La professora Clara Prats és un punt de referència en l’estudi de les malalties infeccioses en el nostre departament on utilitza les eines de la biofísica per portar a terme investigacions en tuberculosi o la malaltia de Chagas entre d’altres. El pas a l’estudi de la COVID19 va ser natural, però la capacitat de recerca i divulgació de l’epidèmia ha estat una cursa de fons amb jornades maratonianes per ella i l’equip que lidera. Informes a la Comissió Europea, estructuració del seguiment de l’epidèmia a Catalunya, prediccions hospitalàries, anàlisi de variants, transmissió a escoles o anàlisi de factors de risc i de protecció són només una pinzellada de tota la feina que ha dirigit. Aquest any li hem demanat que ens faci unes reflexions sobre l’epidèmia per la revista.

“Una pandèmia com la que estem vivint afecta totes i cadascuna de les persones de la nostra societat i, probablement, del planeta. No podem oblidar els col·lectius que han patit la cara més crua de la pandèmia: gent gran a residències, persones socioeconòmicament vulnerables o el personal sanitari, entre d’altres.

Nosaltres com a grup hem pogut donar un cop de mà per entendre millor l’epidèmia amb una primera clau: el treball en equip, en tota la seva dimensió. Amb la capacitat d’organitzar, repartir i compartir feina, però també fer-ho en un entorn de confiança mútua, generositat, respecte i empatia envers els companys. Saber que on no arriba un, arribarà l’altre. L’equip de treball, i el treball en equip, són un element clau per treballar bé. I és allò que >
ens hauria d’acompanyar al llarg de la nostra vida professional. De fet, és probable que acabi sent més important amb qui treballarem que amb què treballem.

En aquest sentit, la diversitat de mirades i enfocaments sobre un mateix problema és fonamental per afrontar la seva solució o mitigació, amb perspectives i des de disciplines diferents. I això requereix un gran esforç d’acostament per trencar les barres de llenguatge i conceptuals, requereix respecte i interès per la feina de l’altra, i de consciència sobre l’àmbit de treball d’un mateix. Nosaltres ja feia anys que treballàvem d’aquesta manera estudiant la tuberculosi, i això ens ha facilitat poder-ho fer amb la COVID-19. Des del primer dia ens hem pogut entendre amb metges amb qui no havíem treballat abans, amb especialistes en salut pública i epidemiòlegs, amb especialistes en dades i sistemes d’informació, amb mestres i educadors, o fins i tot amb polítics.

Per altra banda, la transmissió del virus esdevé de persona a persona. Per tant, les persones som part del problema, ja que som el motor de la propagació, però som també part de la solució. Aquesta és la clau de volta de qualsevol problema de salut pública: la condició de problema col·lectiu. En aquest context, la comunicació és una peça cabdal per explicar els mecanismes de transmissió i què podem fer per mitigar-los, quina és la situació epidemiològica i el nivell de risc, o per què són necessàries certes intervencions. Si aquesta comunicació es fa amb arguments tècnics i científics i d’una manera efectiva, és més probable que contribueixi al control de la pandèmia.

Des del grup de recerca, el darrer any hem intentat ajudar en la comunicació no només de les dades i tendències, sinó també de diversos aspectes científics relacionats amb la pandèmia que formaven part del nostre àmbit de coneixement i investigació. Ho hem fet a través de les xarxes socials, dels mitjans de comunicació i de xerrades divulgatives en centres educatius i en altres entorns. Sense ser experts en comunicació, però amb el bagatge que ens donava la nostra experiència en l’àmbit de la docència universitària, hem intentat adaptar el missatge i la forma d’explicar-lo als diversos contextos. La societat és diversa, i per tant no hi ha una forma bona de comunicar. Si hi ha diverses veus, és més fàcil que el missatge arribi a una població més àmplia.”
Daniel Calvete and Francesca Ribas, from the group of Nonlinear fluid dynamics, have been working for a few years on the development of image analysis techniques to extract information from video cameras installed on the beaches of Castelldefels and Barcelona, to be able to quantify their evolution.

