1° SIMPOSIO FuturoINAREA

Mercoledì 18 maggio 2022

CNR - Area Territoriale della Ricerca

Via G. Amendola 122/D 70126 Bari

ABSTRACT BOOK

(Draft v.3)

>> sharing experience

promoting network

PREFAZIONE

Dopo il successo dei seminari a carattere divulgativo, che hanno raccolto la partecipazione attiva di molti ricercatori appartenenti ai vari istituti dell'Area della Ricerca del CNR di Bari ed in alcuni casi hanno visto l'intervento di importanti esponenti della comunità scientifica nazionale, il 18 maggio 2022 è stato organizzato il 1° Simposio di **Futuro**IN**AREA**.

L'idea portante di questo Simposio – e più in generale di **Futuro**IN**AREA** – è quella di promuovere lo scambio scientifico e tecnologico tra laureandi, dottorandi, post-doc e giovani ricercatori desiderosi di condividere le proprie esperienze e conoscenze.

La partecipazione al Simposio ha previsto, per ogni istituto del CNR aderente all'evento, l'esposizione di un "**poster di Istituto**" - riassuntivo delle principali linee di ricerca condotte dell'istituto stesso – e di diversi "**poster di ricerca"** portanti su tematiche più specifiche. La presentazione dei poster è stata affidata ai ricercatori più giovani, favorendo così l'interazione e la costruzione di una rete di conoscenze che, mai come oggi, è di fondamentale importanza per fare ricerca, scrivere progetti e portare avanti studi sempre più complessi e multidisciplinari.

Questo libro racchiude i singoli contributi preparati e presentati il giorno del Simposio dai vari Istituti. Un sistema di votazione ha permesso inoltre di selezionare i poster migliori ai quali sono stati assegnati dei premi.

Desideriamo inoltre esprimere la nostra gratitudine e riconoscenza allo sponsor di questo evento, la Levanchimica srl (www.levanchimica.it), che ci ha permesso di premiare i migliori poster dei giovani ricercatori.

Il Comitato Scientifico permanente di FuturoINAREA

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B1 - IAC

IAC - Istituto per le Applicazioni del Calcolo "Mauro Picone" - Institute for Calculus Applications "Mauro Picone"

Poster presented by: Angela Martiradonna, Fasma Diele

Modern society is becoming increasingly complex, and new technologies are being developed more and more rapidly. In this context, mathematics is not merely a language to describe scientific processes and technologies. Its real value lies much more in depth. The high level of abstraction of mathematics does not only increase theoretical insight, it also provides, at low costs, flexible methods, efficient algorithms and more accurate solutions. In other words, a correct and intelligent combination of mathematics and computing power opens up entirely new possibilities to deal with complexity and to design efficient solution techniques which meet with the flexibility requirements which are typical for today's applications.

The specific mission of IAC is "to develop highly advanced mathematical, statistical and computational methods in order to solve, in a mostly interdisciplinary context, problems with strong relevance to society and industry". Applications can be found in many fields having direct impact on the society such as engineering, medical sciences and biology, environment, transportation, finance and economics, cultural heritage, manufacturing, computer science.

Researchers in Bari are focused on the following macro-areas: optimization, discrete mathematics and decision science; qualitative and numerical analysis of differential for applications; computational models and methods for the signal processing, images and statistical methods for the analysis of complex high-dimensional data; mathematical models and numerical simulation of fluid, classical and quantum relativistic matter; mathematics for the environment; bioinformatics and computational biology.

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B2 - IAC

Soil Organic Carbon models

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Poster presented by: Ilenia Luiso

In 2015 the United Nations adopted seventeen Sustainable Development Goals “to achieve a better and more sustainable future for all”. Some of the global challenges they address are related to climate change: in particular, Target 15.3 asks to strive for achieving land degradation neutrality by 2030. For this reason, we study the dynamics of one of the key indicators of land health, Soil organic carbon (SOC), through simulation models.

To evaluate the local response of the models to variation in temperature, Net Primary Production and land use soil class (forest, grassland, arable), we have performed a sensitivity analysis. We have demonstrated that SOC decreases due to increasing temperatures or to a decrease in the net primary production.

Then, by simulating the SOC behaviour in the Alta Murgia National Park, we observed that it shows positive trends in the case of both forest and grassland systems. Whereas, if we consider the arable class without the farm fertilizer inputs, SOC exhibits a negative trend that can be inverted by a suitable fertilization program.

Finally, we studied the reactivity to measure the amplification rate of SOC to all possible initial perturbations in the system. We showed that an increase in temperature due to climate change might make the SOC equilibria more reactive, and this might cause long-term transitions towards scenarios of loss of soil neutrality.

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C1 - IBBR

IBBR - Istituto di Bioscienze e Biorisorse - Institute of Biosciences and Bioresources

Poster presented by: Pasquale Luca Curci, Giacomo Mangini

The history of the Institute of Biosciences and Bioresources (IBBR) of Bari traces back to 1969, when it was funded under the name “Institute of Germplasm”. Since its foundation, the Institute played a significant role in safeguarding plant genetic resources (PGR) and their biodiversity, a main prerequisite for plant breeding. The main activities carried out at IBBR of Bari embrace exploration, collection, multiplication, evaluation, characterization, ex-situ conservation, and documentation of PGR, as well as studies of genetic diversity, genepool evolution in crop species, research of new allelic variants and physiological parameters underlying seed vitality.

A special focus has been given recently to crop species of cereals, legumes, and vegetables mostly widespread in the Mediterranean area, including patenting and registering “new” plant varieties. Considerable interest has been dedicated from (endangered) agro-ecotypes, to wild "relatives" of cultivated plants, to species potentially useful for nutraceutical and/or technological purposes, and finally to plant model species for genetic studies. Currently, the IBBR GeneBank holds about 56.000 accessions belonging to more than 40 genera and about 600 species. All available genetic resources are described in the Mediterranean Germplasm Database (MGD, https://ibbr.cnr.it/mgd/). Other research lines are also pursued in the fields of crop breeding and biotechnology at IBBR. Consolidated approaches of biochemistry, molecular biology and bioinformatics are used, along with innovative ‘omic’ approaches (*e.g.* genomics, transcriptomics, proteomics, phenomics, network biology) to study biodiversity, productivity, response to (a)biotic stresses, evolution and food quality and safety.

The long-term experience has made the Bari IBBR a centre of excellence for the word scientific community in the field of plant biodiversity safeguard, conservation, characterization and valorisation.

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C3 - IBBR

STABLE QTLs AND CANDIDATE GENES AFFECTING SEED SIZE AND ADAPTIVE TRAITS IN DURUM WHEAT

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Poster presented by: Giacomo Mangini

Background: In wheat grain yield is expressed as the product of different components. Among these, thousand kernels weight (TKW) reflects the combination of several grain related traits including grain length (GL), grain width (GW) and area. Grain weight is also affected by adaptive traits, such as heading time (HT) and plant height (PH). To detect stable QTL and candidate genes involved in phenotypic control of grain yield, a recombinant inbred line (RIL) population derived from two elite durum wheat cultivars (Liberdur and Anco Marzio) was evaluated for yield components and grain related traits for three growing seasons in southern Italy. The mapping population was genotyped with a 90K SNP array and a high-density genetic linkage map with 5134 markers were obtained.

Results: A total of 30 QTL were detected on the durum RIL population including 9 stable QTL for TKW (2 QTL), GL, GW (2 QTL), AREA, HT and PH (2 QTL) distributed on 1B, 2A, 3A and 6B chromosomes. Interestingly, a QTL cluster mapped on 2A included a major QTL for HT explaining at least 70% of phenotypic variance and colocated with a QTL for YLD, TKW, GL and GW and AREA, respectively. In the physical position of this QTL cluster a photoperiod sensitivity gene (Ppd-A1) was found. Serine carboxypeptidase, Big Grain 1 and βfructofuranosidase candidate genes were mapped in clusters containing stable QTL. Candidate genes involved in auxin metabolism were also found in QTL clusters in which a QTL for AREA was declared.

Conclusions: This study showed that yield components and adaptive traits had higher inheritances than grain yield, allowing an accurate stable QTL cluster detection. This was a powerful requisite to physically map QTL on the reference durum wheat genome and to identify candidate genes strongly affecting the genetic grain yield.

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D1 - IBIOM

IBIOM - Istituto di Biomembrane, Bioenergetica e Biotecnologie Molecolari - Institute of Biomembranes, Bioenergetics and Molecular Biotechnology

Poster presented by: Bachir Balech, Cesare Indiveri

The institute of Biomembranes, Bioenergetics and Molecular Biotechnologies (IBIOM) has been established in 1969 as “Center for Study of Mitochondria and Energetic Metabolism”. Today, IBIOM constitutes one of the main national and international research institution in Biomembranes, Bioenergetics and the most recent Omics, Bioinformatics and Molecular Biodiversity fields. The research focus of the institute has a clear multi-disciplinary approach contributing efficiently to the novel perspectives in precision medicine, human bioenergetics and agro-environmental biotechnologies.

The main research activities conducted at the institute include the structural and functional characterization of known or newly identified genes and proteins, involved in mitochondrial biogenesis and energy metabolism, among which respiratory chain complexes and SoLuteCarriers (SLC), the regulation of these systems and their role in cellular homeostasis, cell differentiation, apoptosis and mitochondrial alterations in both inherited and degenerative diseases. In addition, IBIOM covers research lines developed at “omics” scale in comparative genomics, transcriptomics and molecular biodiversity exploiting the potentiality of the new generation sequencing platforms complemented by bioinformatics analyses.

