AIMagn

COLLOQUIA

CNR-ISM
UNIGE-DCCI
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FRIDAY

March **18** 2022

11^{30} – 16^{15} CET

Genova (IT)

SMART MAGNETIC NANOFLUIDS

Magnetic fluids consisting of stable suspensions of magnetic micro and nanoparticles in a carrier liquid have attracted a growing attention for their potential application in many fields including medicine, biotechnology, energy and environment, among others. The AIMagn Colloquium on “Smart magnetic nanofluids” aims at providing a platform to discuss and debate about some of the most recent developments in the field. It includes a keynote lecture given by Prof. G. Friedman (Drexel University, USA) on magnetic nanoparticle micro-robotics, followed by a series of selected talks given by national expert on the topic.

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KEYNOTE SPEAKER

G. FRIEDMAN Drexel University (USA)

MAGNETIC NANOPARTICLE MICRO-ROBOTICS

INVITED SPEAKERS

R. BERTACCO Pol. Milano
M. COISSON INRIM
D. COLOMBARA Un. Genova
A. SURPI CNR-ISMN

THE PARTICIPATION IS FREE OF CHARGE. THE COLLOQUIUM WILL BE HELD IN A HYBRID FORM.
TO FACILITATE THE ORGANIZATION, PLEASE REGISTER AT THIS LINK: https://forms.gle/Aw2u3Zy2DK7xCVsN9

Book of Abstracts

AIMagn

COLLOQUIUM

March 18th 2022

http://www.aimagn.org/conferenze/aimagn-colloquia/

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The event belongs to a series of scientific talks, the **AIMagn COLLOQUIA,** organized by the Italian Association of Magnetism, aimed at promoting the dialogue and exchange between renowned international researchers in the field of Magnetism and the Italian community of Magnetism.

Program

PROGRAM

March 18th 2022

Central EU Time

11^{30}-11^{45}	Open remarks
11^{45} - 12^{45}	MAGNETIC NANOPARTICLE MICRO-ROBOTICS **G. FRIEDMAN** Drexel University
12^{45} - 14^{00}	Lunch
14^{00} - 14^{30}	ON-CHIP MANIPULATION OF MAGNETIC CORPUSCLES FOR BIOLOGY AND DIAGNOSTICS **R. BERTACCO** Politecnico di Milano
14^{30} - 15^{00}	MAGNETIC HYPERTHERMIA: FROM MATERIALS SCIENCE AND METROLOGY TOWARD IN-VITRO APPLICATIONS **M. COÏSSON** INRIM
15^{00} - 15^{30}	REMAP REUSABLE MASK PATTERNING – AN EIC FUNDED PROJECT **D. COLOMBARA** Università di Genova
15^{30} - 16^{00}	PERMANENT MAGNETS CONFIGURATION FOR EFFICIENT CONFINEMENT AND MANIPOLATION OF ULTRA-SMALL SUPERPARAMAGNETIC NANOPARTICLES **A. SURPI** CNR-ISMN
16^{00} – 16^{15}	Closing Remarks

Please, register here: https://forms.gle/Aw2u3Zy2DK7xCVsN9

Abstracts

Gary Friedman
Drexel University
Philadelphia, USA
gf29@drexel.edu

Magnetic Nanoparticle Micro-Robotics

Abstract. The talk will explore various techniques of magnetic and non-magnetic nano- and micro-particle manipulation in fluids. Magnetized surface patterns and other surface feature will be demonstrated to permit control over magnetic particles and non-magnetic inclusions. Control over particle locomotion and pattern formation in bulk fluid volume away from surfaces will also be discussed. Some applications will be reviewed.