> Monitoring the evolution of beaches at high spatio-temporal resolution is crucial to manage them, especially in the present framework of climate change. Researchers from the Nonlinear fluid dynamics (DF) research group in the Physics department have published three articles in the last six months with new results in the journal Remote Sensing, where they address two important open problems in coastal video-monitoring. They apply the developed algorithms to the images obtained from the cameras in Castelldefels (see photo that accompanies the text) and Barcelona, but they could be directly used in the thousands of video-monitoring stations around the world. These works have been done in collaboration with researchers from the Institut de Ciències del Mar (ICM, CSIC, Barcelona).

The first problem is the automatic image calibration. In order to extract quantitative information from video cameras, the position of each pixel of the image must be first transferred to the real world. Once the position of some control points in the study area have been measured with a differential GPS, it is necessary to locate them in the image and apply a linear relationship. The process of finding the points in the image is usually done by hand and is time-consuming. In the articles, progress is made on a methodology to do the calibration automatically. This will allow, in the future, to correct the hourly changes in the images due to the movement of the tower where they are installed and the expansion of the lenses, thus reducing detection errors.

The second addressed open problem is the automatic shoreline detection from the images. Properly registering the shoreline time evolution is crucial for coastal management and there is not yet an algorithm to extract them from existing video images that is fully satisfactory. In the article, a methodology is presented that combines the results of different shoreline detection algorithms in order to obtain an accurate result when compared to the manually digitized shorelines. In the figure that accompanies the text there are examples of (A) manual shorelines digitized by three expert users (in different colors), (B) raw shorelines out of the four methods (red, green, blue and yellow) and combined shoreline (white and black) and (C) filtered shoreline (white and black) of Castelldefels beach on 27 November 2017 at 12 h. The shorelines are detected from the time exposure planview image below them, which are obtained from 10 min of video-camera oblique images after applying the calibration procedure. When the new algorithm is applied to the beaches of Barcelona region, the final computed shorelines have RMSE of the order of 2 m or smaller.

> In a recent article published in Physical Review Letters, a mixed team from the Universitat Politècnica de Catalunya (UPC) and the Universitat de Barcelona (UB), present a microscopic theory of bound quantum droplets that explains their formation.

Liquids are ubiquitous in Nature: from the water that we consume daily to superfluid helium which is a quantum liquid appearing at temperatures as low as only a few degrees above the absolute zero. A common feature of these vastly different liquids is being self-bound in free space in the form of droplets. Understanding from a microscopic perspective how a liquid is formed by adding particles one by one is a significant challenge.
Researchers from the DONLL research group convert the bass chords of a song by the group 'Queen' into an image

Cristina Masoller, Pablo Amil, Donatus Halpaap and Jordi Tiana-Alsina are researchers from the UPC Physics Department at the Terrassa Campus. The team of researchers have detected audio signals at a distance, without listening to the emitter, and have converted them into images using laser light. The experiment, which was performed by recording the first bass chords of the song 'Another one bites the dust' by the British group 'Queen', has been published in the magazine 'Optics Express'. The method has been baptized with the name 'Best Pixel'.

In 1980, the British group 'Queen' led by the famous singer Freddie Mercury released the album 'The Game' which included the hit 'Another one bites the dust'. Now, this famous song is part of an experiment thanks to which a group of researchers from the research group in Nonlinear Dynamics, Nonlinear Optics and Lasers (DONLL) of the Universitat Politècnica de Catalunya - BarcelonaTech (UPC) has managed to transform in images the vibrations caused by the famous notes of the bass of this song, without the researchers being able to hear them.

The researcher Cristina Masoller explains that "there are many research groups working in this line. With our experiment we provide a new method, which we have called 'Best Pixel', much simpler and more effective, with which we can visualize sound vibrations from a source that we didn’t hear."

The team of researchers has shown that the formation of the quantum droplet can be explained in terms of effective interactions between dimers (bound states of two particles). Moreover, by solving the four-body problem they have shown that tetramers (bound states of four particles) can appear and they can be interpreted as simple bound states of two dimers.

The properties of these tetramers already coincide with the ones of large quantum droplets which indicates that many of the feature properties of the many-body liquid are contained in the tetramer. They also discussed the possibility of observing these strongly correlated droplets in dipolar bosons or bosonic mixtures in optical lattices.

