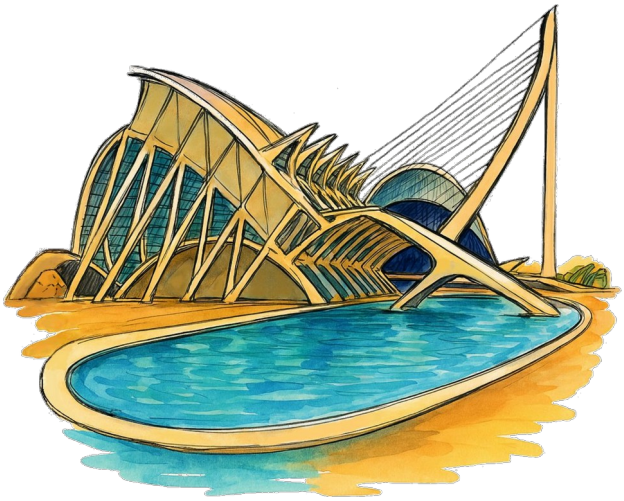
Eighth Physics Erasmus Summer School

Looking Up, Looking Down

Book of abstracts and practical information



September 7th-11th, 2026

Facultat de Física, Universitat de València

ERASMUS+ BIP
Programme 2025/26

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VNIVERSITAT DE VALÈNCIA

Facultat de Física

forthem. Fostering Outreach within European Regions, Transnational Higher Education and Mobility

R.S.E.F.

Università degli Studi di Palermo

Johannes Gutenberg Universität Mainz

Jyväskylän yliopisto

Latvijas Universitāte

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	15:55 - ... Ice - Breaking Games	**17:30 - 19:00 Workshop on data analysis (elective activity)** - Hunting Exoplanets - Eyes in the Sky: Mapping wildfires with satellites	**19:00 - 20:00** Planetarium Session at the Hemisfèric (Ciutat de les Ciències)	**17:10 - ...** Photo - Gymkhana around Valencia	**Afternoon on the beach (optional and recommended)**

Legend	*Astronomy & Astrophysics*	*Earth Physics & Thermodynamics*	*Multidisciplinary & cross-cutting topics*	*Participants talks*	*Activities*

*Online

Note that the vertical size of the boxes is not always related to their duration, nor are the boxes of different days always synchronized. The detailed start and end times are explicitly written inside each box.

2 School venue

The Campus of Science is located at Av. Vicent Andrés Estellés 19, 46100 Burjassot. There are three ways to arrive from afar:

1. By car. There is a free parking lot south of the Campus.
2. By tram. Line 4 → Vicent Andrés Estellés station. Underground connection at Benimaclet and Empalme.
3. By bus. EMT, line 63 → Campus de Burjassot station.

3 Invited speakers' talks

Monday, 7th September

The stormy Sun: the foundations of space weather

Fabio Reale, Università degli Studi di Palermo

Space weather originates from the restless magnetic activity of the Sun and affects the near-Earth environment, satellites, communication systems, navigation, power grids, and human activities in space. This lecture introduces the foundations of space weather by exploring how solar activity is observed, interpreted, and connected to its effects on Earth.

Starting from sunspots and the historical Carrington event of 1859, the lecture traces the chain of physical processes that links magnetic fields in the solar atmosphere to flares, coronal eruptions, energetic radiation, geomagnetic storms, and auroral displays. Particular attention is given to the role of the solar corona, multi-wavelength observations, magnetic energy storage and release, and the Sun–Earth magnetic interaction.

The lecture combines historical examples, modern solar images, and basic physical concepts to provide an accessible introduction to why the Sun can be "stormy" and why understanding its variability is essential for modern technological society.

Geo-neutrinos: a new tool to study the Earth

Livia Ludhova, GSI Helmholtz Centre for Heavy Ion Research GmbH (Darmstadt, Germany) & Johannes Gutenberg - Universität Mainz

Geoneutrinos are tiny particles produced by the radioactive decay of elements such as uranium and thorium inside the Earth. Although they interact only very weakly with matter, modern particle detectors are now able to measure them, opening a unique window into the deep interior of our planet — a region from which no direct rock samples exist. Their study connects particle physics, astrophysics, and geoscience, and can help answer important questions about the Earth's origin, composition, and internal heat production.

The first detections of geoneutrinos were achieved by the KamLAND experiment in Japan and the Borexino experiment in Italy using large underground liquid scintillator detectors. More recently, the SNO+ experiment in Canada also reported evidence for geoneutrinos. These measurements have already provided important constraints on geological models of the Earth, while also demonstrating the challenges of detecting extremely rare signals in the presence of back-

grounds such as reactor antineutrinos and cosmic rays.

A major new step in the field is the JUNO experiment in China, one of the largest neutrino detectors ever built. JUNO started data taking in August 2025, and after the first oscillation physics results released in November 2025, first geoneutrino results may follow in the near future. Thanks to its enormous size and excellent energy resolution, JUNO is expected to collect geoneutrino data at an unprecedented rate, potentially doubling the existing worldwide statistics within little more than a year of operation.