Such activities can be placed into the following major research areas: (i) mitochondrial biogenesis and energy transduction, (ii) functional and pathophysiology of biomembrane and bioenergetic systems, (iii) structure and functional mechanism of SLC of plasma and intracellular membranes, (iv) nucleus-cytoplasm-mitochondria crosstalk in cellular homeostasis, (v) molecular biotechnology applied to human health, environment, and biodiversity, (vi) identification of molecular targets for drugs and nutraceuticals, (vii) genomics and molecular evolution, and (viii) molecular mechanisms in tumor cells.

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D2 - IBIOM

Role of TRIM8 in p53-dependent regulation of the expression of genes involved in the transport of chemotherapeutic drugs

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Poster presented by: Alessandra Amendolare

Background: In 50% of human cancer, the inactivation of the p53 tumour suppressor gene depends on epigenetic or non-coding RNA pathways through the regulation of modulators. The clear cell Renal Cell Carcinoma (ccRCC) is a very aggressive and chemoresistant tumour, although p53 mutations are rare. Recently, our group discovered a new p53 modulator, TRIM8, whose expression is promoted by p53 and in turn stabilizes p53 interacting with MDM2, the main negative regulator of p53. We demonstrated a prominent role for TRIM8 in regulating cell growth in ccRCC. We found TRIM8 deficit in ccRCC explained by the up-regulation of the miR-17-5p and miR-106b-5p, whose expression is promoted by the oncogene MYCN. The restoration of TRIM8 levels induces the p53-dependent cell growth arrest and chemosensitivity in ccRCC cells. Among the mechanisms that induce chemoresistance there is the alteration of the expression of ABC (ATP-Binding Cassette) and SLC (Solute Carrier Transporter) proteins, which regulate the bioavailability of chemotherapy drugs in cells.

The aim of the project is demonstrating the correlation between down-regulation of TRIM8 and the alteration of expression of ABC and SLC drug-carrying proteins.

Methods and results: Western blotting analyses, RTqPCR and proliferation assays (MTT) experiments demonstrated that when ccRCC and control renal HK2 cells are treated with TRIM8 plus the tyrosine kinase inhibitor Axitinib, we observed in ccRCC a significant down-regulation of the expression of all ABC efflux genes examined and an increase of influx transport SLCO1A2 and SLC22A2 genes.

Conclusion: In conclusion, our experiments demonstrated that TRIM8 alone or in association with Axitinib is able to regulate the expression of the ABC and SLC transporter genes, increasing chemosensitivity and helping to decrease the malignant phenotype.

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D3 - IBIOM

Saccharomyces Cerevisiae as a surrogate host to study SARS-CoV-2 replication associated proteins

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Background. Positive-strand RNA [(+)RNA] viruses are agents of important diseases in humans, animals and plants, including COVID-19. Regardless of the host, the replication of all (+) RNA viruses occurs in association with the host endomembrane system. Based on this common replication mechanism, we have used the yeast model to express the replication-associated proteins of human SARS-CoV-2, having a role in the formation of the double-membrane vesicles and in virus replication, to decipher virus-membrane interactions.

Materials & Methods. We expressed the (+)RNA SARS-CoV-2 non-structural proteins nsp3, nsp4 and nsp6, under the control of the inducible GAL1 promoter in Saccharomyces cerevisiae strain W303-1B. Cell growth was determined by spectrophotometric analysis at 600 nm. Cell viability was determined by measuring colony-forming units (cfu) after 2 days of growth on YPD plates at 30 °C. Protein expression was analyzed by Western blot and immunofluorescence analyses.

Results. SARS-CoV-2 non-structural proteins nsp3, nsp4 and nsp6 expression was obtained in yeast. Cells expressing nsp3 showed a low but significant decrease of growth rate, whereas nsp4 showed dramatically reduced growth. Moreover, nsp4-expressing cells showed a loss of cell viability compared to control cells harboring empty plasmid. Immunofluorescence analysis showed nsp3 and nsp4 intracellular aggregates. The effect of viral nsp expression on yeast cells will be analyzed by differential metabolomic profiling. We show that the yeast model system can be successfully employed to study human virus replication-associated proteins. S. cerevisiae was confirmed as an invaluable model host to study the molecular pathogenesis of (+)RNA viruses. Elucidating virus-host cell interaction complexity is crucial to the identification of novel druggable targets for the development of broad-spectrum antivirals.

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E1 – IC

IC - Istituto di Cristallografia - Institute of Crystallography

Poster presented by: Vincenzo Mangini

The Institute of Crystallography (IC) merges the main souls of crystallography, the methodological and the experimental ones, with the most advanced basic and applied researches in different fields, such as biosciences, nanomedicine, structural biology, applied chemistry and/or physics, and material science.

The principal research activities address several interdisciplinary thematic areas:
- the development of innovative crystallographic methodologies aimed at improving and automating the structural characterization process from diffraction data, the elaboration of new computing algorithms and software packages;
- the study of structure-activities-function of inorganic, organic compounds, bioinorganic and pharmaceuticals;
- the structural and morphological characterization, at the micro and nanoscale, of innovative materials for health, photonics, electronics, bioelectronics, and energy sectors;
- the structural characterization, conducted by crystallographic techniques and assisted by computational modelling, of small and macro molecules, or protein-ligand complexes of biotechnological and biomedical interest;
- the use of computational modelling for the design of innovative molecules for diagnosis and therapy of high impact human diseases and the evaluation of toxicity in biological systems.

To take up these challenging targets in all their complexity, specialists from various disciplines, such as physics, chemists, geologists, biologists, and biotechnologists work together within their different know-how and multidisciplinary competences, to produce rigorous and reproducible results, always with a view to innovative science. The IC has also strong interactions with national and international pharmaceutical industries, with companies working in the field of technological interesting materials and with companies of scientific instrumentation, with the aim to develop quality technical activities adequately to meet the needs of the industry and economy.

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E2 - IC

EXPO Software: Advances Tools for Structural Analysis of Crystalline Materials by X-ray Powder Diffraction

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Poster presented by: Marzia Dell'Aera

Powder X-ray diffraction (PXRD) is not only a common and rapid method primarily used for phase identification of a crystalline material in a multiphase mixture sample [1] but also a valid tool for crystal structure characterization at atomic level of materials available in the form of microcrystalline powders. It is widely used in many fields such as material science, mineralogy, chemistry, and biology. X-ray powder diffraction has a key role also in many industrial applications, *e.g.* for building materials and pharmaceuticals [2].

Over the past years, the research group of the Institute of Crystallography of CNR, seat of Bari, has developed the computer program EXPO able to manage powder diffraction data for solving crystal structures.[3] EXPO boasts thousands of users all over the world. In this communication, the most recent advances implemented in EXPO will be disclosed. Among these, we mention innovative graphical tools making the structural study of microcrystalline powders more user-friendly. In particular, the current version of EXPO is capable to solve an unknown structure from a mixture composed of one unknown structure and one or more phases with known structures.[4] As well, the program has been supported by powerful computational and graphical tools for facing the structure solution process in the real space as effectively and speedily as possible. The solution by Simulated Annealing can be also run by parallel computing.

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E3 - IC

DeLA-Drug: A Deep Learning Algorithm for Automated Design of Drug-like Analogues

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Poster presented by: Giuseppe Lamanna

We present DeLA-Drug, a recurrent neural network (RNN) model composed of two Long Short-Term Memory (LSTM) layers and conceived for data-driven generation of drug-like compounds. DeLA-Drug captures the syntax of SMILES strings of more than 1 million molecules belonging to the ChEMBL28 database and generates analogues starting from a single user-defined query compound by employing a new strategy called Sampling With Substitutions (SWS). The generative model preserves drug-likeness and synthetic accessibility of the known bioactive compounds belonging to the ChEMBL28 repository. The absence of any time-demanding fine-tuning procedure enables DeLA-Drug to perform a fast generation of focused libraries for further high-throughput screening and makes it a suitable tool for performing de-novo design even in low-data regimes. DeLA-Drug, available as a free web platform (http://www.ba.ic.cnr.it/softwareic/deladrugportal/), can help medicinal chemists interested in generating analogues of compounds already available in their laboratories and, for this reason, good candidates for an easy and low-cost synthesis.

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E4 - IC

X-ray multiscale investigation of hierarchical materials

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Poster presented by: Alberta Terzi

The XMI- L@b [1], the X-ray micro imaging laboratory of the - Institute of Crystallography of Bari of CNR is equipped with a high-brightness X- ray microsource for Wide (WAXS) and Small (SAXS) Angle X ray Scattering acquisition that are employed for the materials exploration at both atomic and nanoscale. X-ray diffraction techniques have demonstrated to be a useful tool for the multiscale characterization of several hierarchical materials, including inorganic materials for optoelectronic applications, such as perovskites, and biological tissues for biomedical applications. The application of WAXS has been crucial to determine the growth, structure and localization of the hydroxyapatite nanocrystals, either in the early stage biomineralization steps within cell cultures, or across biomimetic scaffolds. Over the years the application of both X-ray diffraction techniques was extended to the evaluation not only of the crystalline component of the tissues, but also of the fibrillary ones, such as type I collagen [2,3], the main fibril-forming protein of the mammalian extracellular matrix (ECM), as well as to lipidic nanovesicles. Moreover, also silk fibroin and cellulose, widely employed not only in textile field but also in biomedical one, have aroused growing interest. In particular, their biocompatibility, bioactivity and biodegradability make them attractive as biomaterials. They can be extracted from different sources by chemical and/or enzymatic processes, leading to structural alteration of the fibrillary arrangement that can be investigated with X ray techniques. Through the X-ray multiscale inspection of the materials, the restoration of natural arrangement of the proteins can be followed during manufacturing processes of the biomaterials, allowing to screen the suitable manufacturing protocol according to the final use of the biomaterial.