Gary Friedman obtained his PhD at the University of Maryland, USA. Between 1991 and 2001 he was with the Department of Electrical and Computer Engineering at the University of Illinois at Chicago and, since then, with the Department of Electrical and Computer Engineering at Drexel University in Philadelphia. Between 2005 and 2018 he was an Affiliate Professor of Surgery at Drexel University. He has published over 120 papers spanning the areas of magnetic hysteresis modeling, magnetic field computations, magnetic nanoparticle applications in micro-robotics, biotechnology and medicine, as well as applications of atmospheric pressure plasma discharges in medicine. He has developed miniature NMR systems, magnetically targeted drug delivery, remote magnetic manipulation of miniature devices in soft tissues for robotic & minimally invasive surgeries, plasmonic tools for single cell analysis. He is a recipient of multiple awards including the US National Science Foundation Young Investigator Initiation Award, Outstanding Teacher award at the University of Illinois in Chicago and the International Society for Plasma Medicine research achievement award. He currently serves as the Director of the Graduate Program at the Electrical and Computer Engineering Department at Drexel and as an Associate Editor for the IEEE Transactions on Magnetics

Riccardo Bertacco
Politecnico di Milano
Milan, Italy
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On-chip manipulation of magnetic corpuscles for biology and diagnostics

Abstract. Manipulation of magnetic particles or magnetic biological entities in lab-on-chip platforms offers many advantages with respect to competing techniques, mainly related to the absence of local heating, minimum perturbation of biological activities and force tunability. In this talk I review some technology platforms we have developed over last 10 years for the manipulation/detection both of magnetic nanoparticles and magnetic biological entities. In particular, I'll focus on the magnetophoretic capture and detection of malaria infected red blood cells, which is the basis of the rapid diagnostic test TMek.

Riccardo Bertacco (orcid.org/0000-0002-8109-9166) received his PhD in Physics in 2000. In 2001 he has been visiting researcher in the group of A. Fert (Nobel Laureate for Physics 2007) working on oxide spintronics. He is full professor at the Physics Department of Politecnico di Milano, where he leads the *Nanomagnetism for Biology and Spintronics* group (http://nabis.fisi.polimi.it/). From 2015 to 2021 he has been vice and director of the micro and nanofabrication facility (PoliFab) of Politecnico di Milano (http://polifab.polimi.it/). He is member of the board of the European Magnetic Association. Starting from a background on electron spectroscopy and surface magnetism, his research activity is nowadays focused on spintronics, nanoelectronics and on the applications of magnetism to biology and medicine.

Marco Coïsson
INRIM
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Magnetic hyperthermia: from materials science and metrology toward in-vitro applications

Abstract. Magnetic hyperthermia aims at killing cancer cells by delivering to them heat, or heat-released drugs, generated by magnetic nanoparticles injected or otherwise conveyed in the tumour, and then submitted to a radio frequency electromagnetic field inducing power losses. In order to be effective, this approach needs to overcome a number of obstacles, including an adequate performance of the magnetic materials, an assessment of their biocompatibility and cellular uptake, the ability to measure their specific loss power in laboratory conditions, the understanding of their behaviour in phantoms mimicking tissues and even in living organisms. Materials science and metrology are fundamental tools in helping address these challenges. In this talk, we will discuss how the problem of measuring the specific loss power has been addressed in INRIM, how novel magnetic « nanoparticles » (e.g. nanodisks) have been studied in search for an optimised performance, and how these systems have been applied in-vitro, for cytotoxicity and cellular uptake studies, and for heat-release investigations in tissues-mimicking phantoms.

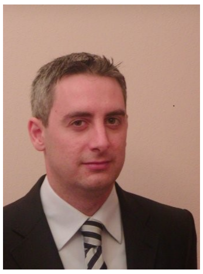
Marco Coïsson obtained his degree in Physics at the University of Torino, Italy, in 1998 and his PhD in Metrology at Polytechnic of Torino in 2002. Since then, he has been an active researcher in the field of magnetism and magnetic materials, first at IEN « Galileo Ferraris » and then at INRIM, Torino. His main research interests include magnetic thin films and nanoparticles, as well as out-of-equilibrium rapidly-solidified or bulk magnetic alloys, for applications in biomedicine, sensors, information technology, and other domains where novel materials are required. He has developed an expertise in magnetic force microscopy, high-sensitivity magnetometry, specific loss power measurements. He is co-author of more than 170 publications with more than 1900 citations, with an h-index of 21.