This lecture will introduce the basic physics of neutrinos and geoneutrinos, explain how these elusive particles can be detected, and show how particle physics experiments can help us understand the Earth's interior. The talk will also provide an overview of current experiments and discuss future prospects for this rapidly developing interdisciplinary field.

Inside AEMET: forecasting heavy rain and flood risk

Violeta Matos, Agencia Estatal de Meteorología (AEMET)

Extreme precipitation and violent storms pose a growing threat to public safety, requiring faster, more precise warning systems. This presentation provides an inside look at a large-scale European project bringing together national meteorological services, civil protection agencies, and research centers.

The primary objective of this initiative is to anticipate the direct impacts of severe storms and flooding, enhancing early warning systems across the region. By shifting the focus from standard weather parameters to actionable, impact-based forecasting, the project bridges high-resolution meteorological models with real-time risk assessment—equipping decision-makers and emergency responders with the critical insights needed to protect communities and save lives.

Transforming agriculture: remore sensing for sustainable management

Belén Franch, Universitat de València

Remote sensing is transforming agriculture by enabling crop conditions to be monitored consistently across large areas and throughout the growing season. Satellite observations can support crop mapping, stress detection, irrigation and nutrient management, yield forecasting, and early warning of production risks. These technologies can improve resource efficiency, reduce environmental impacts and strengthen decision-making from farm to policy level.

However, operational use requires more than accurate-looking maps. Agricultural signals are influenced by crop structure, spatial resolution, observation geometry and environmental conditions, and models may not always transfer reliably across regions or seasons. Progress therefore depends on combining Earth Observation with field measurements, physical understanding and transparent uncertainty assessment. The future of agricultural monitoring lies not only in generating more predictions, but in delivering timely, interpretable and trustworthy information that supports sustainable management and climate resilience.

Tuesday, 8th September

Sub-Neptunes, the most common type of planet in the Galaxy... and the most habitable?

Rafael Luque, Instituto de Astrofísica de Andalucía

Sub-Neptunes (planets between the size of Earth and Neptune) are the most abundant type of planet in the Galaxy, but they do not exist in our Solar System. In this talk, I will present how we detect them and what we have learned about their formation and diversity from demographic studies and the discovery of individual systems with unique properties. Beyond their seemingly inhospitable nature, I will discuss whether these planets could harbor conditions favorable for life, from temperate atmospheres to water-rich interiors. This is an open question that could change forever our understanding of habitability in the universe.

What happens inside stars?

Tuomas Grahn, Jyväskylän yliopisto

Laws of thermodynamics play important role also in astrophysics. Chemical elements up to iron are formed in nuclear fusion process since such reactions are energetically favourable. In order to fusion to proceed, the participating nuclei must have enough thermal energy to overcome the repulsing Coulomb force. Thermal energy is distributed according to Maxwell-Boltzmann distribution between the constituent particles. Occasionally, such energy is high enough for the fusion to proceed. This temperature range defines the so-called Gamow window, in which fusion can occur. In this talk I will present the foundations of the stellar nucleosynthesis that proceeds via fusion reactions up to the iron nuclei within stars.

Thermoacoustics - key to space and energy harvesting technologies

Arturs Brekis, Latvijas Universitāte

This lecture explores advanced magnetohydrodynamic (MHD) technology for direct electrical power generation, with emphasis on systems coupled with thermoacoustic energy conversion. The combination of conductive fluid flows, acous-

tic oscillations, and magnetic fields offers promising possibilities for compact, reliable, and mechanically simple power systems with minimal moving parts or no moving parts at all. Applications relevant to long-duration Deep Space missions, where robustness and efficiency are critical, will be discussed alongside potential terrestrial energy solutions utilizing waste heat and renewable thermal sources.

Sustainability and the terminal crisis of capitalism

Antonio Turiel, Institut de Ciències del Mar - CSIC

We are entering a new era of conflict for the last resources while simultaneously dealing with an environmental disaster. Those two problems are a consequence of the need of growth of our economic system. Capitalism is an ever-expanding system and cannot be otherwise, what conditions the kind of energy transition we are trying. In this talk, we will discuss on the roots of our predicament and review the scientific evidence of the insustainability of capitalism, and how we can go beyond its limits and propose a real sustainable society

A journey through the Universe: expansion and cosmological models

Tiziana Di Salvo, Università degli Studi di Palermo

How did the Universe begin, and what is its ultimate fate? This talk offers a journey through the fundamental concepts of modern cosmology, starting from the groundbreaking discovery that our Universe is expanding. We will move beyond the big picture to explore the "ingredients" that make up the cosmos—from the visible matter we see to the mysterious Dark Matter and Dark Energy that drive its acceleration. By comparing different cosmological models, we will see how the Universe evolved from a hot, dense soup of particles into the vast web of galaxies we observe today.