Recently, a new type of quantum droplets has been experimentally observed in ultracold atomic systems. These ones are made of alkaline atoms which are cooled down to extremely low temperatures of the order of nanokelvins. The main peculiarity of these systems is that they are the most dilute liquids ever experimentally observed. An extraordinary experimental control over the system opens the possibility of unraveling the mechanism leading to the formation of quantum droplets.

In a recent article published in Physical Review Letters, UPC researcher Grigori Astrakharchik in collaboration with Ivan Morera, Bruno Juliá-Díaz and the late Prof. Artur Polls from UB, present a microscopic theory of lattice quantum droplets which explains their formation.

And is that 'Best Pixel' consists of using laser light to generate an image that moves with sound. This image is called a 'speckle' and is the product of the wave interference captured by a coherent light source such as the laser. Masoller argues that "we have projected laser light onto a sound source that interprets the bass chords of the song 'Another one bites the dust' by 'Queen' in conditions where we couldn't hear it. So due to vibrations, the speckle moves. If we videotape this movement that reveals the laser light, we get a film with a series of dots or pixels that are actually the image of the sound produced by the bass. It is as if we could see the vibrations of the leaves of a plant in a room caused by the conversation of two people," says Masoller.

The 'Best Pixel' method could have different uses in the industrial field, such as creating remote noise detectors in places that are difficult for technicians to access, such as ventilation systems, pumps, or underground or refrigeration extraction systems. With a technology based on 'Best Pixel', maintenance managers could anticipate breakdowns and monitor equipment, obtaining images of vibrations caused by mechanisms subjected to constant operation and suffering from imbalances, wear, misalignment, bearing defects, or cracks and fractures that can cause excessive vibrations.

Apart from Cristina Masoller, researchers Pablo Amil, Donatus Halpaap and Jordi Tiana-Alsina, from the UPC Physics Department, have also participated in the study, and has had the collaboration of scientists from the Università degli studi di Catania.
> Blas Echebarria and Enric Àlvarez, researchers in the Physics department of the research group in Computational Biology and Complex Systems (BIOCOM-SC), together with researchers from the Heart Rate Analysis and Control (ANCORA) research group at the UPC, and other international scientists have identified one of the molecular mechanisms responsible for cardiac alternation. This is an alteration of the heart rhythm that facilitates the induction of ventricular fibrillation, a potentially lethal type of arrhythmia. This discovery, published in the journal Circulation Research (AHA Journals), opens the door to new pharmacological treatments.

Cardiovascular disease is one of the leading causes of death worldwide, accounting for about 18 million deaths each year. In Spain, and in Catalonia, they represent almost a third of the deaths. Diseases that also cause a significant decrease in quality of life. Now, an international team of researchers, led by Professor SR Wayne Chen of the University of Calgary (Canada), and formed by the Heart Rate and Contraction of the Institut d’Investigacions Biomèdiques de Barcelona (IIBB-CSIC) and the Institut d’Investigació de l’Hospital de la Santa Creu i Sant Pau (IIB Sant Pau), and the research groups in Biologia Computacional i Sistemes Complexos (BIOCOM-SC) and Anàlisi i Control del Ritme Cardíac (ANCORA) have identified one of the molecular mechanisms responsible for cardiac alternation, an alteration of the heart rhythm that facilitates the induction of ventricular fibrillation, a potentially lethal arrhythmia.

The research group BIOCOM-SC of the UPC has been using computational models for some time to study the origin of cardiac alternations. Thanks to different multidisciplinary collaborations, he has managed to develop computational techniques that allow him to study different physiological scenarios that explain his origin. Professor SR Wayne Chen of the University of Calgary, and one of the leading experts on the ryanodine receptor, proposed that this alteration in receptor function could be due to its binding to another protein (calmodulin or CaM), which regulates its function. To confirm this, Professor Chen designed an experiment, with the help of researcher Hove-Madsen: to change the function of CaM by introducing into adenovirus mice modified to produce either the protein in its normal state or mutations in the protein that increased or decreased their function, observing whether this decreased or increased the propensity to develop alternates.

