and digital restoration for paintings documentation

Spectral imaging for radiation wavelengths different from the visible ones, namely in the infrared (IR) and ultraviolet (UV) ranges provides useful information about the actual preservation state and past conditions of paintings. As a consequence, it is possible to combine this information with that obtained in the usual RGB visible basis and to propose digital or 'virtual' restoration of a painting, taking into account its history, modifications and

repaintings done in the past.
As an example, a painting on wood of Pietro Lianori is discussed and analysed. In this paper we consider a very controversial and partial restoration carried out on a painting by Pietro di Giovanni Lianori, representing the Virgin and the Child, an artist active in the fifteenth century. This work is conserved in the Museum of Cappuccini in Bologna, Italy, since 1928. In the provincial archives of the Cappuccini Friars of Bologna the photographs are preserved, documenting the status of the work before and during the restoration that has been interrupted because of the discovery of the original painting below a successive remaking.
These images confirmed a very difficult situation for restorers and conservators, due to a complex overlapping of layers both original and repainted in order to refresh the painting and to highlight the identity of a new donor. In fact, the comparison between data recorded from multispectral images in various spectral bands has allowed the identification of quantitative and qualitative differences subsequent to the drafting of the original.
The comparison of the recovery image of this panel in visible light before, during and after the restoration of the seventies of the twentieth century clearly shows that the work had been almost entirely repainted. If the choice to remove, in some areas, repaintings arising from the seventeenth century modifications made it possible to uncover the original paint surface that is still preserved in the underlying layers, although very impoverished in terms of material, it has also compromised the ability to read all work in a consistent manner. If the word restoration means restoring the legibility of the artwork in a state as close as possible to the original, then it is clear that only an adequate search backwards in time will determine what actually was this initial condition.
We all know the purpose of "restoring classic" (directly on the work), the virtual restoration is placed, no more or less as the physical intervention, as it tries to rebuild (maybe even more freely than the manual) the aspect that the work had, but at the same time not actually and physically interacting with the object, thanks to the qualities of this technique: Reversibility of the action, compatibility of materials, minimum intervention, recognition of the intervention.
The final result of Virtual Restoration, is to restore the primary function that has an artistic work, which is to depict something, and then bring both a figurative and emotional message.

8. Nencini Elena (postgraduated, guest researcher, Faculty of Preservation of the Cultural Heritage, University of Bologna, Ravenna site, 5, via Mariani, Ravenna, Italy)
From the physical restoration for preserving to the virtual restoration for enhancing

Digital image processing techniques are increasingly applied to the study of cultural heritage, namely to the analysis of paintings and archaeological artefacts, in order to identify particular features or patterns and to improve the readability of the artistic work. Digital or 'virtual' restoration provides a useful framework where comparisons can be made and hypotheses of reconstruction proposed without action or damage for the original object, according to the adopted general rules for practical restoration.The case study object of this paper is an experimental project of virtual restoration carried out on a mosaic from the church of San Severo in Classe, near Ravenna. The construction of San Severo dates from the late sixth century, was consecrated in 582 and was pulled down and abandoned in the early '20s of the XIX century. The floor of the church was formed by a rich mosaic, which was only partially found.
At the end of the 1966 excavation campaign, a mosaic carpet - 4.50x2.75 m – was discovered at the center of the main nave. This mosaic showed a grid of rows of tangent pised square containing figures of birds made of glass paste, of great elegance and extremely naturalistic; around this main schema runs a shaded three strand guillocheon on a black ground.

9. Maurizio Indirli, Elena Candigliota, Francesco Immordino, Lorenzo Moretti (UTSISM, ENEA Bologna), Dante Abate, Graziano Furini, Samuele Pierattini (UTICT, ENEA Bologna), Augusto Screpanti (UTPRA, ENEA Roma), Matteo Angelini, Teresa Gambatesa, Chiara Massaia (students of Master in "Bio-sustainable Architecture", University of Bologna)
Multidisciplinary assessment of historic centres through remote sensing, direct survey and GIS approach

About two years after the April 6th, 2009 Abruzzo (Italy) seismic event, a scientific team set up by ENEA (Italian National Agency for New Technologies, Energy and Sustainable Economic Development) with Universities of Pescara-Chieti, Naples "Federico II" and Ferrara visited the Municipality of Arsita (district of Teramo), a small town damaged by the earthquake, to show its resources for training and demonstration activities within the Master in