Round Table: Science and Education in the Question of Palestine and Global Human Rights: Impact and Responsibilities

In April 2024 university students around the world participated in protest encampments in solidarity with the Palestinians of Gaza. Their demands were that universities call to end the genocide and divest from institutions and companies complicit in Israel's actions. In times of political uncertainty and violence, univer-

sities have a crucial role to play as moral compasses for society. Are they fulfilling that role?

This roundtable will examine the impact of the current and historical situation in Palestine on the academic community and discuss the ethical responsibilities of academics, researchers, and students in responding to these realities. The discussion will be organised into four thematic blocks: (1) the historical roots of the colonisation of Palestine; (2) Palestinian universities and *scholasticide*; (3) ethics in science and technology; and (4) resistance and activism.

The panel will bring together representatives from Comunitat Palestina, Red Universitaria por Palestina, Voces x Palestina, BDS, and Assemblea d'Estudiants per Palestina UV.

Wednesday, 9th September

Harnessing the Potential of Remote Sensing for Forest Fire Management

Patricia Oliva, Universidad de Alcalá

Wildfires are unplanned and uncontrolled vegetation fires that can damage social, economic, and environmental assets, requiring management responses. Their occurrence is influenced by human-related factors such as population density, reduced forest management, or the expansion of the wildland-urban interface. At the same time, anthropogenic climate change is increasing the frequency and duration of conditions favourable to fire activity, including longer droughts and more frequent heat waves. Consequently, wildfire activity has intensified in recent years, leading to an increase in megafires and record-breaking fire seasons. Remote sensing provides essential information on vegetation moisture content, fuel types and loads, fire occurrence, burned area and burn severity assessment, and forest recovery. This talk will explore how remote sensing technologies are used to generate and deliver this information to support fire prevention, forest management, and post-fire recovery monitoring.

Planetary atmospheres: insights from Earth

Philipp Reutter, Johannes Gutenberg - Universität Mainz

Earth is our best-observed atmosphere and the natural reference for worlds we can barely reach. Starting from the shared physics, this session compares Earth with other planets. As one example, we look at ice-supersaturated regions: on Earth they shape cirrus clouds and the tropopause, on Mars they play an important role for clouds and water transport in a thin, cold atmosphere.

The Hoyle state and the cosmic origin of life

Panu Ruotsalainen, Jyväskylän yliopisto

One of the essential ingredients of life is carbon, and most of it exists as 12C. But how is this nucleus formed in stars? In this lecture, I will introduce a very important excited state of the 12C nucleus, known as the Hoyle state. This special state enables the formation of 12C through the fusion of three alpha particles in stellar interiors, making the production of carbon in the universe possible. The

existence of this sate was predicted by Fred Hoyle in 1954 and later confirmed experimentally, hence the name " the Hoyle state".

The rent crisis strikes again: galaxies and their landlords

Elena González, Universitat de València

In the current understanding of the Universe, 80% of the matter content is dark matter. Ever since the Big Bang, initially tiny overdensities have grown under the weight of gravity to form larger structures and the large-scale structure of the Universe. Dark matter halos are the basic units of this structure and they are assumed to contain the whole matter content of the Universe.

In this context, galaxies form and evolve inside halos and they naturally develop a close connection with them. This galaxy-halo connection is a complex relationship between the properties of galaxies and halos that can inform about the physics of galaxy formation, clustering and cosmology. However, far from fully understood, there are still several open questions about this relationship, increasing the complexity and the need of further studies. We will review what information we can obtain from the galaxy-halo connection and which remaining mysteries are still resisting to be solved.

The reinvention of Science: from invoking invisible entities to the dinosaur extinction debate

Vicent J. Martínez, Universitat de València

In this talk, one of the authors of The Reinvention of Science: Slaying the Dragons of Dogma and Ignorance explores how science has often relied on postulated but invisible entities to explain observations. Historical examples include phlogiston, the luminiferous ether, the homunculus, and the crystalline spheres. Some of these entities hindered scientific progress, while others were later confirmed.

The second part examines a paradigm shift that is still unfolding regarding the mass extinction at the end of the Cretaceous Period, 66 million years ago. The dominant view attributes the extinction of the dinosaurs to an asteroid impact in the Yucatán Peninsula, a conclusion widely accepted in both science and popular culture. However, research led by Princeton paleontologist Gerta Keller suggests that intense volcanism in the Deccan Traps of India began at least 400,000 years before the impact and had already triggered a widespread ecological decline.

Thursday, 10th September

Gravitational waves: A decade of exploring the Universe

Alicia Sintes, Universitat de les Illes Balears

On September 14, 2015, the first direct detection of gravitational waves revolutionized our understanding of the Universe. By November 2025, the LIGO–Virgo–KAGRA (LVK) collaboration completed its fourth observing run, marking a decade of discovery. This talk reviews the major scientific achievements of this era, including the characterization of hundreds of mergers involving black holes and neutron stars. These observations have provided profound insights into astrophysics, fundamental physics, and cosmology, bolstered by multi-messenger astronomy and improved detector sensitivity.