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F1 - IIA

IIA - Istituto sull'Inquinamento Atmosferico - Institute of Atmospheric Pollution

Poster presented by: Fabio Michele Rana

The activities of CNR-IIA researchers refer to the thematic area of Earth Observation (EO). Development of devices and methodologies for environmental analyses aims at integrating multi-source data by means of artificial intelligence techniques, data cube systems and cloud computing on European platforms, which provide access to Copernicus data and to all the information for generating new knowledge.

The EO group in Bari focuses research activities on the monitoring of natural ecosystems, in particular, the estimation of land covers, the identification of habitats, the evaluation of phenology status of vegetation, allowing estimation of its primary productivity, and the estimation of snow cover as well. This line of research has been unfolded in European Projects, such as Ecopotential, Geoessential (Eraplanet) and eShape, in the regional project COHECO and 3 POR Habitat contributions. A new line of research has been also developed to directly support the biodiversity estimation, looking at temperature in marine environments to map coral colony and land plant biodiversity using spectral diversity. A SAR technique for sea surface wind retrieval recently grew up with uncertainty analyses. Furthermore, urban ecosystem studies were approached within the framework of the project SMURBS (Eraplanet) and devoted to fine grained mapping of census urban population within the volume of city buildings.

The analyses of essential variables, indicators derived from them, and temporal trends of change, deployed with Virtual Laboratories and provided to end users with GIS, have a twofold objective: impacting the global agenda thanks to the involvement of CNR-IIA in the GEO group as well as supporting local managers at level of National Parks and Regional administrations.

These activities are synergic to the ones of the EO group in Rome, which are concentrated on methodological aspects of atmosphere correction and UAV photogrammetric estimation in multi- and hyper-spectral approaches

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F2 - IIA

Earth Observation for Sustainable Development Goal 11: methods and tools in support of policies for resilient and inclusive cities

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In the framework of the United Nations (UN) 2030 Agenda and the New Urban Agenda (Habitat III), local and regional authorities require indicators at the intra-urban scale to design adequate policies in support of the Sustainable Development Goal (SDG) 11: “Make cities and human settlements inclusive, safe, resilient and sustainable”. Nevertheless, the current literature provides national, regional and city scale indicators. Earth Observations (EO) data have been recently recognized as a fundamental source of information in support of SDGs. In particular, the spatial distribution of population and settlement layers, derived by EO-based surveys and methodologies, are considered essential variables requested for quantifying SDG 11 indicators. However, the complexity of EO data handling and processing makes difficult a direct integration of such data in evidence-based decision-making processes. To fill such gaps, a set of method and semi-automatic tools were developed to compute grid population density map and settlement layers at high spatial resolution (respectively, 100 and 10 meters). These variables were used as input to implement SDG 11.3.1 indicator: “Ratio of land consumption rate to population growth rate”, *i.e.*, Land Use Efficiency (LUE) indicator. For Bari city (southern Italy), LUE and other additional indicators (SDG 11.1.1, 11.2.1 and 11.6.2) were measured for both the total population and the regular migrant population components. When observed over time and per unit area, the obtained indicators provide useful trends for SDG 11 monitoring progress. The evaluation of the population growth rate and indicators evidenced, in Bari, that native and regular migrant population components are settling according to different logics. Thus, these findings allow to evaluate the great impact of the proposed intra-urban scale implementation of indicators SDGs 11 in designing evidence-based policies, which reserve attention to social cohesion and inclusion issues.

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G1 - IPCF

IPCF - Istituto per i Processi Chimico Fisici - Institute for Chemical and Physical Processes

Poster presented by: Roberto Comparelli

The research activity of CNR-IPCF Bari is intrinsically interdisciplinary and devoted to the chemical and physical investigation of organic and inorganic (nano)materials. The research activity focuses on the development and study of hierarchical organized hybrid materials, starting from building blocks (atoms and molecules) up to the mesoscopic level. Object of the study are complex systems based on colloidal inorganic nanocrystals (NCs) hierarchically organized in 2 / 3D and the "living soft matter" *i.e.* complex biological molecular machinery.

The main research activities focus on:
• Design, synthesis and investigation of colloidal inorganic nanoparticles and nanocrystals (semiconductors, metals, oxides, perovskites, carbon dots and magnetic materials), also in quantum confinement regime
• Preparation and study of the properties of nanocomposite materials and nanostructured hybrid materials based on polymers or on different carbon allotrope forms (carbon nanotubes and graphene derivatives) and colloidal inorganic nanoparticles and nanocrystals
• Strategies for the chemical surface functionalization of nanomaterials and their assembly in 2-3D nanostructures
• Development for nanostructured materials and composites for environmental and energy applications
Design and synthesis of nanovectors for diagnosis and therapy in nanomedicine
• Formation of hybrid nanocrystal-biological molecule systems
• Study of supramolecular and biological systems for biomedical, analytical, environmental and energy applications
• Immobilization of proteins in supramolecular systems to be used as an active layer in biosensors.
• Investigation of the photodynamic activity of chlorophyll / cyclodextrin inclusion complexes.
• Study on the substitution of the central metal of chlorophyll for the development of new photosensitizers

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G2 - IPCF

Emerging Applications of Colloidal Nanostructured Materials

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Poster presented by: M. Dell'Edera, I. De Pasquale, C. Lo Porto, A. Madonia, G. Mandriota, F. Vischio

The Nanomaterials Group at the Bari Division of the CNR IPCF focuses its research activity mainly on the chemical and physical investigation of nanostructured materials. Considerable knowledge has been acquired in the synthesis and chemical functionalization of the surface of semiconductor, metallic, magnetic and / or oxide colloidal nanoparticles, playing with the composition and size of the material, with a high control over the phase and crystalline phase. The synthesized nanomaterials have also been studied for fundamental studies, as well as for potentially relevant technological applications in various technological fields. In particular, the research at Bari Division of the CNR IPCF concerns the main following activities:

- Synthesis and chemical-physical characterization of inorganic colloidal nanoparticles
- preparation of hybrid nanocomposites based on organic sensitizers, ionic liquids or polymers
- organization of nanoparticles in 2/3 D assemblies
- nanoparticle immobilization on functionalized surfaces
- solvothermal synthesis and physical chemical characterization of Carbon dots and their processing in polymeric nanocomposites
- Fabrication of functional materials and coatings for photocatalysis, including environmental remediation and sensing for the environment.
- development of targeted multifunctional nanoplatforms for applications in nanomedicine
- functionalization of carbon-based nanostructures, including carbon nanotubes and graphene derivatives
- manufacturing of smart textiles
- cultural heritage protection

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G3 - IPCF

Microbial Photosynthesis & Soft Polymers: the yellow brick road to sustainability

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Poster presented by: Rossella Labarile

In bio-electrochemical systems, living and metabolically active microorganisms can be used for the sustainable production of energy. Conductive polymer layers on the surface of several bacterial species have been used to intercept the electron flow produced by microbial metabolism, funnel it outside the cells, and eventually transfer it toward the electronic circuit of a biohybrid device.

Purple photosynthetic bacteria are anoxygenic microorganisms with very versatile metabolisms that use sunlight1 to oxidize a broad variety of organic compounds in addition to heterotrophic and photoautotrophic alternative metabolisms.

Biocompatibility of several monomers, such as gallic acid, L-DOPA, EDOT and dopamine were tested by in vivo addition in the growth media of the photosynthetic purple non sulphur Rhodobacter (R.) sphaeroides. Furthermore, the ability of these monomers to self-assemble and polymerize was considered. Among the tested monomers, polydopamine (PDA), produced by self-assembly of dopamine, is a very versatile and bioinspired polymer which has found widespread applications2 due its ability to adhere and cover surfaces of different chemical composition. The oxidative conditions employed for the formation of this dark insoluble polymer are mild and biocompatible and have inspired scientists to develop novel nanomaterials for optoelectronics. We have used PDA conductive coatings as biotic-abiotic interfaces in biohybrid photoelectrochemical devices through the encapsulation of entire bacterial cells or single components – *e.g.* photosynthetic reaction center (RC) - of R. sphaeroides3, ensuring electronic communication of the biological component with the electrodes' surfaces in photoelectrochemical cells. Post-functionalization of PDA also enables fine-tuning of properties.

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H1 - IPSP

IPSP - Istituto per la Protezione Sostenibile delle Piante - Institute for Sustainable Plant Protection

Poster presented by: Loredana Barbarossa

The Institute for Sustainable Plant Protection of the National Research Council of Italy (ISP-CNR) was founded in May 2014 from the merger between the Institute of Plant Virology (IVV-CNR) and the Institute for Plant Protection (IPP-CNR).