Experimentally, however, it is not possible to observe what happens with RYR, so there is always the possibility that CaM is affecting another regulatory mechanism, and that there is an alternative explanation for this effect. To confirm whether the effect of CaM on RYR is responsible for this change, researchers in the BIOCOM-SC research group have used a computational model that describes in detail the interaction between CaM and RYR and its effect on cardiac dynamics. The results of the mathematical model agree perfectly with what is observed experimentally.

> Huixia Lu and Jordi Marti from the SIMCOM research group of the Physics department publish an article on the anchoring mechanism to the cell membrane of certain proteins relevant to oncological studies.

Oncology is a branch of medicine that studies benign and malignant tumors; the latter known as cancers. Oncology begins with prevention, aimed at reducing the incidence of cancer, continuing with care for the sick and, finally, it is completed with research, which deals with the study of all the elements that intervene in the development of malignant diseases and its treatments.

Ras proteins, together with the gene that bears the same name, are a set of very important molecular switch-regulators in a wide variety of cellular signal transmission routes that control different phenomena such as the integrity of the cytoskeleton, proliferation, cell differentiation, adhesion and migration and apoptosis. Both the gene and related Ras proteins are often altered in a wide variety of malignant tumors, causing increased invasiveness and metastasis, and decreased apoptosis. In particular, Ras proteins are directly involved in cancers of the lung, colon, and pancreas. These proteins function as binary switches between guanosine-diphosphatase and guanosine-triphosphatase (GDP-GTP) and are capable of regulating the cytosplasmic signaling networks that control various cellular processes, playing

Long-lasting Salt Bridges Provide the Anchoring Mechanism of Oncogenic Kirsten Rat Sarcoma Proteins at Cell Membranes

Ca2+-CaM Dependent Inactivation of RyR2 Underlies Ca2+ Alternans in Intact Heart. Circulation Research. 2021 Volume 128, Issue 4: e63–e83, Research. 2021  Volume Heart' .  Circulation Alternans in Intact Underlies Ca2+ Inactivation of RyR2 Ca2+-CaM Dependent arrhythmia cardiac serious a type of that causes mechanism published on results Important

an essential role in the signaling of transduction pathways involved in growth, differentiation and cell survival, in such a way that it is believed that excessive signaling is what can cause the growth of tumors. One of the most difficult challenges is the design of selective mutations that lead to efficient therapeutic strategies. In this work, the GTP-bound protein "Kirsten rat sarcoma" (KRas-4B) with a farnesylated tail and mutated to the amino acid G12 has been simulated at the interface of an anionic cell membrane model (DOPC / DOPS / cholesterol). Using molecular dynamics and metadynamic simulations, a specific long-term salt bridge between the farnesyl group and the hypervariable region of the protein has been identified as the main mechanism responsible for the binding of KRas-4B to the cell membrane. Free energy hypersurfaces have made it possible to characterize their global and local minima, which reveal the main transition pathways between anchored and non-anchored states.

Thesis 1
Adrià Casanovas Hoste defends his thesis on measures of effective neutron capture sections of importance for the study of stellar nucleosynthesis

Adrià Casanovas Hoste defended his thesis, co-directed by Francisco Calviño (UPC) and César Domingo (IFIC, Valencia), on 27 October at the ETSEIB. Titled “Neutron capture cross section measurement of the heaviest s-process branching 204Tl and of 203Tl at CERN n_TOF”, the thesis presents the first ever measurement of the effective neutron capture section of the radioactive isotope of such 204Tl, of special relevance to the slow process of stellar nucleosynthesis, and performed in the CERN n_TOF experiment.

Neutron capture cross sections are fundamental in the study of the slow neutron capture process of nucleosynthesis, also known as the s-process, which produces half of the observed solar system abundances of elements heavier than iron.

Some nuclei along the nucleosynthesis chain are unstable, and there the capture process competes with the decay process, creating a split in the nucleosynthesis path. The nuclear properties of some of these radionuclides change with the conditions of the stellar environment, a fact that influences the local abundance pattern. 204Tl is a very interesting branching point, because it is shielded from any contribution from other nucleosynthesis processes. The result is that both 204Tl and its stable daughter isotope 204Pb are only produced by the s-process. Hence, by competing with the beta decay, the capture cross section of 204Tl crucially determines the final abundance of 204Pb. A faithful prediction of the solar abundances of s-only isotopes, like 204Pb, is one of the key accuracy tests for modern stellar nucleosynthesis calculations.