As gravitational-wave astronomy enters its second decade, new challenges emerge: probing compact object evolution across cosmic time, searching for continuous or stochastic signals, and testing gravity in extreme regimes. These milestones have transformed the field from an experimental pursuit into a mature observational science. Looking ahead, the groundwork is laid for next-generation observatories like the Einstein Telescope and Cosmic Explorer to further explore the dynamic Universe.

How do we simulate a black hole merger?

Inês Rainho, Universitat de València

We cannot travel to a black hole or recreate one in a laboratory, yet we can predict in remarkable detail what happens when two black holes merge. How is this possible? The answer lies in numerical relativity, a field that combines Einstein's theory of gravity with high-performance computing. This talk will introduce the challenges of solving Einstein's equations, explain how physicists simulate compact binary mergers on supercomputers, and show how these simulations help us interpret gravitational-wave observations.

The future of computers: taking inspiration from the brain

Sergio Portillo, Universitat de València

Artificial Intelligence (AI) has become an extremely powerful tool in modern society, in particular in science and technology. However, actual computers require a

lot of energy to train and run increasingly complex AI models. This growing demand has motivated the exploration of a new generation of computers taking inspiration from the most energy-efficient information-processor we know: the human brain. The field of neuromorphic computing aims to mimic the way the brain process and stores information using emerging devices such as nanofluidic memristors to artificially replicate the properties of the biological connection between neurons, the synapses. The unique characteristics of memristors make them an ideal building block to a new generation of brain-inspired computers to overcome the actual energy limitations.

Coriolis force: what it does and what it doesn't do

Jonathan Bustos, Universitat de València

Whenever you read something about the Coriolis force, take it with a pinch of salt and don't believe everything they tell you. In this talk, we'll see some of the myths and legends surrounding this force.

Friday, 11th September

Human-induced climate change amplification on storm dynamics in Valencia's 2024 catastrophic flash flood

Juan J. González-Alemán, Agencia Estatal de Meteorología (AEMET)

Global warming alters the hydrological cycle, increasing heavy rainfall events worldwide. In October 2024, Valencia (Spain) experienced rainfall accumulations in a few hours surpassing annual averages (771.8 mm in 16 h in the official weather station at Turís) and breaking the record for one hour rainfall accumulation in Spain (184.6 mm), resulting in 230 fatalities.

Here, we present a physical-based attribution study employing a km-scale pseudo-global warming storyline approach to assess the contribution of anthropogenic climate change. We show that present-day conditions led to a 20% $^{\circ}C^{1}$ increase in 1-hour rainfall intensity, exceeding Clausius-Clapeyron scaling. This intensification was driven by enhanced atmospheric moisture from warmer sea surface temperatures, leading to increased convective available potential energy, stronger updrafts, and microphysical changes including elevated graupel concentrations. These results demonstrate that anthropogenic climate change could intensify the occurrence of flash-floods in the Western Mediterranean region: in this particular case, it intensified the 6-h rainfall rate by 21%, amplified the area with total rainfall above 180 mm by 55%, and increased the volume of total rain within the Jucar River catchment by 19% compared to the pre-industrial era.

This study highlights the urgent need for effective adaptation strategies and improved urban planning to reduce the growing risks of hydrometeorological extremes in a rapidly warming world.

Aberrometry and wavefront correction in Astronomy

Varis Karitans, Latvijas Universitāte

Adaptive optics is an advanced optical technology used to correct the wavefront distortions caused by turbulent optical media. Basically speaking, the core components of adaptive optics is a wavefront sensor and a wavefront corrector. The most popular types of wavefront sensors and wavefront correctors used in astronomical adaptive optics will be reviewed in the presentation.

Various configurations of adaptive optics systems will be covered. Light sources used as the reference sources and the cone problem will be addressed. The presentation will also discuss various metrics and parameters used in astronomi-

cal adaptive optics to characterize the wavefront to be measured and the performance of adaptive optics.

The presentation will also discuss some practical experiments. These experiments involve all steps starting from selecting the objects to be measured, building the optical system, and carrying out the measurements. Practical measurements obtained with Alpao adaptive optics systems will be presented.

The harvest was written in the sky: remote sensing from crop monitoring and yield prediction

Italo Moletto-Lobos, Universitat de València

Phenology and crop mapping are two pillars that, combined with remote sensing, enable agricultural yield monitoring. Phenology, tracks the temporal evolution of these vegetation indices throughout the growing cycle, detecting key stages such as emergence, flowering, maturity, and senescence. Crop mapping in turn, uses satellite imagery and classification based on satellite signal to identify what is grown and where, delineating the area covered by each crop type. These time series isolate the vegetation signal and the duration of each phase, factors directly linked to biomass accumulation. By integrating the precise location of each crop with phenological metrics, seasonal integral of the vegetation index, cycle length and environmental variables, empirical models can estimate yield before harvest. In this way, remote sensing translates spectral and temporal patterns into spatially explicit productivity predictions, supporting agronomic decisions and food security.