Diego Colombara
Università di Genova
Genoa, Italy
diego.colombara@unige.it

REMAP Reusable mask patterning – An EIC funded project

Abstract. Surface patterning is crucial for the progress of key enabling technologies such as advanced manufacturing, microelectronics, nano/biotechnology and photonics. The current paradigm in surface patterning is optical projection lithography (OPL), a paradigm designed for high-resolution. However, emerging green technologies like micropatterned photovoltaics (PV) require high quality patterning at scale/throughput that is hardly attainable by OPL economically and sustainably. Furthermore, OPL is unsuited, because it relies on disposable masks with extremely high embodied energy. While the key asset of OPL is the mask, it is the component that currently makes it low-throughput and energy/material inefficient. Extensive efforts have been directed to develop maskless strategies, but most fall short when it comes to throughput and design flexibility. REMAP envisions a radically new and green surface patterning technique based on the spontaneous formation of reusable magnetic masks. This talk will outline REMAP's vision.

Diego Colombara is Associate Professor of Inorganic Chemistry at the University of Genova (Italy). His Master studies in Italy and UK focused on solid state chemistry and metallurgy, with emphasis on phase equilibria, crystallography and alloys microstructure. His doctorate at the University of Bath (UK) was devoted to the synthesis and photoelectrochemical characterization Earth-abundant chalcogenides for PV applications by electroplating and reactive annealing, as well as by chemical vapour transport (EPSRC-funded project SUPERGEN, 2008-2012). His PhD advisor was Prof. Laurie M. Peter, pioneer of semiconductor (photo)electrochemistry. DC acquired 5 years of postdoctoral research and teaching experience within the Physics department at the University of Luxembourg, including 3 years as a researcher in FP7 project SCALENANO and 2 years as the Principal Investigator of GALDOCHS (a 453 kEUR research project funded by the FNR), where he discovered, studied and developed a novel methodology for extrinsic doping of PV semiconductors that enabled to refute a 20-years old assumption on CIGS PV technology. DC joined the University of Genova after 2 years of Marie Curie fellowship at INL (Portugal), where he appears as the inventor of a patent that represents the basis of REMAP. He has authored ca. 40 articles and served as peer reviewer for ca. 100 studies.



Alessandro Surpi

CNR-ISMN

Bologna, Italy

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Permanent magnets configuration for efficient confinement and manipulation of ultra-small superparamagnetic nanoparticles

Abstract. Confinement and manipulation of magnetic nanoparticles (MNP) is increasingly important in biomedicine [1]. Presently, the vast majority of applications relies on relatively large MNPs as it is difficult to magnetically control sub-50 nm nanoparticles against thermal fluctuations. Yet, it would be highly beneficial to use MNPs with size comparable to biological entities: proteins (5-50 nm) or virus (> 20 nm). Here we experimentally demonstrate that a specially designed arrangement of permanent magnets can efficiently confine batches of 20 nm MNPs in a capillary, organizing them in clepsydra-like configurations, stable in both static and dynamic regimes. The experimental tool is composed of two rectangular shape permanent magnets put alongside a submillimeter-wide capillary and moved by a linear actuator. The magnetic field is tailored so to have extremely high magnetic gradients, sharply confined in regions chosen for MNPs localization inside capillary. The 20 nm large nanoparticles solidly follow the magnets movements and, during the translation, the nanoparticles remain confined in the same geometrical configuration. Our results are explained by general physical estimations and refined by accurate magnetic simulations. Assuming the situation of thermal equilibrium, a magnetic particle is held in a magnetic trap if the energy of randomizing thermal fluctuations is lower than the variation of magnetic energy between in-of- and out-of-trap spatial regions. We will present an accurate and detailed classification of the magnetic fields and gradients able to confine efficiently magnetic nanoparticles of different diameters, and we will explain both possibilities and limitations. We also show few examples of bio-medical applications. Namely, we will experimentally demonstrate that our technology can efficiently separate and extract from a clinically relevant volume of sample solution one of the most important biomarker of the Alzheimer's disease (AD): the *β*-amyloid. The technology can be also combined with magnetic sensors for ultra-high sensitivity diagnostics. We also show that precise confinement and guiding of MNPs allows developing accurate protocols for movement and positioning of cells [2] and cell-differentiating agents in both scaffold-based and scaffold-free *in vitro* bio-medical applications.