However, until the present work, due to the challenges of performing a capture measurement on 204Tl, there was no experimental data of its cross section. Thus, large uncertainties existed in its capture cross section, which hampered a more accurate and precise knowledge of the predicted s-process production of 204Pb.

By affecting the abundance of 204Pb, the cross section of 204Tl(n,γ) also influences the ratio of abundances 205Pb/204Pb. 205Pb is also produced only by the s-process, and it is radioactive, with a long half-life of 17.2 My. Therefore, the ratio of abundances of 205Pb/204Pb has the potential to be used as a chronometer of the s-process.

In the year 2013, a sample enriched up to a few percent in 204Tl was produced by neutron irradiation of a 203Tl seed sample at the high thermal neutron flux nuclear reactor of the ILL, in Grenoble (France). Two years later, the 204Tl enriched sample was employed to measure, for the first time, the capture cross section of 204Tl at the n_TOF time-of-flight facility at CERN. The measurement was possible thanks to the unique features of this facility, in particular, its high instantaneous neutron flux low background levels. The measurement was performed employing the well-established Pulse Height Weighting Technique (PHWT), which offers a very low neutron sensibility, and low levels of background, compared to other methods like the Total Absorption technique.

The main challenges for the 204Tl measurement were the very high background due to the activity of the sample, the very low amount of material, and the limited knowledge of the geometry of the sample. Such difficulties required the adoption of specific solutions during the measurement and the posterior or data analysis. Related to this, several sources of
systematic error were evaluated by means of Monte Carlo simulations.

The complications with the 204Tl sample geometry required to apply an in-sample normalization procedure. For this purpose, an ancillary capture measurement on a 203Tl sample was also performed in the same experimental campaign. As a stable nuclide, most of the sources of systematic error could be kept under control. This allowed an accurate R-matrix analysis of the most relevant capture levels in the resolved resonance region of 203Tl, including the first ever measurement under 3 keV of neutron energy. As a result, the present work has contributed, as well, to improve the 203Tl stellar capture cross section in the 8 to 25 keV neutron energy range.

With the improved 203Tl(n,γ) cross section, an R-matrix analysis of several 204Tl resonances was made possible. These results were employed to experimentally constrain the 204Tl stellar cross section at low energies, and setting additional limits to the stellar cross section predicted by nuclear data evaluations at s-process temperatures.

Highly detailed large-scale computational fluid dynamics allow resolving all the spatial and temporal scales of the flow, thanks to the use of massive computational resources. A highly parallel finite element code running on supercomputers can solve the transient incompressible Navier-Stokes equations on unstructured meshes. Given that the finest mesh contained 350 million elements, the study sets a precedent for large-scale simulations of the respiratory system, proposing an analysis strategy for mean flow, fluctuations, wall shear stresses, energy spectral and particle deposition on a rapid and short inhalation.

The thesis addresses a drug delivery study of nasal sprayed particle from commercial product in a human nasal cavity under different inhalation conditions; sniffing, constant flow rate and breath-hold. Particles were introduced into the flow field with initial spray conditions, including spray cone angle, insertion angle, and initial velocity. Since nasal spray atomizer design determines the particle conditions, fifteen particle size distributions were used, each defined by a log-normal distribution with a different volume mean diameter.

This thesis indicates the potential of large-scale simulations to further understanding of airway physiological mechanics, which is essential to guide clinical diagnosis; better understanding of the flow and delivery of therapeutic aerosols, which could be applied to improve diagnosis and treatment.

As we inhale, the air drawn through our nose undergoes successive accelerations and decelerations as it is turned, split, and recombined before splitting again at the end of the trachea as it enters the bronchi. Fully describing the dynamic behaviour of the airflow and how it transports inhaled particles poses a severe challenge to computational simulations. The dynamics of unsteady flow in the human large airways during a rapid and short inhalation (a so-called sniff) is a perfect example of perhaps the most complex and violent human inhalation inflow. Combining the flow solution with a Lagrangian computation reveals the effects of flow behaviour and airway geometry on the deposition of inhaled microparticles.