AGN jets: How Black Holes shape their galaxies

Kiara Hervella, Universitat de València

The observed galaxies in the Universe present a wide range of masses, shapes, and star formation activity. However, the first cosmological models lead to cooler and more massive galaxies than the ones we observe. The missing mechanism behind this mismatch was one of the most extreme objects in nature: supermassive black holes. Although black holes are famous for accretting matter from their surroundings, they can also release enormous amounts of energy through powerful jets that extend far beyond their host galaxies.

In this talk, we will explore how astronomers discovered that galaxies cannot be understood without these energetic phenomena. Starting from the observable Universe and the theories of galaxy formation and evolution, we will see

how black hole activity can heat their surroundings and suppress the birth of new stars, shaping the evolution of galaxies across cosmic time.

Beyond invention: How societies shape(d) technology

Pedro Ruiz-Castell, Universitat de València

This talk explores the history of technology through a series of emblematic objects, revealing how innovation is never purely technical. Rather than viewing technology as the simple application of scientific knowledge, the lecture highlights the social, cultural, political, and economic forces that determine which inventions succeed and which do not. By examining these objects in their historical contexts, we uncover how human values, power structures, and cultural meanings have shaped technological development across time. Ultimately, the talk invites the audience to rethink innovation as a deeply human process—one that reflects not only ingenuity, but also inequality, belief systems, and collective choices.

4 Participants talks

Where have the stars vanished? Spatial analysis of light pollution in Timisoara

Evelyn-Boglarka Berta, Universitatea de Vest din Timișoara

Light pollution can cause serious health issues and ecological problems. As more specialists are working to find solutions, it is clear that, in the near future, illumination will be seriously regulated. It is crucial not only to make the issue better known, but also to develop a reliable measurement method that can be easily implemented.

The goal of my research is to map out light pollution levels in Timisoara at different times, thus taking into consideration constant pollution and early-night brightness. To create intuitively interpretable measurements, I developed a new method that involves gathering data with a calibrated digital camera by photographing the starry sky, then using a Python program to process and overlay the data onto the city map.

The results show that the entire city's population is exposed to serious light pollution. For residents living in the central area or next to main roads, light pollution can be considered a health hazard.

Triangulations and the Art Gallery Problem

Alejandro Córdoba Ruiz, Universidad de Zaragoza

The Art Gallery Problem, proposed by Victor Klee, is a fundamental problem in computational geometry with applications to spatial coverage, sensor placement, surveillance, data acquisition, and computer vision. We present Steve Fisk's simple and elegant proof, based on polygon triangulation and a three-colouring argument. This approach illustrates how geometric and combinatorial ideas can be combined to solve a practical visibility problem.

Who's causing climate change and why we are the main suspects

Marc Girona Pla, Universitat de València

Climate change has been occurring for millions of years due to variations in solar activity, volcanic eruptions, and changes in atmospheric composition. However, over the last 150 years we have observed a sharp increase in global temperatures, shifts in precipitation patterns, melting glaciers, and the desertification of major subtropical regions. These changes appear to be driven by the significant

greenhouse gas emissions produced by humans since the Second Industrial Revolution.

Since atmospheric physics is a complex field that requires thorough examination of all contributing factors to fully understand current observations and making future projections, this talk aims to analyse point-by-point the net contribution of each element to climate change in order to determine whether human-induced climate change is indeed the principal cause of current global warming.

The Myth of "Try-All-Paths": Understanding Quantum Interference

Mykhailo Hryho, High School Senior Student

1. Context Popular literature frequently mischaracterizes quantum computers as magical parallel machines capable of testing every possible solution simultaneously.

2. The Problem This naive "try-all-paths" narrative fundamentally misrepresents the underlying physics and computer science. It fails to explain why a raw superposition yields nothing more than uniform randomness upon measurement, leaving students without a true understanding of quantum acceleration.

3. Methods This presentation bridges this gap by dismantling the parallelism myth through the lens of elementary linear algebra. We explicitly contrast classical real-valued probabilities with quantum complex amplitudes that allow the interference to occur.

4. Results and Conclusion We show that the true power of quantum algorithms lies in the deliberate orchestration of quantum interference—forcing incorrect computational paths to destructively cancel out while constructively amplifying the correct solution. Ultimately, this talk equips the audience with a rigorous, conceptually accurate mental framework, proving that quantum computing is not an optimization of classical brute-force, but an entirely new paradigm of mathematical manipulation.

MESE (Motor Elèctric amb Sincronisme Estroboscòpic)

Eduardo Josias Melgar Molina & Josep Muñoz Torregrosa, High School Senior Students

This project shows the potential of reuse and sustainable innovation, thereby promoting a circular economy with educational applications in the academic field.