"Bio-sustainable Architecture" of University of Bologna.
The main goal of the investigation was to show the effectiveness of a multidisciplinary prompt approach, based on the simultaneous application of updated remote sensing technologies and skills, together with quick procedures for survey and vulnerability evaluation, in order to check hazard, vulnerability and risk due to natural disasters (mainly earthquake and landslide) in the historical center, and propose mitigation actions and urban habitat rehabilitation strategies.
In a one-week stay, a group of about twenty researchers and stage graduates (architects, structural engineers, geologists, remote sensing experts, art historians, and other technicians) worked hardly in multi-faceted activities, as landscape analyses (to identify hazard phenomena though images in great scale), surveys (topography, damage, vulnerability, maintenance, materials features and architectural details of buildings, open space and viability), urban planning, and infrastructure characteristics.
In this context, image processing data (satellite and aerial photos) drove to the characterization of the study area both in synoptic and multi-temporal mode, in order to extract themes such as landscape, land use, morphology, construction aggregates, etc., and check/correct the maps provided by the municipality. The topographic survey consisted firstly by a set of about ten points along the city center main street, measured by DGPS (Differential Global Positioning System), in order to provide sharp geographic coordinates; moreover, a Laser Scanner survey has been done, aiming to: build up a high-definition three-dimensional database and create a volumetric model of the historic center; document the conservation state of the front façade of each construction along the principal streets; obtain images of the damaged buildings for cracks analysis. From the acquired point cloud, it will be also possible to extract CAD drawings (prospects, plans, sections) as well as high definition ortho-photos of the digitized buildings from multiple point of views.
Another engaging work carried out by the researchers and the stage graduates has been to fill up several forms to evaluate damage/vulnerability/maintenance of masonry construction aggregates and structural units present in the Arsita historic centre. The energy aspects of the built environment have been also taken into account.
The in situ investigation allowed to collect a lot of data at different levels, which necessitate a well organized storage: remote sensing, DGPS, historic, geologic, statistic, architectonic, structural, urban planning, infrastructure, etc. Therefore, a GIS (Geographical Information System) digitized database and building inventory will be now implemented, with the aim to describe, analyze, question and represent all the different layers of the information. In fact, when a multidisciplinary approach is followed in the study, as in our case, the geo-database surely represents the best solution and synthesis, providing an updated "vision" of the territory, which is always complex and stratified, made of people, history and culture, also for the little village of Arsita. Finally, all the materials, present in the geo-database, will be available on line to the researchers, for immediate consultation, modification, update and query.

In addition to the authors, the working group is composed by Roberta Chiarini, Stefania Bruni, Fabio Geremei, Maria Anna Segreto, Giuseppe Nigliaccio, ENEA Bologna; Enrico Miccadei, Samuele Biondi, Enrico Spacone, Matteo Cavalera, University of Chieti-Pescara; Antonio Formisano, Gilda Florio, Antonio Fornaro, Roberta Forni, University of Naples; Carmela Vaccaro, University of Ferrara.

How To Reach Ravenna

Ravenna is at about 75 km from Bologna, 35 km from Forlì and 50 km from Rimini.
• By air:
Bologna, Forlì, Rimini and Venice airports run main line and charter services among the major Italian and European cities. From each one of these airports you can rent a car (see how to reach Ravenna by car) or go to the railway station (by bus) and take a train to Ravenna.
• By train:
Trains currently run between Bologna, Rimini, Forlì, Venice and Ravenna. Please, check timetables and travel times on *http://www.trenitalia.com/en/index.html*
• By car:
From Bologna: Motorway (in Italian *Autostrada*) A14; about 6 km after Imola exit, follow the deviation to Ravenna.
From Rimini: Motorway A14. Leave the motorway at Cesena Nord and take the *Superstrada* E45.
From Forlì: State road SS 67 Tosco-Romagnola
From Rome: *Superstrada* E45
From Venice: State road SS 309 Romea.

Ravenna Monuments

Monuments in the Unesco World Heritage List

A . Mausoleum of Galla Placidia (5th C.)
Contains the earliest wall mosaics in Ravenna.
B . Neonian Baptistry (5th C.)
Contains Greco-Roman style mosaics.
C . Basilica of S. Apollinare Nuovo
(6th C.). Originally Theodoric's palatine church. Its wall mosaics, including the ceremonial processions of martyrs and female saints, rank among the largest to have came down to us from antiquity.
D . Arian Baptistry (6th C.)
E . Cappella di S. Andrea (5th C.)
F . Mausoleum of Theodoric (6th C.)
Built by the King himself, its monolithic dome is in Istria stone.
G . Church of S. Vitale (6th C.)
One of the marvels of Western Byzantium. Marbles, capitals and mosaics including depictions of the retinues of Justinian and Theodora.
H . Basilica of S. Apollinare in Classe (6th C.) Set in a green landscape, it is grandiose for its architecture and its mosaics depicting the Transfiguration.