> The evaluation of the effects of correlations in quantum systems constitutes a laborious task since it is not possible to follow standard mean field approaches when solving the Schrödinger equation. This thesis presents two approaches to fulfill this goal: the development and application of quantum Monte Carlo methods and the realization of beyond mean field calculations following the Bogoliubov-de Gennes formalism. Regarding the first approach, we show how to modify the standard Diffusion Monte Carlo (DMC) algorithm such that it can sample SOC interactions. The thesis develops the formalism of two DMC methods suited to the simulation of SOC systems: the Discrete Spin T-moves DMC (DTD-MC) and the Spin-Integrated DMC (SIDMC). Since the ground state wave function of a SOC system is complex, these methods work under the fixed phase approximation, meaning that they can not provide exact ground state estimates. DTD-MC corresponds to an adaptation to discrete spin variables of a pre-existing SOC DMC algorithm. This method requires the definition of an effective Hamiltonian to cure a sign problem in the propagator, which worsens the quality of its estimations. On the other hand, SIDMC, a completely original method developed in this thesis, is able to bypass the definition of the effective Hamiltonian by propagating the spin-integrated wave function of the system in imaginary time. As a consequence, SIDMC yields physical estimates closer to their ground state values. However, the SIDMC...
method is unable to sample spin-dependent two-body interactions. Through the use of the DTDMC algorithm, we elaborate the extension to the correlated regime of the phase diagram of a many-body Raman SOC system with spin-dependent two-body interactions. The results show that correlations favor the exotic stripe phase, which features density modulations, meaning that the stripe region of the phase diagram is enlarged as the level of correlations is increased. The thesis also reports results for the pair-distribution function, the static structure factor, the one-body density matrix and the superfluidity of the system. The thesis shows that the superfluid fraction across the stripes is non-zero, meaning that the stripes are superfluid, a consistent result with previous mean-field calculations.

Regarding the second prescription to account for correlations in a SOC system, authors follow the Bogoliubov-de Gennes formalism in order to compute the first order correction by correlations to the mean field result. Authors compute the Lee-Huang-Yang (LHY) energy correction for a Raman SOC system in the stripe phase for the first time. As an application, we are able to determine the role played by quantum fluctuations in a Raman SOC system that is unstable at the mean field level due to attractive interactions. Such system is currently under experimental development. The results show that quantum fluctuations stabilize the collapse predicted by mean field theory, giving rise to a stabilized gas, or a stabilized liquid, depending on the values of the parameters of the Hamiltonian. Moreover, the finite system supports the existence of self-bound droplets as its ground state. These droplets show density modulations, induced by SOC. Therefore, they represent a novel state of matter in the field of ultracold atoms that combines the self-bound character of liquids, density modulations reminiscent of solids, and superfluidity. The thesis also provides a phenomenological analytical functional of the density in order to ease the evaluation of the LHY energy.

Finally, a brief analysis of a quantum many-body system that features Spin Orbital Angular Coupling (SOAC) reported perform DTDMC calculations in order to evaluate the impact of correlations in the system and show that the mean field and DTDMC predictions for the energy and spin polarization agree in the range of parameters considered, meaning that correlations are not very relevant.