The mission of the IPSP is the study of the plant response to biotic and abiotic stresses, in order to identify resistance mechanisms, adaptation processes and protection methods.
The activities are aimed at promoting plant health in agriculture and forestry, that means strengthening of natural antagonisms and beneficial microorganisms in integrated pest management, the qualitative and quantitative improvement of agri-food productions, the selection and recovering of valuable plant germplasm, the characterization and production of bio-molecules of agro-industrial interest, the mitigation of the impacts of global change and, ultimately, a sustainable and environmentally friendly growth.

Main areas of the research activities:
BIODIVERSITY OF AGRO-FOREST ECOSYSTEMS
Characterization of the biodiversity of organisms and microorganisms associated with agricultural and forest systems (holobionts, insects, fungi, bacteria, viruses, viroids, weeds and nematodes) for knowledge/description purposes and in order to support the defense of production chains from adverse biotic and abiotic environmental factors.
PLANT PROTECTION DIAGNOSTICS
Development and validation of diagnostic tools to detect plant pathogens via both direct and indirect methods. Support to plant health monitoring programs to prevent, limit and manage the spread of pests and epidemic events.
INTERACTION OF PLANTS WITH BIOLOGICAL AGENTS
Study of plant-parasite-antagonist-symbiont interactions in natural, agricultural and forest ecosystems through a multidisciplinary approach that aims at expanding the molecular, biochemical, physiological knowledge about the mode of action of microbial biological control agents against plant diseases.

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H2 - IPSP

Spittlebug vectors of Xylella fastidiosa in Apulia

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Poster presented by: Vincenzo Cavalieri

Background
Philaenus spumarius (Ps) is the main vector of *Xylella fastidiosa* (Xf) to olive trees in Italy. Very few information was available about the biology of this insect until 2013, when Xf was found in Apulia. Since then, several studies have been conducted on Ps that have allowed a better understanding of the relationships between this species, the Apulian agrosystem and Xf. Among these lines of research some of the most important are the following: a) phenology, seasonal abundance and stage-structure of Ps; b) dispersal of Ps in agrosystem and c) dynamics of the transmission of Xf.

Materials and Methods: Phenology, seasonal abundance and stage-structure of Ps.Field surveys were conducted during the 2016–2018 period in four olive orchards in the Apulia and Liguria regions in Italy. The nymphal population in the herbaceous cover was estimated using quadrat samplings. Adults were collected through sweep nets on three different vegetational components.

Dispersal of Ps in agrosystem. In this study, we have examined the dispersal of Ps adults in an olive grove in Apulia and a meadow in Piedmont. Insects were marked with albumin and released during seven independent trials over 2 yr. The recapture data were pooled separately for each agroecosystem and used to estimate the dispersal kernels of Ps.

Dynamics of the transmission of Xf. Factors that influence Xf transmission by Ps to olive are still largely unknown. We have performed two sets of experiments to study the transmission biology of Xf by Ps to understand the kinetics of the bacterial persistence, transmission efficiency and the spread rate of Xf among olive trees in summer and autumn.

Results: The knowledge obtained from these studies allowed to assess the risk of spread of the bacterium in the territory and to be able to implement more efficient and effective measures to reduce the population of Ps and the spread of Xf in the field.

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H3 - IPSP

Tackling emerging plant diseases threatening food crops with “omics” technologies

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Climate change and global trade of plant materials are two key drivers responsible for the emergence of plant pathogens ravaging economically important crops. Among different pathogenic microbes, insect-borne pathogens (*i.e.* plant viruses) pose major challenges for their control and are frequently responsible for detrimental diseases. Thus, the accurate and early identification of the causal agent(s) is critical for prevention and disease management.

Our pioneering application of high-throughput sequencing (HTS) allowed for the description of virome profiles of important crops (grapevine,citrus). Moreover, HTS led to study the molecular bases of antiviral response and to discover new viruses in diseases of unknown etiology [1].

In 2013 the bacterium Xylella fastidiosa was first identified in Apulia (Italy), causing a severe disease (Olive Quick Decline Syndrome) with loss of the olive trees and productions, and then in other EU countries.

HTS and “omics” technologies were firstly exploited to obtain the complete genome of the Xf isolate associated to OQDS9,10 then to perform population genomic studies, clarifying the origin/evolution of the Apulian Xf outbreak [2]. Transcriptome approach on naturally Xf-infected olives unraveled differential gene expression profiles in resistant and susceptible cultivars. In order to identify genes and pathways involved in host response, RNASeq data were also generated from olives artificially infected under controlled conditions [3]. Because there is no cure for Xf infections, searching for source of resistance in the olive germplasm represents one of the strategies to counteract Xf’s spreading, while olive metagenomics studies could identify potential antagonistic microorganisms.

Machine learning approaches will be tested on gene expression data, to exploit this resource with the aim to characterize resistance traits in new olive selections while identifying novel diagnostic biomarkers of the plant responses to biotic stresses.

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H4 - IPSP

Evaluation of xylem vascular occlusions in olive cultivars infected with Xylella fastidiosa

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Poster presented by: Vito Montilon

Background: Studies in the *Xylella fastidiosa* (Xf) plant pathosystems indicate that the biofilm-embedded bacteria occlude the xylem thus eliciting the formation of tylose-like structures aiming to isolate the pathogen. Understanding the role occlusions in disease progression may be important for the disease control. Occlusions were evaluated in diverse Xf subsp. pauca-infected and healthy olive plants of the susceptible Cellina di Nardò and the resistant Leccino and FS17 cultivars.

Materials and methods: From each plant, three twigs were selected, while ten cross sections of each twig were observed by optical microscope to determine the percentage of occlusion. Ultrastructural evaluation of the occlusions was achieved by TEM. Vascular tissues from infected and healthy plants were excised and embedded in epoxy resin. 1µ and 80nm thick sections were cutted from the embedded tissue blocks by the ultramicrotome and then analyzed at the transmission electron microscope.

Results: Respectively, 0.15%, 0.02% and 0.13% of average occlusions were found in healthy plants of Cellina, Leccino and FS17. In infected plants occlusions, were significantly higher in Cellina (9.65%) with respect to Leccino (6.81%) and FS17 (1.33%). TEM observations showed that vessels of infected plants were occluded by Xf cells embedded in a dense matrix and no tylosis-like structures were observed as observed by the IAWA according to which in olive the tyloses development is unlikely [1; 2].

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I1 - IREA

IREA - Istituto per il Rilevamento Elettromagnetico dell'Ambiente - Institute for Electromagnetic Sensing of the Environment

Poster presented by: Francesco Mattia

The activities of the Bari secondary unit of IREA concern the use of Earth Observation (EO) data at high space/time resolution to characterize the state of our environment and provide scientific support for the implementation of strategies for sustainable social, economic and environmental development as set forth by the United Nations 2030 Agenda.

The science objectives aim to i) improve the knowledge and prediction of the water cycle at scales ranging from regional to continental, ii) support the use of sustainable agriculture and iii) mitigate the impact of extreme events.

The activities include i) estimating and monitoring the water content of soils, their use and quality, ii) classification and systematic control of the phenological/phytosanitary state of crops and iii) monitoring of calamitous phenomena such as floods and droughts and related hydrogeological hazards, such as landslides and subsidence.

The skills of the IREA team encompass numerical signal processing, physical interpretation and statistical analysis of time series of EO data acquired by spaceborne, airborne and/or UAV platforms, integrated with in situ measurements. Processing and managing these data sets on a large scale also requires competencies for the development of interoperable geospatial data infrastructures that the team has acquired over the years.

Another important skill concerns the management of sensor networks located throughout the territory for the collection of in situ measurements that are used in activities of calibration/validation of national and international satellite systems and EO products.

Methodologies for extracting information from EO data include Change Detection (coherent and incoherent), Machine Learning and Deep Learning.

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I2 - IREA

Integrating SAR interferometry into surface soil moisture retrieval: a Sentinel-1 case study

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Poster presented by: Davide Palmisano

BACKGROUND: SAR interferometry is a powerful remote sensing technique that enables high accurate measurements of geophysical parameters as surface topography, ground deformation, and subsidence. It is based on the measurements of the phase difference between two SAR images (*i.e.*, the interferometric phase) acquired at slightly different positions (single-pass interferometry) or at different times (repeat-pass interferometry). In the last case, physical (*e.g*, soil moisture) or geometrical changes in the surface conditions influence the SAR interferometric phase. On the other hand, surface soil moisture (SSM) from SAR sensors is usually retrieved from incoherent SAR backscatter, i.e., the soil response to the intensity of the radar signal. The current research activity is focused on the development of a SSM retrieval approach combining SAR backscatter and SAR interferometric phase. A retrieval scheme has been proposed at C-band. It has been assessed through a numerical and an experimental study using S-1 data [1].

MATERIALS & METHODS: The proposed approach combines the incoherent change detection by Balenzano et al. [1] and the coherent change detection by De Zan et al. [2]. Time series of C-band SAR data acquired by the Sentinel-1 radar observatory and of in situ SSM temporally collocated with the SAR acquisitions and recorded by hydrologic networks are used to assess the retrieval performance.

RESULTS: The approach has been assessed through both a synthetic and an experimental study. In the synthetic case, forward backscattering models have been used to link SAR observables to in situ measured SSM. In the real case, the retrieval method has been applied to Sentinel-1 data. The assessment showed encouraging results about the feasibility of coherent-incoherent integration. In both cases, a good retrieval accuracy (*e.g.*, Pearson correlation R=0.8 and RMSE=0.05 m3/m3) over bare or sparsely vegetated soils has been attained.