[1] P.Blümer "Magnetic Guding with Permanent Magnets: Concept, Realization and Applications to Nanoparticles and Cells" Cells 2708, 10 (2021)

[2] V.Goranov et al. "3D Patterning of Cells in Magnetic Scaffolds for Tissue Engineering", Sci.Rep. 2289, 10 (2020)

Alessandro Surpi earned a PhD at University of Rome "La Sapienza" in 2007 with a thesis on Fabrication of novel X-ray optics. Then he got a post-doc fellowship at University of Uppsala from the Swedish Foundation for Strategic Research (SSF) to develop nanostructured devices for single-molecule manipulation. After working for some years in private companies, in 2017 he joined ISMN-CNR where he is responsible for the experimental activity concerning magnetic manipulation of biomolecules in the European projects MADIA and BOW.

Practical Information

How to reach Department of Chemistry and Industrial Chemistry DCCI - UniGE

By plane

Genova has one airport named after Cristoforo Colombo (https://www.airport.genova.it/). The easiest way to reach University using public transport is to take a train from Genova Cornigliano or Genova Sestri Ponente stations (both are close to the airport) with destination Genova Brignole (~20 min). Tickets and timetables are available at the Genova Cornigliano Train Station (automatic machines and ticket office) or through the website www.trenitalia.com. Otherwise, you can take a Volabus to reach the train stations of Genova Principe and Genova Brignole, at the Arrival area in the airport (more information at https://www.aeroporto.net/aeroporto-genova/collegamenti-aeroporto-genova/).

From the airport of Milano

An alternative option is to use one of the airports of Milano. Airports of Milano have many more destinations and well connected with Milano. One of the biggest is Malpensa. Please check if you can take a direct bus from the airport to Genova using FlixBus website. If not, take a shuttle bus or train (more convenient) from the airport to Milano Centrale train station (tickets are available inside). Tickets and timetables of trains are available at the Milano Centrale train station (automatic machines and ticket office) or through the website www.trenitalia.com. Milano and Genova are well and regularly connected by trains. Destination of FlixBus and some of the trains from Milan is Genova Principe. From Genova Principe take a metro to Genova Brignole. It is very easy since the metro of Genova has only one line and the destination has the same name Brignole. Use the same ticket for the bus, it is valid for 110 min (how to buy will be explained below). Another option is to take a train from Genova Principe to Brignole.

By train

If possible, we suggest to get off at **Genova Brignole station**. Proposed *train solutions to arrive in Genoa:*

March, 18^{th}

Milano Centrale 08:05 – Genova Brignole 09:53 *(direct)*
Milano Centrale 08:30 – Genova Brignole 10:39
Firenze Santa Maria Novella 07:54 – Genova Brignole 10:38 *(direct)*
Bologna Centrale 06:33 – Genova Brignole 10:24 *(direct)*
Torino Porta Nuova 07:30 – Genova Brignole 09:53
Torino Porta Nuova 08:30 – Genova Brignole 10:39 *(direct)*

March, 17^{th}

Bologna Centrale 16:56 – Genova Brignole 20:03
Bologna Centrale 17:36 – Genova Brignole 20:53
Roma Termini 13:57 – Genova Brignole 18:43
Roma Termini 14:35 – Genova Brignole 20:07
Roma Termini 15:57 – Genova Brignole 21:17
Firenze Santa Maria Novella 16:28 – Genova Brignole 20:07
Firenze Santa Maria Novella 17:00 – Genova Brignole 21:39
Firenze Campo di Marte 18:15 – Genova Brignole 21:08

Proposed daily retour solutions:

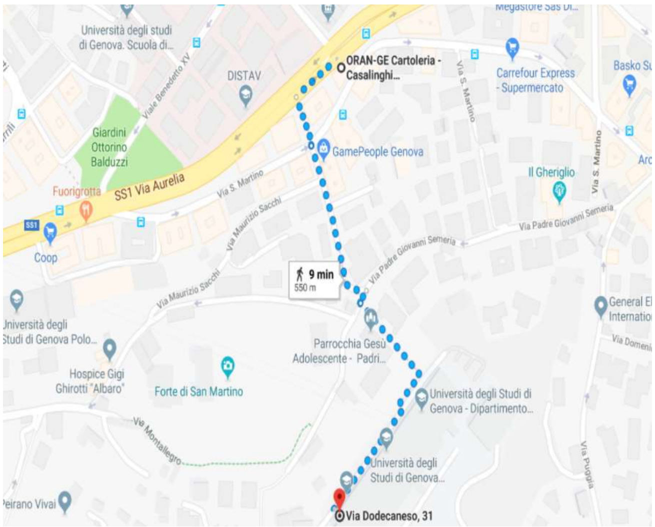
March, 18^{th}

Genova Brignole 18:09 – Milano Centrale 19:57
Genova Brignole 18:13 – Torino Porta Nuova 20:30
Genova Brignole 17:25 – Bologna Centrale 21:25
Genova Brignole 17:12 – Roma Termini 22:03
Genova Brignole 18:47 – Roma Termini 23:00
Genova Brignole 17:56 – Firenze Santa Maria Novella 21:39

From there, you can continue by bus. The Genova Brignole bus station is in front of the train station, the stops are separated by sectors, each sector equipped with a timetable and a label with the number of bus lines stopped here.

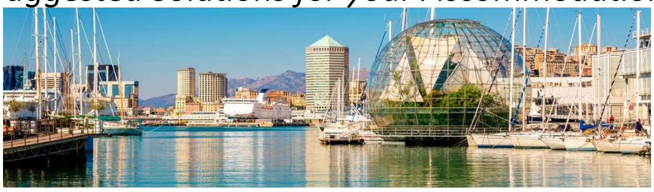
Tickets are easily available in an automatic machine, ticket office, “tabaccherie” and by using an application for smartphones (AMT Genova -> Biglietti -> Biglietto con carta di credito).

To reach University take a bus from the list:
• 18, 45, 85, 86 or 87 (stop: San Martino 2/PAPIGLIANO);
• 16, 17, 70, 75, or 76 (stop: Europa 1/OSPEDALE San Martino).
From the bus stop, follow the attached map to reach University (less than 10 min walk).

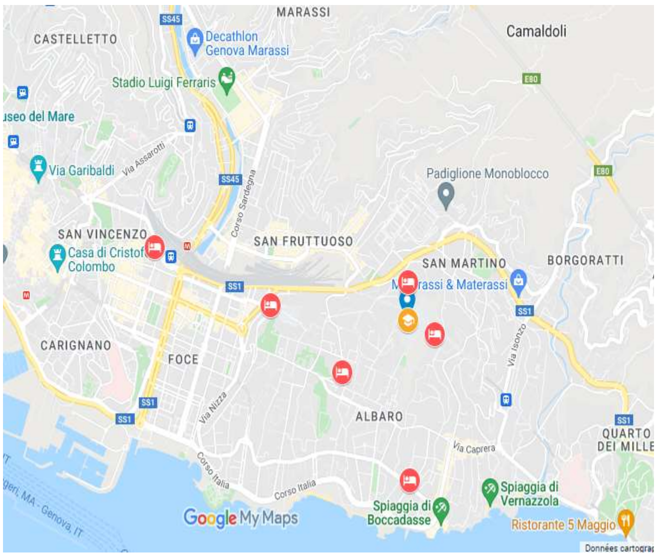


AMT Genova is the official application of the Mobility and Transport S.p.A. of Genova. Using the application you can consult the bus transits, buy tickets by credit card, Google Pay, Apple Pay or SMS (for Italian sim cards). [Google Store](#) - [Apple Store](#)

Suggested Solutions for your Accommodation



Hotel/B&B Name	Walking distance (min)	Price/night (€)	Phone number
[Villini Albaro](#)	13	50	3383607668
[Il Giardino di Albaro](#)	18	115	010366276
[Il Genovino](#)	11	117	375 5773101
[Midnight in Genova](#)	19	76	3534389822
[Best Western Hotel Moderno Verdi](#)	30	91	105532104



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Nanostructured Magnetic Materials

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