Semiconductor lasers in high-power regime typically manifest a poor beam quality due to its asymmetric beam divergence and its large beam quality factor (M2). The emission along one of the transverse directions (slow axis) is typically multimode while being single mode in the perpendicular direction (fast axis). Due to the multimode emission and the absence of any intrinsic mode selection mechanism, the beam quality of broad area semiconductor (BAS) laser is degraded. In this work, the authors demonstrate that, by means of spatial filtering technique, the beam quality may be improved along the lateral direction (slow axis). For the filtering purpose, we propose the use of photonic crystal (PhC) as the spatial filtering element. The PhC offers an advantage in terms of its compact size, which allows miniaturization of the device. The successful implementation of this scheme could lead to monolithic integration, with the PhC directly integrated between the front facet of the semiconductor material and the laser cavity mirror. The PhCs were fabricated on N-BK7 glass substrate using tightly focused femtosecond Bessel beam. Two different PhC with different parameters were used in the experiment. The filtering of the PhC appears due to the deflection of selected components of the beam out of the propagation direction, using the Laue configuration. Since the PhC operates only in the near field plane, the access to this plane for the experimental testing of the idea introduces a technological difficulty in such small devices. The authors followed a simplified approach using an extended cavity configuration, which mimics the action of the compact cavity. The advantage of the extended cavity setup is that it allows testing different filtering geometries in the same setup. The extended cavity was built using AR coated single emitter BAS laser, fast axis collimator, a double 4f lens system, and an external mirror with reflectivity.
of 4%. This extended cavity allows implementing two different techniques, i.e. an intracavity slit and a photonic crystal in the same setup. The cavity was characterized by measuring the output power, beam quality factor (M2), spectrum, and near/far field laser profiles. Before testing the action of PhC, authors tested the conventional spatial filtering using intracavity slit placed in the far field and acting on the beam in the lateral direction by blocking the higher angular components of the beam. The output beam from the external cavity was characterized by measuring the M2 along the slow axis and calculating the brightness of the beam. Authors demonstrate an enhancement in the brightness by factor of two compared to the unfiltered beam situation. Authors further evaluated the effect of the reflectivity of the feedback mirror on the output power and spatial profile of the beam. The filtering action of the PhCs was characterized using the same extended cavity configuration. In this configuration an enhancement of the brightness by a factor between 1.3 and 1.5 was demonstrated for the different crystals. The experimental results obtained using intracavity slit and PhC were compared with the numerical results obtained from numerical model of broad area laser created to simulate the action of spatial filtering using either the intracavity slit or the PhC. Both results showed a good agreement between the experiments and the numerical results. The numerical code was used to further optimize the brightness enhancement by simulating different filtering geometries.

> Materials and methods used in the production of modernist (late 19th and early 20th century) stained glass from the city of Barcelona with special regards to the degradation mechanisms of enamels, grisailles and silver stains have been studied. Coloured enamels from the raw materials used in the Rigalt, Granell & cia modernist workshops from Barcelona were produced and compared to those found in the buildings and belonging to the private collection of J.M. Bonet workshop to explore the reason for the reduced stability of the blue and green enamels.

The chemical composition has been determined (and pigments identified) by means of Laser Ablation Inductively-Coupled Plasma Mass Spectrometry (LA-ICP-MS), X-Ray Diffraction (XRD) and UV-Vis-NIR spectroscopy, and the thermal properties of the enamels measured by Differential Scanning Calorimetry (DSC) and Hot Stage Microscopy (HSM). The enamels are made of a lead-zinc borosilicate glass characterised by its low softening temperatures maintaining a good stability against chemical corrosion, in particular to water corrosion. However, the relatively narrow range of firing temperatures necessary for correct adherence of the enamels to the contemporary glass base may have required the addition of a high lead borosilicate flux, which would have increased the lead content of the enamel, decreasing the firing temperature but also its stability.

The historical enamels show a lead, boron and zinc depleted hydrated silica rich amorphous glass, with precipitated lead and calcium sulphates or carbonates, characteristic of extensive atmospheric corrosion. The blue and green enamels show a heterogeneous layered microstructure more prone to degradation which is augmented by a greater heating and thermal stress affection produced by the enhanced infrared absorbance of blue tetrahedral cobalt colour centres and copper ions dissolved in the glass and, in particular, of the cobalt spinel particles.
> Neutrons play a fundamental role in fields so apparently different as nuclear reactors, or some nucleosynthesis processes. In both situations, matter is irradiated by a neutron field, so, the time evolution of nuclides is governed by a balance between neutron-induced reactions and decays of radionuclides.

Nowadays, it is accepted that elements heavier than Fe are produced by neutron induced stellar nucleosynthesis. Starting from Fe, a chain of n-capture reactions followed by β decays processes are thought to account for most of the isotopic-abundances in the universe.