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L1 - IRPI

IRPI - Istituto di Ricerca per la Protezione Idrogeologica - Research Institute for Geo-Hydrological Protection

Poster presented by: Luca Pisano, Luciano Nunzio Fazio, Maurizio Polemio

The mission of the Research Institute for Geo-Hydrological Protection (IRPI) is to design and implement scientific research and technological development concerning natural hazards (landslides, floods, sinkholes and earthquakes) and the sustainable utilization of natural resources (groundwater and geothermal sources).

The research and development activities of the Bari IRPI Unit are particularly focused on landslides (also induced by earthquakes), flash floods and karstic floods, karst collapse, pollution and depletion of surface water and groundwater resources, especially of coastal aquifers, at salinization risks due to saltwater intrusion. We work to define criteria, methods, models and tools for the prediction and prevention of geo-hydrological events and their consequences, with the final purpose of defining and mitigating risks, and supporting end-users to implement adequate adaptation strategies. In the case of natural resources, our efforts support optimal resource management and long-lasting resource availability, minimising risk due to overutilisation or misuse.

One of the strengths of the Bari IRPI Unit resides in the multidisciplinary workflow that starts from a multi-temporal and multi-scale identification, mapping and analysis of natural hazards phenomena, applied in different environmental domains. Special attention is addressed to the peculiarities of our immediate area (*i.e.* Southern Italy and Apulia).

This multidisciplinary attitude leads our office to have a continuous interchange with local/national/international partners providing suitable technical and scientific expertise before, during and in the aftermath of natural disasters, contributing to providing important information in terms of soil conservation, land use planning, civil protection and on social security. Finally, the office plays an active role in training and disseminating information and knowledge to improve the awareness of individuals and the community about natural risks.

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L2 - IRPI

Geotechnical numerical modeling activities of Bari IRPI unit

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Poster presented by: Nunzio Luciano Fazio

The research activities on geotechnical numerical modeling of the Bari IRPI unit are focused on the study of geo-hydrological instability processes, such as landslides in soil and rock, collapses due to underground cavities, or rocky cliff failures, at site-specific scale or large scale, by using two- and three-dimensional numerical models.

The research is aimed at the influence analysis of specific controlling factors, predisposing and/or triggering factors, such as the piezometric regime of the slopes, the physical-mechanical characteristics of geomaterials, the anthropogenic actions or the rainfall regime, the reconstruction of cause-effect relationships of the initiation processes and evolution of instability phenomena and the identification of possible evolution scenarios of the processes.

The research group also works on: propagation models of landslide run-out for the study of the kinematical features; methodological approaches for the assessment of coastal cliffs stability through three-dimensional structural models based on photogrammetric UAVs, geotechnical laboratory testing, and two- and three-dimensional finite element analyses (FEM); 2D and 3D numerical models of underground cavities for the analysis of the relative susceptibility to failure, as related to the evolution of the degradation processes of the physical-mechanical characteristics of the rocky materials; development of a methodology for the evaluation of the safety factor of underground cavities in static condition, through stability charts based on the cave geometry and the geo-mechanical parameters (iSUUM).

In recent years, the research activities of the group are also oriented to rock/soil dynamic analysis for the verification of the local seismic response produced by earthquakes and, in general, of the effects of cyclic loads on rocks and soils.

The research carried out by the group can have strong impacts to improve the management and mitigation actions of the aforementioned phenomena.

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L3 - IRPI

The impact of landslides on urban development and road network: an example from the Southern Daunia Mountains, Italy

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Poster presented by: Veronica Zumpano, Luca Pisano

A multitemporal landslide inventory map is prepared for the urban areas of Motta Montecorvino and Volturino, two municipalities located in the Daunia Mountains (Apulia Region, Italy). These territories show a high propensity to landslides of different types and magnitude, which periodically interfere with the anthropic structures and infrastructures. For the study area, the spatial and temporal distribution of landslides is detected for the period between 1954 and 2003, through the visual interpretation of multiple sets of black and white digital stereoscopic aerial photographs at different scales. The analysis reveals locally high frequency of landslide occurrence over the years and how new residential areas were developed despite the presence of large old mass movements.

Furthermore, for the two municipalities, the potential impact of landslides on roads is evaluated. This is first indicated as percentage of road length crossed by landslides. Then, we exploit a landslide intensity index combined with landslide hazard zones, which represents the areas of likely enlargement of the pre-existing landslides or the occurrence of new landslides and whose extent is defined with reference to the slope geomorphic setting, local knowledge and experience. Through this approach we evaluate where and how, in terms of the expected intensity, the roads could be affected by future landslide activity. Moreover, we illustrate how the road deformation results obtained from satellite multi-temporal interferometry-MTI can be associated with detailed landslide maps to foster more reliable interpretations of MTI results and pin-point the sections of the road network affected by instability. We claim that this information can assist the regional government in a rational allocation of funds for future prevention and mitigation measures.

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M1 - IRSA

IRSA- Istituto di Ricerca Sulle Acque - Water Research Institute

Poster presented by: Marco Berardi

Water Research Institute (IRSA) was established in 1968 with the task of carrying out research activities in the sectors of water resources management and protection, and in the development of methodologies and technologies for water purification and wastewater treatment. Multidisciplinarity is the main peculiarity and "strength" of IRSA, in fact at IRSA, engineers, chemists, geologists, biologists, physicists, mathematicians collaborate together in the various research groups.

IRSA, which is part of ”Earth System Science and Environmental Technologies” Department of CNR, is a center of competence of the Civil Protection, carries out consultancy activities - even pre-normative - for public bodies (*e.g.* Ministry of the Environment, MITE, ISPRA, Guardia di Finanza, District Authority and Basin Authority, ARPA) and private companies; morevoer, IRSA plays a coordinating role in EurAqua, the network of Public Water Research Institutes in the EU Member States, and makes part of the Joint Programming Initiatives, JPI-FACCE and JPI-Water, as well as being involved in many European projects. IRSA activities can be grouped according to different thematic areas:
1) integrated and sustainable management of water resources and understanding of phenomena for the definition of methods and models for evaluating the effects of anthropogenic pressures on the environment;
2) biodiversity and functionality of aquatic ecosystems through the analysis of ecological and biochemical interactions between biotic and abiotic components;
3) technologies for water purification, also for the purpose of reusing civil and industrial wastewater; sludge management and enhancement;
4) advanced processes for the recovery of resources and energy from the treatment of wastewater, sludge, waste, biomass in the framework of circular economy;
5) innovative technologies for the characterization, safety and remediation of contaminated sites and environments.

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M2 - IRSA

Efficient and sustainable processes for the conversion of municipal sewage sludge into biofuels and fine chemicals

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Poster presented by: Luigi di Bitonto

Environmental problem targeted: In Europe, wastewater treatment processes produce 10 MM ton yr-1 of dry sludge. Such a value will increase up to 13 MM ton yr-1 according to the Wastewater Directive (91/271/EEC). Considering the current restrictions on the use of sewage sludge in agriculture and the high costs related to its disposal, the introduction of sustainable technologies to minimize sludge production has become strictly necessary. One promising way to address this issue is to save the chemical potential of the organic components present in the sewage sludge through processes that isolate valuable useful compounds. Sewage sludge is a source of lipids, as well as cellulose and proteins which can be used for the production of biofuels and fine chemicals.

Objectives of research: Sustainable solutions were developed for the recovery of valuable products from sewage sludge. In detail, the research activities are aimed at:
- Chemical characterization of raw urban sewage sludge with the identification of the main organic components to be exploited;
- Optimization of green technologies for the recovery of lipids from sludge and conversion into biodiesel or valuable products [1,2];
- Valorization of the cellulosic component (toilet paper) to produce platform-molecules and value-added products (HMF, FDCA, levulinic acid and biobased solvents) [3];
- Development of simulation models to evaluate the potential of technologies proposed, at an industrial scale.

Results and future prospects. These novel technologies will lead to achieve the following objectives:
- Reduction of sewage sludge generated from wastewater treatment;
- Maximization of recycling/reuse of resources;
- Production of biofuels at lower costs than commercial products;
- Limit landfills to non-recyclable and non-recoverable waste.

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M3 - IRSA

Assessment of analytical approaches for the detection of contaminants of emerging concern and sustainable solutions for reducing their spread in water bodies

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Poster presented by: Sapia Murgolo

The quality of water bodies is continuously threatened by the growing human activities and the consequent release of different classes of pollutants into the aquatic environment. Conventional wastewater treatment plants (WWTPs) do not efficiently remove persistent and toxic pollutants before discharging treated wastewater into the aquatic environment and consequently, they are detected in receiving water bodies such as surface and groundwater. Some of these pollutants are classified as contaminants of emerging concern (CECs) with the potential to cause known or suspected adverse ecological and/or human health effects. Considering the current focus on sustainability and water reuse, the identification and removal of these CECs is important to preserve the quality of water.

The research activities aimed at:
- assessment of sustainable advanced oxidation processes (AOPs) for the removal of CECs in water bodies, particularly referring to photocatalysis employing supported nano-sized catalysts [1,2];
- detection of organic contaminants employing very sensitive analytical techniques based on high-resolution mass spectrometry combined with the development of target, suspect and non-target workflows for the identification of known and unknown substances [3].