Monuments

1 . Rocca Brancaleone (15th C.)
2 . National Museum
Remarkable Roman, Early-Christian, Byzantine and Mediaeval collections.
3 . Church of Sant'Eufemia (1742-1747)
The church is decorated with eighteenth century paintings.
4 . Domus of the Stone Carpets (5-6th C. AD.)
entrance church of S. Eufemia
Magnificent floor mosaics of a large Byzantine Palace covering about 800 square metres.
5 . City Tower (12th C.)
6 . Church of the Holy Spirit
7 . Basilica of San Giovanni Evangelista (5th C.)
8 . Church of Intercession
Consecrated 1728.
9 . Alighieri Theatre (19th C.)
10 . Palazzetto Veneziano (15th C.)
Town Hall.
11 . Palazzo del Mutilato (sala mosaici)
12 . Dante's Tomb (1780) and Dante Museum
13 . Church of S. Francesco (5th C.)
14 . The so-called Palace of Theodoric (7-8th C.)
15 . Rasi Theatre
16 . City Art Museum - Loggetta Lombardesca (1508)
Home of the museum and of the Municipal Pictures Gallery.
17 . Basilica of S. Maria in Porto (1533-1606)
18 . Public Park
19 . Planetarium
20 . Duomo (1734) and Archiepiscopal Museum. The Duomo contains an ambo dating back to the time of Bishop Agnellus (6th C.), 5th-century sarcophagi, and a 10th-century crypt. The Museum houses the "ivory throne" which belonged to Bishop Maximian (6th C.).
21 . Classense Library (16th C.)
22 . Church of San Nicolò (8th C.)
A very large church with a single aisle, which became "la Cavallerizza", a military riding stable.
23 . Church of S. Agata Maggiore (5th C.)
24 . Park of Peace
Contemporary mosaics by artists from various nations.

Conference Locations

- Facoltà di Conservazione dei Beni Culturali, Palazzo Corradini, Via Mariani 5, Ravenna
- Casa Matha, Piazza Andrea Costa 3, Ravenna

Ravenna Map


Camper service
Darsena
Via Magazzini Anteriori
Piazzale Aldo Moro
Bus turistici
Antico Squero
Via Darsena
Sottopassaggio
Viale G. Pallavicini
Viale S. Baldini
Sosta bus turistici
Via Alberoni
Via S.P. Damiano
Via P. Genocchi
Piazza Farini
Via Maroncelli
Via Ugo Bassi
Viale Farini
Via Carducci
Brancaleone
Piazza Mameli
Sosta breve bus turistici
Rocca Brancaleone
Via L. Rava
Via G. Falier
Via Rocca ai Fossi
Via B. Alighieri
Via di Roma
Via Venezia
Falier
Via Diaz
Via Mariani
Vicolo Porziolino
Via Francesco Negri
Via Oriani
Via Pascoli
Via Cerchio
Via Tombesi Dall'Ova
Via Paolo Costa
Via Ariani
Via Corradini
Palazzo dei Congressi
Palazzo Corradini
Via Antica Zecca
Largo Firenze
Via Boccaccio
Via Guaccimanni
Via Anastagi
Via Ghiselli
P.le G. Rossi
Via Girolamo Rossi
Piazza Einaudi
Piazza Garibaldi
Via Alighieri
Via Carrari
Via Mazzini
Via Serafino Ferruzzi
Via Mura Porta Serrata
Via S. Vittore
Via P. Alighieri
Via Matteucci
Via Ponte Marino
Vicolo Gabbiani
Casa Matha
Piazza A. Costa
Via IV Novembre
Piazza del Popolo
Vicolo Padenna
Via Gordini
Via C. Ricci
Piazza Caduti
Via Baccarini
Via Rondinelli
Via Cairoli
Via Guidone
Via Mentana
Via Matteotti
Piazza XX Settembre
Via Corti alle Mura
Via Pier Traversari
Via Gamba
Via Salara
Via Cavour
Via F. Mordani
Via Rasponi
Via Fantuzzi
Via Gessi
Via Guerrini
Via R. Gardini
Piazza Arcivescovado
Via Canneti
Via De Gasperi
Via Zirardini
Via IX Febbraio
Via M. di Savoia
Piazza Kennedy
Via Longhi
Via Sabbionara
Via Galla Placidia
Largo Giustiniano
Via Argentario
Via C. Morigia
Via Pasolini
Via Garatoni
Piazza Duomo
Piazza D'Annunzio
Via Duca D'Aosta
Via S. Teresa
Via N. Baldini
Via S. Vitale
Via Flandrini
Via Fanti
Via C. Cattaneo
Via M. D'Azeglio
Via Porta Gaza
Via Don Minzoni
Via Barbiani
Via Agnello Istorico
Via G. Oberdan
Via Porta Aurea
Via Guidarelli
Via Nino Bixio
Circonvallazione S. Gaetanino
Via G. Morelli
Piazza Baracca
Via Uccellini
Via Ercolana
Viale F. Baracca
Via C. Battisti
Via Sauro
Via S.P. Grisologo
Via Porta Aurea
Via Chiesa
Via Portoncino
Via Maggiore
Circonvallazione Fiume
Via Cura
Vallona

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