There are two main scenarios in stellar nucleosynthesis, namely s-process (slow) and r-process (rapid). The main difference among them is the neutron-density per unit time available. In the r-process, a large neutron-density per unit time, allows for multiple capture reactions to take place before a decay occurs, therefore far-from-stability neutron-rich radionuclides are formed. On the contrary, the s-process tend to proceed through close-to-stability radionuclides.

Therefore, to study nucleosynthesis or nuclear reactors, one would need to know the neutron-capture cross-sections –σ– and decay probabilities, among other magnitudes.

Our group have been leading several measurements of cross-sections and decay constants, carried out at international facilities. Each experiment needed the development of specific detector systems. As a consequence, we have been able to invent cutting-edge detection system for practical applications. As examples of our activities, In the next sections, you will find one recent experiment and the design of an advanced neutron dosimeter.

**Beta delayed neutron probabilities (Pn) relevant to the rare-earth r-process peak (REP).** The contribution of the r-process to the abundances is, usually, obtained by subtracting the prediction of the model for s-process (considered as well established) from the experimental measurements. That makes the abundance peaks due to, mainly, r-process –A~130, 160 and 195–, so interesting. These peaks help to improve the understanding of the r-process. Pn measurements are carried out by implanting exotic nuclide of interest into an active target, and then measuring the rate of neutron-emissions.

The measurement of isotopes near the REP –(A~160)– has been performed from 2018 to 2021. Radionuclides were produced by fission of a U-238 beam –345 MeV– impinging on a Be-9 target, using the RIBF-accelerator and BigRIPS, both at RIKEN (National Institute of Physical and Chemical Research, Wako, Saitama, Japón).

Data analysis is very complex. Radionuclides need to be identified in flight using BigRIPS, β decays need to be measured in the active target, and neutrons are counted in the n-detector. All these processes have to be time-correlated, background events need to be removed… until life-times and Pn could be determined for each isotope of interest. The analysis is underway. There are a tenth of new life-times and Pn values expected to be determine for the first time.

To perform this experiment, the BRIKEN (Figure 1) neutron detector was designed and built. It consists of a polyethylene block with a beam hole in the center, and several rings made of a total of 148 He-3 counters. So far, this is the most advanced BEta deLayEd Neutron (BELEN) Detector in the world.

**Neutron dosimeters**

If present, neutrons tend to dominate the radiological doses in a site. Therefore, detection of neutrons, is an important radiological protection issue in areas such as radiotherapy, nuclear power plants...

However, commercial neutron dosimeters, in pulsed fields, or in transient situations in continuous fields, present serious drawbacks. These limitations can be overcome through the use of a digital data-acquisition system, like that used with BELEN. Another issue with neutron dosimeters is their heavy weight due to the "jacket" of the moderator-converter. An optimized design with Monte Carlo simulation codes can improve that aspect.

During 2018-2020, four prototypes of low-weight neutron dosimeters have been devised, built and tested. Their correct responses to intense pulsed beams were verified at CERN n_TOF facility (neutron Time Of Flight facility, Geneva, Switzerland). In addition, they have been tested in a experimental nuclear...
Before I came here, I was confused about this subject. Having listened to your lecture, I am still confused but on a higher level.”

Enrico Fermi
Last November, the department carried out the first Best Research Poster Awards where graduate students presented their research in a poster format together with a short video explaining the poster and the research behind it. Students submitted 14 posters of very high quality. The research committee of the department selected three prizes of 500 €.

The students awarded were:
1. Araceli Aznar
2. David Roca
3. Gerard Pascual

We reproduce here their posters in small format. You can see the full poster and the explanatory video here: https://fisica.upc.edu/en/research/posters-awards

Winners of the price: "Convocatòria 2021 d’ajuts a la formació per estudiants del Màster en Enginyeria Física de la Universitat Politècnica de Catalunya-BarcelonaTech".
The three prices of 1000 € each were awarded to the following students and their corresponding Master’s Final Project (TFM)

1. Mateo Alonso, TFM: "Development of a cardiac model for the study of sudden cardiac death in infants"

2. Jon Gari, TFM: "Restricted Boltzmann Machine learning though RAPID equations"

3. Eva Rifà, TFM: "Study of the evolution of new variants during a epidemic"