The investigated AOPs have proved to be suitable for practical applications in the field of water treatment for the removal of CECs. Investigated processes still need many improvements to be a reality in scale-up.
Target, suspect and non-target screening allowed the detection of a spectrum of compounds as wide as possible in the water bodies, including transformation products produced by the application of AOPs. The impact of the research on this task will enhance the knowledge in the analytical tools for the monitoring of relevant contaminants by collecting data in an online platform for data sharing to be used as a source of information.

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N1 - ISPA

ISPA - Istituto di Scienze delle Produzioni Alimentari - Institute of Sciences of Food Production

Poster presented by: Giuseppina Mulè

CNR-ISPA is an internationally recognized center of excellence, which operates through a multidisciplinary, supply-chain oriented approach in the area of food and feed production. The research activities carried out at CNR-ISPA Bari promote innovation, competitiveness, and technology transfer to academia and industries worldwide in the area of food production. The competencies encompass various disciplines, such as chemistry, toxicology, microbiology, biotechnology, veterinary science, agronomy, biology, and plant pathology. By creating synergistic actions between research and production sectors, CNR-ISPA fosters technological innovation paths of small, medium, and large national and foreign agro-food enterprises.

CNR-ISPA is recognized worldwide as a leader in the fields of food and feed safety, with particular regards to innovative methodologies for the detection of food contaminants (*e.g.* mycotoxins, toxigenic fungi, pathogens, heavy metals, pesticides, nitrates), toxigenic fungi, microbial pathogens, and the development and validation of analytical methods for food allergen quantification in foods. In addition, CNR-ISPA aims at improving food nutritional and organoleptic quality, adding value to typical local products (dairy, bakery and meat products, fruit and vegetables). Innovative functional foods using traditional products are being developed in cooperation with enterprises and regionally-based medical and health research groups for the assessment of their health benefits.

CNR-ISPA built and implemented strategic cooperative partnerships with world leader Institutions in the area of agro-food (FAO, EFSA, FSA, USDA, etc.) as well as with SMEs and large enterprises (Barilla, IBM Italy, Syngenta, Bayer, Thermo, Copaim, etc.); the transfer of know-how and innovative technologies is continuously performed within funding programs promoted by local, national, and international institutions (POR, PON, FP7, H2020, Horizon Europe etc).

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N2 - ISPA

Sensor-based technology for the rational management of fertigation in tomato soilless cultivation

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Poster presented by: Lucia Bonelli

In Mediterranean areas, where the use of brackish water for irrigation purposes is common, open (free drain) systems, often associated to empirical methods for fertigation management (such as timer) resulting in excessive leaching rate and consequent discharge of harmful substances into the environment, are the most widespread in soilless cultivation. This brings into question the environmental sustainability of soilless production. On the other hand, the adoption of closed cycle cultivation, potentially more sustainable, implies periodic discharge into the environment of the recirculating nutrient solution (NS), due to Na accumulation.

In this study, an innovative precision automatic irrigation system, based on real time measurements of substrate volumetric water content (VWC) and electrical conductivity (EC) performed by a wireless sensor network (GS3, Decagon Devices, Pullman-WA, USA), was evaluated in tomato open-cycle soilless cultivation (sensor Open Cycle - sOC). Results in terms of water use efficiency and effects on crop yield and quality were compared with those obtained in semi-closed cycle (Closed Cycle - CC) and empirically timer-based open free drain soilless cultivation (Open Cycle - OC). The experiment, carried out at the Experimental Farm “La Noria” (ISPA-CNR) in Mola di Bari, provided the use of moderately saline water (NS EC=3,7 dS/m). A value of 5 dS/m was set as EC set-point for substrate leaching automatically operated by the sensor-based system in sOC, and for NS replacement in CC, respectively.

Compared to the control (OC), sOC and CC treatments reduced plant growth, as well as crop yield (≈30%, on average). However, better fruit quality was obtained (6,8 °Brix in OC vs. 7,8 °Brix in CC and sOC, on average), as a result of controlled salinity stress conditions imposed. sOC treatment also allowed to increase water use efficiency by 68%, on average, compared to the other two systems.

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N3 - ISPA

A predictive growth model for pro-technological and probiotic Lacticaseibacillus paracasei strains fermenting white cabbage

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Classically the predictive microbiology was used to identify microbial hazards and to predict their growth or destruction to ensure food safety. A few studies have been performed until now on the application of predictive microbiology to technological strains to optimize the fermentation process [1; 2]. In the current study, the growth cardinal parameters of 4 pro-technological and/or probiotic *Lacticaseibacillus paracasei* strains (IMPC2.1, IMPC4.1, P40 and P101), were determined. Strains were grown in liquid medium and incubated at 10 temperature (from 5.5 to 40°C) and 15 pH (from 3.2 to 9.1) values. The cardinal temperature model with inflection (CTMI)[3] was used to describe the temperature effect on the maximum specific growth rate of strains, whereas a new equation was developed for the effect of pH. Maximum specific growth rates of *L. paracasei* IMPC2.1 in white cabbage (*Brassica oleracea* var. *capitata*) were used to calculate the Correction Factor (C_f) defined as the bias between the bacterial maximum specific growth rate in broth and in the food matrix. A simple bi-linear model was also developed for the effect of temperature on the maximum population density reached in white cabbage. This information was further used to simulate the growth of *L. paracasei* strains in cabbage and predict the time to reach the targeted probiotic level (7 $\log_{10}$ CFU/g) using *in silico* simulations. A fermentation temperature (30°C) close to the T_{opt} value of strains allowed to reduce time of food processes to about 24h. This study demonstrated the potential of mathematical modelling to predict the growth of beneficial and pro-technological strains in foods in order to optimize the fermentative process. The growth cardinal parameters determined for these strains, will be implemented in new databases and exploited to simulate the fermentation process in other food matrices after performing *in food* experiments.

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N4 - ISPA

Optical biosensor systems for fast and on-site quantification of bacteria in food and on surfaces

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Poster presented by: Elisa Santovito

New biosensor systems were developed for rapid and simple quantification of total aerobic counts (TAC) of surface and food microbiota by oxygen respirometry, that use sterile disposable vials or swab vials with culture medium and phosphorescent oxygen sensor coatings in the bottom part.

Biomonitoring of the microbial growth in food and surface swab samples via oxygen respiration was evaluated in real-time and contactless and gave rapid and quantitative readouts of TAC. The sensing measurements of the sensors revealed time profiles of dissolved O2 consumption by the growing microflora in/on samples. Once the signal threshold Time (TT, hours) of the sensor signal was determined, TAC values were calculated using once-off predetermined calibration equations. The biosensor vials for food analysis use the same sample preparation procedure as the established plate counting TAC method for meat/surfaces. After this liquid samples are transferred into standard sample vials with built-in phosphorescent O2 sensors and incubated on a block heater with hourly readings of sensor signals with a handheld reader, to determine the TT for each sample.

The new tests have time to result in 1–10 h with faster detection of more contaminated samples and show a good correlation with the ISO reference methods which take 48-72 hours to result. The testing requires no dilutions or plating and covers the ranges 2–7 Log(CFU/g) for meat samples and 0.65–7.87 Log(CFU/cm2) for surface swabs.

The sensor-based testing platforms are rapid, simple, affordable, provide good sensitivity and analytical performance and allow on-site use. These systems address the demand of the industry, particularly the food sector, consumers, and society, and provide rapid, simple and de-centralised testing. Unlike other methods that rely on colony counting, these systems provide medium levels of automation, sample throughput and integration, along with modular flexibility, portability, and on-site deployment capability.

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O1 - ISTP

ISTP - Istituto per la Scienza e Tecnologia dei Plasmi - Institute for Plasma Science and Technology

Poster presented by: Olga De Pascale, Vincenzo Laporta

The Institute for Plasma Science and Technology - ISTP - is a CNR institute, founded in April 2019, which combines three CNR research groups active for many decades in plasma research. With the establishment of ISTP, the scientific and technological skills of the Institute of Plasma Physics "Piero Caldirola" (IFP-CNR) of Milan, of the Institute of Ionized Gases (IGI-CNR) of Padua and of P.Las.M.I. Labs of the Institute of Nanotechnology (NANOTEC-CNR) of Bari have fused into a single institute.

The CNR has thus integrated most of its scientific and technological expertise on plasmas in ISTP, which now boasts a broad spectrum of skills to face its mission: Modelling, design, construction and operation of thermonuclear fusion plants; Low temperature plasmas and their applications; Plasmas for aerospace; Astrophysical plasmas and space plasmas; Interaction of plasmas with particle beams, electromagnetic radiation and materials.

Plasma science is a very broad, highly multidisciplinary and interdisciplinary field of research. It concerns phenomena that occur in the universe (stars, solar wind, interstellar medium, interplanetary space, star systems and galaxies), in the laboratory (hot and low temperature plasmas) and in natural environments (lightning, auroras, ionosphere).

Plasmas are characterized by an extremely wide range of scales and parameters. The spatial scales vary from the nanoscale to the parsecs, the time scales from the attosecond to the centuries and the plasma parameters for more than ten orders of magnitude. Despite great diversity and variety, all plasmas exhibit common physical phenomena on these enormous scales and share basic scientific concepts, theoretical descriptions and experimental techniques.

ISTP investigates most aspects of the rich and diversified science of plasma, addressing both fundamental phenomena as well as applied processes, developing technological applications and promoting technology transfer.