This work is based on the construction of an electric motor by modifying a three-phase alternator recovered from a car affected by the DANA. The first objective for the motor was to achieve magnetic levitation, but this was not possible as it lacked sufficient speed in relation to the diameter of the magnets; therefore, we had to pivot to a different objective. Consequently, we designed and built two electronic circuits, using them to perform a series of studies and analyses centered around motor synchronism and stroboscopy. In the same way, we also studied its asynchronism, which, if achieved, could explain the April 2025 Black-out and even predict similar cases in the future.

Physics of banner cloud formation

Peer Schierer, Johannes Gutenberg-Universität Mainz

Banner clouds are persistent cloud plumes forming exclusively on the leeward side of steep mountains, like the Matterhorn, even on otherwise cloud-free days. Because clouds typically form on the windward side, their counter-intuitive presence has been debated for over a century. Three main historical hypotheses attempt to explain them: adiabatic cooling via the Bernoulli effect, the mixing of distinct air masses, and forced uplift within a lee vortex. Within the last years, using numerical simulations, the atmospheric physics of banner cloud formation have been reviewed and quantified, such that it is clear today that the main effect of banner cloud formation is lee vortex uplift. While turbulent mixing can have a small but nonnegligible impact on modifying existing clouds, the Bernoulli effect was found to be practically irrelevant.

Will Quantum Computers Change Internet Security?

João Pedro Yin, High School Senior Student

Quantum computing has advanced rapidly in recent years, with many world's leading technology companies investing in this field. And here comes the question: will quantum computers change the way we ensure information on Internet? Long story short, it will not do it immediately. So, to understand why, in this presentation we will discuss the fundamentals of quantum computing, then explore its main applications, and, especially, how it may change the Internet, breaking many of today's encryption methods, such as the RSA, while also enabling new approaches to secure communications.

5 Participants posters

Physics in agriculture: Using radiation for soil monitoring

Albert Català Escamilla, Universitat de València

An essential part of modern agriculture and sustainable land management is soil monitoring, allowing for a more efficient use of resources. Modern physics provides powerful non-invasive techniques that use radiation to estimate properties such as erosion rates, soil distribution and humidity. This poster presents two complementary methods witch utilize both naturally occurring and man-made radiation as a basis for their measurements. Gamma-ray detectors exploit emissions from radionuclides such as ^{137}Cs, deposited worldwide during atmospheric nuclear testing, whose distribution in soil acts as a tracer for erosion. On the other hand, Cosmic-Ray Neutron Sensing (CRNS), uses neutrons produced by cosmic rays interacting with the atmosphere and surface water, allowing for a continuous estimation of soil moisture. Thus, this poster offers a broad view on how these radiation-based measurement techniques are being used to improve agricultural practices.

Physics Meets Cryptography: Electromagnetic Side-Channel Attacks

Borja Cervera Villora, Universitat de València

Cryptographic algorithms are designed to be theoretically uncrackable, though their physical implementations on microchips are still bound by the laws of nature and electromagnetism. While processing efforts are taking place, the currents in transistors generate specific electromagnetic emissions. This poster explores how these physical mechanisms can be exploited to bypass digital security without cracking the highly complex math behind it. With the help of an EM probe and an oscilloscope, it's possible to capture emissions from a microcontroller executing the standard AES-128 algorithm. By analyzing these emissions based on the Pearson correlation coefficient, the secret cryptographic key may be isolated. It's proof of how digital security can be threatened by its own hardware realities, highlighting the vital role of physical countermeasures like electromagnetic shielding in the cybersecurity landscape.

The physics of Doppler ultrasound in medical imaging

Asier Godino Duro, Universitat de València

When people think about the Doppler effect, the first thing that usually comes to mind is the change in pitch of a passing siren. However, this phenomenon extends far beyond sound. It can also be used to explain the redshift and blueshift observed in light from galaxies, and forms the basis of several non-invasive medical techniques, such as Doppler ultrasound. This poster explores the role of the Doppler effect in medical physics and the physical principles that make Doppler ultrasound possible. The aim is to demonstrate the versatility of this phenomenon and show how fundamental physics concepts have enabled the development of non-invasive technologies that have transformed modern medicine.

Physics at 300 km/h: Fluid Dynamics and Ground Effect in Modern Formula 1

David Gozalo Leal, Universitat de València

This poster analyzes the fluid dynamics of the "ground effect" reintroduced in Formula 1 (2022–2025) to reduce turbulent wakes and enable overtaking. By sculpting the underfloor into an inverted wing, modern single-seaters generate up to 60% of their total aerodynamic downforce. The physical mechanism functions as a large-scale Venturi tube, governed by the Continuity Equation and Bernoulli's Principle. As air accelerates through the chassis's narrowest point, a significant drop in static pressure creates a low-pressure zone that sucks the vehicle toward the track. Additionally, the study addresses "porpoising," a violent harmonic oscillation driven by aerodynamic stall. This occurs when extreme downforce chokes the underfloor airflow, causing the suspension to rebound and cycle rapidly, compromising stability and safety. Computational Fluid Dynamics (CFD) visualizations confirm that managing these pressure extremes is crucial for optimizing downforce.