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O2 - ISTP

Electric Propulsion Technologies and Computer Simulations

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Poster presented by: Filippo Cichocki

Electric propulsion is an enabling technology for both space exploration and utilization, thanks to the enormous propellant mass savings it offers compared to the traditional chemical propulsion. Electric thrusters, also known as plasma thrusters since they ionize a gas before accelerating it through electric and magnetic fields, can accelerate the propellant to much larger velocities (which are not limited by the type of chemical reaction employed), thus achieving specific impulses one order of magnitude larger than those of chemical thrusters, at the cost of a much smaller thrust, in the order of tens to hundreds of mN, given the limited available electrical power onboard the S/C. Several categories of electric thrusters exist, and from the point of view of the physical principle behind thrust generation, they can be divided into electrostatic and electromagnetic thrusters. Two important representatives of these families are the gridded ion thrusters (electrostatic) and the Hall thrusters (electromagnetic), but there exist a large number of other thruster types under development or that have already flown in space missions (field emission electric thrusters, helicon plasma thrusters, ECR, VASIMR, etc…).

Given the large cost of their experimental test and characterization campaigns, which require the use of sufficiently large vacuum chambers on ground, computer simulations are extremely important at assessing the performance and understanding the physical working mechanisms of electric thrusters. Again, there exists a large number of numerical approaches, from the fully kinetic particle-in-cell method, to multi-fluid models, or hybrid methods that combine the strength of both kinetic and fluid methods.

This poster will present an overview of both the existing electric thrusters and the numerical methods considered for their simulation. Moreover, a description of the active research lines at ISTP, with recent simulation results, will also be provided.

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O3 - ISTP

Innovative methods to study plants nutritional status and biotic and abiotic stresses

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Poster presented by: Nadine Othman

Plants nutritional status is generally determined by assessing the concentration of macro- and micro-nutrients in plant tissues. However, the concentration and distribution of such nutrients can be altered by abiotic and biotic stresses that can modify element homeostatis within plant organs. Considering the innovations in the field of spectroscopy, portable-X ray Fluorescence (pXRF) and handheld Laser-Induced Breakdown Spectroscopy (hLIBS) emerged as appealing tools for the determination of nutrients concentrations in plants tissues, being robust, simple, and portable, and thus suitable for the fast, in-situ analysis of plants tissues directly in the field [1].

The current on-going research aims for testing the use of pXRF and hLIBS to study plants nutritional status and the alteration in the nutrients contents that may occur as a consequence of biotic and abiotic stresses.

As a case study, we are investigating the nutrients content in table grapevine leaves directly in the field. Five table grape varieties from Apulia region were considered: Autumn crisp, Carlita, Great green, Italia, and Timco. Fresh grapevine leaves were analyzed using the pXRF and hLIBS. The macro-nutrients and micro-nutrients detected were, respectively, by pXRF: Ca and K, and Cu, Mn, and Fe; and by hLIBS: Ca, K, Mg, N, and P and Cu, Mn, B, Fe and Zn. The inductively coupled plasma - optical emission spectroscopy (ICP-OES) analysis after sample digestion was performed as reference analytical method.

Working with fresh samples is quite challenging because of the effects of moisture content on the stability of the spectral signal intensities and for quantification issues. Most of the research work until now has used pelletized leaf samples, which consist of dried leaf samples grinded and pressed for a better homogeneity. The objective of this study is to find a method and a protocol allowing the use pXRF and hLIBS in-situ with high analysis speed for a preliminary plant diagnosis.

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O4 - ISTP

Plasma-wall interactions in thermonuclear fusion reactors.

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Poster presented by: Vittorio Sciortino

One of the most important open issues in the development of a fusion reactor with a net positive power outcome is represented by the heat fluxes on the divertor, which is a crucial component in a thermonuclear fusion reactor, conceived for power exhaust. In this context, a complete understanding of plasma-wall interactions is essential to achieve the goal of regulating and maintaining under the threshold values the heat and particle fluxes to the divertor.

Due to intrinsic difficulties in designing precision instruments to measure the plasma properties in the divertor region, a performant and fast simulation is the only possible tool to understand if the power flow can be distributed over larger surfaces and time windows, thus avoiding peaks in time and space, and assess the effect of plasma-gas interaction, a typical mark of high-recycling detached regimes.

A simulation based on the particle-in-cell (PIC) method is the best way to probe the velocity distribution function and the fluxes to the wall. While PIC codes have already been used for divertor simulations, in literature no studies have considered so far, the effects of self-consistent inter-particle collisions and wall interactions, which are believed to play a very important role close to the divertor mono-blocks. Our code will try to bridge this gap, through the simulation of such physical phenomena.

This poster illustrates the fundamentals of plasma behaviour in proximity of a metal surface and introduces the main features of the PIC simulation that our group is developing and expanding with the introduction of other important physical phenomena, and also using parallelization techniques to achieve speed-ups. Finally, the results of a parametric simulation that varies the magnetic field orientation with respect to the wall, and of a more realistic one, are illustrated: potential, density and temperature maps of the 2D domain and 1D plots of average quantities along the normal to the wall are shown.

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P1 - ITB

ITB - Istituto di Tecnologie Biomediche - Institute for Biomedical Technologies

Poster presented by: Flavio Licciulli, Domenica D'Elia

The ITB-Bari [1] has been operating, for over thirty years, in Bioinformatics and Genomics, with multidisciplinary skills in bioinformatics, biology, medicine, statistics and computer science, with a particular focus on neurodegenerative diseases, cancer and nutrigenomics studies.

Research lines, through a complementary and synergistic approach between “wet” and “dry” laboratories, include: the development and use of innovative Bioinformatic tools, Biostatistics and Artificial Intelligent applications for the management, integration, analysis and interpretation of big data produced by Omic sciences and their correlation with biobank data; the study and characterization of biomarkers involved in cell proliferation and tumors, as well as in the complex molecular mechanisms underlying some multifactorial neurodegenerative diseases; the study of the cross kingdom effects of plant miRNAs on human cell lines; the study of abiotic/biotic effects on crop plants. Thanks to the strong expertise in massive sequencing technologies, the functional study of these mechanisms is also approached with genome-wide methodologies for genomic, transcriptomic and epigenetic analysis.

In the last years, activities have been oriented to integrated in-silico and in-vitro experimental approaches investigating the role of small and long non-coding RNAs in biological processes for the identification of new prognostic and diagnostic biomarkers, and to understand the network of interactions involving both the coding and non-coding fraction of the genome.

Research activities are supported by a powerful IT infrastructure and a molecular biology lab maintained by experts in: management of HPC/Cloud infrastructures, development and maintenance of bioinformatics services, omics technologies, training, community building and networking at national and international level (e.g. PON-CNRBiOmics, ELIXIR[3], EMBnet[4], GOBLET[5]).

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P2 - ITB

Multiomics+ at ITB: analysis and integration of different Omics data through advanced Bioinformatics pipelines and Data Science methods

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Poster presented by: Arianna Consiglio

Background: New advances in Next-Generation Sequencing technologies have provided unprecedented opportunities for "omic" sciences, such as Genomics, Proteomics, Transcriptomics, Epigenomics and Metagenomics. Therefore, different types of data can now be integrated for holistic studies of biological systems with an multiomic analysis approach [1]. Such a complex source of data requires innovative bioinformatic strategies and advanced statistical and artificial intelligence analysis techniques.

Materials & Methods: In the project Multiomics+ we propose a software infrastructure for multiomic data analysis, enriched with ad hoc modules developed for the application of statistical analyses or artificial intelligence techniques. Machine learning methods are applied for feature selection, hidden pattern extraction and data classification, while uncertainty management methods are applied for the representation and the interpretation of the results. Multiomics+ is therefore composed of a series of bioinformatics pipelines integrating specialized modules, developed to extract knowledge from the experiment under analysis.

Results: We are applying the analysis strategy conceived for Multiomics+ to several projects that involve two or more types of omic data produced simultaneously on the same samples. In the PedMS project (Pediatric Multiple Sclerosis) we combined gene, long non-coding and small non-coding RNA analysis with pattern recognition and classification methods. In the CoV-ncRNAsig project we approached the analysis of the interaction between human and viral genome and transcriptome by statistical metrics. In the TITAN project we are building an integrated analysis of genome sequencing, optical genome mapping, bulk RNA and single cell RNA sequencing, with deep learning pattern search. In the MATITE project we are planning to integrate data from DNA, RNA and chromatin accessibility sequencing, with mapping uncertainty management through fuzzy sets.

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Q1 - NANOTEC

NANOTEC - Istituto di Nanotecnologia - Institute of Nanotechnology

Poster presented by: Alberto Perrotta, Paolo Stufano

The Institute of Nanotechnology CNR-NANOTEC develops fundamental and applied research in the fields of nanosciences and nanotechnology.

It gathers scientists from the disciplines of physics, chemistry, engineering, materials science, as well as biology and medicine. The institute operates through its four research sites located in Lecce (headquarter), Bari, Roma and Rende.

The operative unit of Bari, PlasmaCheM@Bari, has as mission the removal of knowledge and technological barriers to the development of multifunctional materials by designing and advancing innovative chemical and plasma processes for the synthesis, surface functionalization and engineering of materials, nanostructures and devices. Moreover, additional activities involve the study of the basics of plasma chemistry and physics and the development of new plasma methodologies for application in fields such as environment, energy and life sciences.