Radiation Biology

Tim Hayer, Johannes Gutenberg-Universität Mainz

The poster gives an inside of radiation used in medicine. It shows some motivation and possible use of radiation as well as some physical basics for radiation. The effects of radiation when hitting a cell are shown from different perspectives (physical, chemical and biological). A model used to analyse how radiation dam-

ages cells and how this can be used and improved to guarantee a successful radiation therapy is a part of the poster. Especially the linear quadratic model of the survival fraction and the therapeutic window which shows the dose where Tumour cells are killed effectively without causing too much harm to the normal tissue are in focus since they perfectly show the connection between physics, the calculation made and the real possible application in therapy. The method of fraction and how it effects the therapeutic window are explained.

The Doppler Notch: How Geometry and Physics Can Make a Fighter Jet Invisible

Sanni Hiekkanen, Jyväskylän yliopisto

Modern fighter jets utilize Pulse-Doppler radar to track and detect targets against the Earth's surface by filtering out stationary ground clutter. This way, the radar tracks only frequency-shifted returns. This dependence on the Doppler effect raises one critical problem: the Doppler notch. In this poster, we examine the physics and geometry underlying the notch manoeuvre. This tactical flight profile involves the pilot flying exactly perpendicular (90°) to the enemy's radar beam. Doing so, they reduce their relative radial velocity to zero and, as a result, the target's radar return exhibits no Doppler shift. Consequently, the tracking radar misidentifies the aircraft as stationary terrain and filters it out. We examine the mathematical principles behind this blind zone and explain how modern digital signal processing (DSP) and pulse repetition frequency scheduling are developed to counter this exploitation of basic wave physics.

Positron emission tomography (PET)

Moritz Kolter, Johannes Gutenberg-Universität Mainz

Positron emission tomography (PET) is an imaging technique which utilizes the beta+-decay. A pharmaceutical which is traced with beta+-radiators (such as 18F-flourode-oxyglucose) is injected into the patient. Due to different metabolism behaviours in different tissues, the pharmaceutical gathers more at different places. Cancer cells for example have an increased glucose metabolism. Hence, determining the place of the beta+-annihilation is equivalent to determining the place of the cancer cells. The beta+-decay then emits a positron which annihilates with an electron and emits 2 gamma-rays. Because of momentum conservation the gamma-rays have exactly opposing direction. This is taken advantage of with a ring of crystal scintillators with photomultipliers around them to determine the

place of annihilation. Two detectors detect the incoming gamma-rays and they are checked on coincidence. If the gamma-rays are coinciding, a line of response between the two detectors is drawn and the place of annihilation can be determined.

Gravitational waves, the new messenger of the universe

Alicia Lafuente González, Universitat de València

Gravitational waves, predicted in 1916 by Albert Einstein's theory of General Relativity, had long remained undetectable to us, until 2016, when the LIGO and Virgo observatories were able to detect this distortion of space-time caused by supermassive astrophysical events. Today, we are able to obtain a great deal of information about these events by analysing these oscillations. However, this requires solving complex calculations, which are sometimes non-analytical. To avoid this, we will carry out an analysis using classical physics of the collision between two black holes, which will allow us to obtain information such as their mass, distance, Schwarzschild radius, radiated energy, etc. This is intended to be an order-of-magnitude approximation and will give us an idea of the scale of these events.

Computed tomography

Emely Lehner, Johannes Gutenberg-Universität Mainz

Computed tomography (CT) combines the physics of X-ray generation and attenuation with mathematical image reconstruction to obtain cross-sectional images of the human body. This poster explains the physical principles underlying CT, including X-ray attenuation described by the Lambert–Beer law, data acquisition, and the function of the main hardware components such as the X-ray tube, filters, anti-scatter grid, and detector. It also illustrates the relationship between tube current, radiation dose, and image quality, highlighting one of the central challenges in CT imaging. Finally, the reconstruction process is outlined, from projection measurements and sinogram formation to filtered back projection. Together, these concepts demonstrate how physical measurements are converted into diagnostic images.

ER = EPR: Are Wormholes Hidden in Quantum Entanglement?

Mario Linares Mas, Universitat de València

General relativity and quantum mechanics are the two main theories that we use to describe our universe. Over the course of history, theoretical physicists have tried to unify these two theories. Still, they seem fundamentally different and difficult to reconcile.

However, in 2013, Juan Maldacena and Leonard Susskind proposed a conjecture called "ER = EPR", which suggests that Einstein-Rosen bridges (wormholes) and quantum entanglement could actually be two different ways of describing the same phenomenon. This idea has not been experimentally verified, but has become one of the most influential proposals in modern theoretical physics.