The research highlights of the unit involve: 1) design and synthesis of 2D materials (e.g., graphene and metal (di)chalcogenides) for applications in (opto)electronics; 2) synthesis and development of metal halide perovskite-based devices with application in solar-to-electricity and solar-to-fuels conversion; 3) water heavy-metals analysis at sub ppm level by nanoparticle enhanced laser induced breakdown spectroscopy (NELIBS); 4) plasma-based technologies for biology and medicine; 5) surface engineering via plasma treatments of functional materials and optical coatings; 6) plasma technologies in the agri-tech field; 7) hybrid coatings for photocatalytic water remediation; 8) synthesis and development of innovative sustainable nature-based and -inspired materials (e.g., nanocellulose) and their chemical and/or plasmo-chemical treatment for possible application in sensing, (opto)electronic, energy, packaging and composites for ultra-light components. 9) plasma surface engineering of materials for sustainable mobility, environmental protection and remediation

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Q2 - NANOTEC

Plasma processing of fullerene for industrial applications

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Poster presented by: Regina Del Sole

Fullerenes, and in particular C60, are of interest for several applications due to their physical, photochemical, and electrical properties. Two different processing methods of fullerenes are investigated:
1) Plasma treatment of C60
2) Plasma deposition of composite coatings containing C60

1) The low solubility in water of fullerenes (less than 0.04 ng/mL for C60) calls for novel methods, both efficient and sustainable, for their dispersion. The O2 Low-Pressure (LP) Plasma treatment presented in this work is time-saving and eco-friendly: indeed, it allows to graft polar oxygenated moieties at the surface of C60 powders. Different conditions of plasma power and treatment time were tested; afterwards, treated powders were dispersed in distilled deionized water. The non-destructivity of plasma treatment was proved via MALDI-TOF and XRD on powders. The enhancement in C60 concentration in water was supported by UV-Vis spectroscopy. Particles size, polydispersity index and ζ potential of the suspensions were assessed via DLS and ELS. Furthermore, XPS analysis highlighted a huge presence of carboxylic groups on the surface of dispersed fullerenes.

2) the deposition of thin films of fullerene and a semiconductor in a polymeric matrix is widely studied for environmental applications. Among n-type semiconductors, TiO2 is often used, even though its band gap of 3.2 eV leads to absorption only in the UV region and a fast electron-hole recombination rate is typical of its photocatalytic activity. Often, nanocomposites of TiO2 with carbon nanomaterials are produced to overcome all the limitations of TiO2. In this scenario, we addressed the Aerosol Assisted Atmospheric Pressure Plasma Deposition (AA – APPD) of nanocomposite TiO2/C60 films, exploring different concentrations of C60 in the aerosol suspensions. Chemical composition and morphology were characterized by means of FT-IR and SEM. Coatings deposited on glass were tested for the photodegradation of methylene blue.

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Q3 - NANOTEC

Metal halide perovskite solar cells and strategies for improved stability and efficiency

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The recent rapid development in perovskite solar cells (PSCs) has led to significant research interest due to their notable photovoltaic performance, currently exceeding 25% power conversion efficiency for small-area PSCs. However, surface imperfections of perovskite films impede improvement in device performances and are considered as weak points catalyzing material degradation and introducing undesired energy losses under sunlight illumination [1]. Herein we present different strategies to treat the perovskite thin film surface with the final aim of improving their optoelectronic properties and the overall device efficiency and lifetime [2]. The incorporation of colloidal nanocrystals (NCs) onto perovskite thin films has shown great potential on improving the band alignment in solar cell structures, passivating bulk and surface defects, and enhancing overall device performances. In this work we discuss the effect of all-inorganic perovskite CsPbBr3 NCs introduced through antisolvent process on MAPbI3 [3] with the aim of modulating interfacial engineering to improve the performance of perovskite solar cells. In particular, in the preliminary studies we evaluated the effect of NCs commonly prepared prepared by hot injection technique bearing different capping ligands, to explore their efficacy in defect-passivation and charge-transfer. The variation of photoluminescence intensity is used as diagnostic tool for the change in the trap-related non radiative recombination. This study represents a preliminary step towards a comprehensive knowledge of the interaction mechanism between perovskite thin film-NCs to extend the application to the devices.

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R1 - STIIMA

STIIMA - Istituto di Sistemi e Tecnologie Industriali Intelligenti per il Manifatturiero Avanzato - Institute of Intelligent Industrial Technologies and Systems for Advanced Manufacturing

Poster presented by: Marcello Valori

The secondary unit of Intelligent Industrial Systems and Technologies for Advanced Manufacturing (STIIMA), located in Bari via Lembo 38/F, is named STIIMA-Bari Lembo in the following, with its four laboratories (Micro EDM And Characterization Lab, Micro Injection Molding Lab, Precision Injection Molding Lab, Mechatronics and Prototypes Development Lab) and equipment at state of the art, is mainly involved in three macro research topics:

Micro-Manufacturing Technologies, developing methodological knowledge and technologies for the conception, design, manufacture, and exploitation of innovative micro-manufacturing products and devices featuring 3D geometries with micrometric dimensions and precision and/or high aspect ratio [1]. The research activities include the mechanical and technological characterization of pre- and post-transformation materials, their manufacturing, and assembly. The study of these technologies (*i.e.* extrusion, injection molding, micro-Electro Discharge Machining, additive manufacturing at macro and micro level, micro-robotic assembly) is carried out by considering them individually or as part of the process chain for the production of manufactured goods. All studies can also use modelling techniques and multi-physics or mechatronic numerical simulations.

Machines, Components, And Intelligent Mechatronic Systems with the study, development, and analysis of mobile robots [2], machines, and components.

Digital Twin based Solutions for Smart Environments, with the study of methodologies and technologies to realize a faithful digital replica of a physical entity that allows to monitor, analyze, simulate, and predict behavior of this entity along its various life cycle phases. In particular, an effective Digital Twin asks for research in different fields such as multi-scale data modeling, integration and interoperability of methods and tools, and synchronization between the real and digital representation [3].

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R2 - STIIMA

STIIMA - Istituto di Sistemi e Tecnologie Industriali Intelligenti per il Manifatturiero Avanzato - Institute of Intelligent Industrial Technologies and Systems for Advanced Manufacturing

Poster presented by: Cosimo Patruno

The Institute of Intelligent Industrial Systems and Technologies for Advanced Manufacturing carries out scientific research, development, technology transfer, training and strategic activities to contribute to innovation, competitiveness and sustainability of enterprises and to promote the central role of people in enterprises and society. In particular, the activities are aimed at the design of smart systems, enabling industrial technologies, products and processes that co-evolve dynamically over time to meet different social and market requirements and to support new production paradigms.

The group in the Bari branch has the mission of studying, designing and developing intelligent perceptual systems for decision support in different application domains. Intelligent systems, using multi-sensory technologies, perceive and respond to the environment around them and interact with humans and/or other agents in complex and dynamic physical and social environments.

The methodological approach integrates artificial intelligence, machine learning, computer vision, data science and intelligent computational approaches to produce innovation in challenging application contexts such as: manufacturing, aerospace, robotics and automation, rail transport, logistics, ambient assisted living, agriculture, agri-food, personalized medicine, bioinformatics, drug design, innovative human-machine interaction, marine science, tracking and study of motor activities in laboratories and clinics.

Continuous learning from available data, knowledge formalization, data-driven modelling, integration and interpretation of heterogeneous multisensory data, design of innovative human-computer interaction systems, design and management of sensor networks are examples of the challenges faced by research and the development of systems able to solve perception and decision-making problems in complex real-world contexts with a high level of dynamism and uncertainty.

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R3 - STIIMA

Intelligent perception systems for Agricultural Robots

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Poster presented by: Rosa Pia Devanna, Arianna Rana

Our research focuses on the development of multi-sensor systems and data processing algorithms for in-field crop monitoring and characterization by autonomous agricultural robots. Data acquired by on-board exteroceptive and proprioceptive sensors are combined to make the vehicle able to autonomously navigate in the crop, as well as to extract important information on the crop status. Specifically, collected data are elaborated with Computer Vision (CV) and Artificial Intelligence (AI) techniques for tasks, such as:

• 3D mapping: data coming from heterogeneous but complementary sensors are combined to generate a multimodal representation of the environment including mechanical, geometric, and appearance properties;

• scene classification: classification of the scene into broad classes of interest, *i.e.*, safe-drivable terrain, (positive/negative) obstacles, highly-challenging terrain, etc.;

• crop assessment and yield estimation: fruit detection and counting, measurement of biomass, density, crop height, crop health, etc.;

• autonomous navigation: development of self-localization and autonomous navigation algorithms both using simulation tools and in-field data to allow a precise and reliable control of the vehicle along desired routes (*e.g.* following rows) defined within the operative areas, also exploiting previously built maps.

In field testing and validation of the developed systems and approaches is performed using different robotic platforms available at CNR-STIIMA or other project partners. These platforms are equipped with multi-sensor systems that include 2D and 3D vision sensors, RTK-GPS and inertial systems.

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R4 - STIIMA

Deep learning applications on 2D/3D data: a case study

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Poster presented by: Gaetano Pernisco

In this work we propose an analysis and a comparison of deep learning methods for point cloud semantic segmentation.

We compared two state-of-the-art models, PointNet [1] and PointNet++ [2], on publicly available datasets from different domains. Then, we took advantage of these results to improve their performance on a dataset in the railway domain. On this dataset, we evaluated PointNet++ comparing results using different training protocols. Finally, we modified the architecture to perform transfer learning from models trained on other datasets. Results show that transfer learning can enhance the performance of the model in the railway domain.

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