If it were proven true, it would have huge implications and would completely change the way we understand the universe. For example, it could help in the search for a theory of quantum gravity and also in the understanding of black holes and spacetime.

Multistability in a Planar System with Competing Forces

Ángel Linuesa González, Universitat de València

A magnetic pendulum consists of a mass moving under gravity and the influence of several fixed magnetic attractors. Despite its simple design, the competition between these forces gives rise to highly sensitive dependence on the initial conditions and rich nonlinear dynamics.

Using numerical simulations, we investigate the system by exploring its trajectories and the basins of attraction associated with its stable equilibria. A systematic scan of initial conditions is performed through numerical integration to characterize the system's long-term behavior.

Our results show that small changes in the initial position can lead to completely different final states, revealing a complex organization of the basins of attraction. This illustrates how multistability shapes the global dynamics of the system and provides an intuitive example of the emergence of complex behavior in nonlinear dynamical systems.

Estimation of parameters from gravitational waves emitted by black hole binaries.

Octavio Miguel Muñoz Bausili, Universitat de València

The gravitational-wave detections made over the last 11 years by the LIGO-Virgo-KAGRA collaboration have revolutionized the field of astronomy, as they contain valuable information about binary systems of compact objects located throughout the distant universe. To estimate the parameters of these binary systems, a characterization process based on Bayesian inference and waveform models based on general relativity is necessary.

This talk aims to explain the logic behind using machine learning models in gravitational wave astronomy and how they can be used in order to estimate the astrophysical parameters of the black hole binaries that produced these gravitational waves.

Predict me if you can (Predíceme si puedes): The Physics of Deterministic Chaos

Óscar Nieto Val, High School Senior Student

Despite hyper-advanced satellites and supercomputers crushing the laws of fluid dynamics, accurate long-term weather forecasting remains famously elusive. This poster explores the physics of non-linear dynamics and deterministic chaos to explain why weather forecasts often let us down. Using Edward Lorenz's foundational three-dimensional atmospheric convection equations, we demonstrate sensitive dependence on initial conditions, the phenomenon where an imperceptible measurement variance exponentially diverges into radically different macro-outcomes over time. By mapping these trajectories in phase space, we visualize the iconic, non-repeating fractal geometry of the Lorenz Attractor. Finally, we examine how modern meteorology combats this inherent physical limit through ensemble forecasting by running parallel simulations with minute perturbations to calculate statistical probability and define the strict two-week "horizon of predictability" dictated by chaotic systems, consolidating that while the weather follows strict physical laws, it remains fundamentally unpredictable.

Lightning: The Physics Behind One of Nature's Most Powerful Phenomena

Rebeca Reig Puerto, Universitat de València

Lightning shows how different areas of physics can work together to describe this powerful atmospheric phenomenon that occurs when warm and humid air rises upwards forming large storm clouds in the atmosphere. Inside there are moving and colliding particles of ice, water and small hailstones which lead to the presence of unequal distribution of electric charge. When the electric field is strong enough, the surrounding air becomes ionised and this leads to the creation of the lightning channel. This channel gets incredibly hot, reaching temperatures of about 30000 K. The heat generated inside the channel expands the air in the atmosphere very quickly producing the sound known as thunder. The branched shape of lightning results from the propagation in space of the lightning through areas of minimum resistance, which creates patterns similar to natural fractals. Understanding these processes helps explain one of nature's most fascinating phenomena.

The emergent technology of Perovskites

Santiago Sánchez Blasco, Universitat de València

This poster will explain the main motivation of the actual usage of perovskites and some applications related with solar cells and other photo electronic applications

Cold Welding: The driving force behind vacuum cohesion

Darío Satorres Hernández, Universitat de València

Cold Welding is an important macroscopic manifestation of surface thermodynamics. It happens when two identical metallic surfaces make contact without any contaminant, not even air. Because of the resolution of unsatisfied chemical bonds of the outermost atoms, a symmetry-breaking event happens in the crystal. In this framework, we will understand why Cold Welding happens by looking at the Gibbs free energy; as long as this energy change remains negative, the process will be spontaneous. Furthermore, this work provides a rigorous theoretical framework of ideal cohesion, establishing the baseline physics required to understand metallic interactions in space environments. Last but not least, we will point at what happens when there are contaminants, seeing the reality behind

the theory.

Current Research Milestones and the Path to Climate Neutral Energy

Mia Smit, Johannes Gutenberg-Universität Mainz

Can fusion help Europe achieve a climate neutral energy system? The climate crisis demands reliable, carbon free electricity, and in 2026 fusion research has reached critical milestones. ITER is poised for its first plasma, private compact tokamaks are closing in on net energy gain, and stellarators have demonstrated sustained high temperature operation. These advances show that basic physics is no longer the barrier. The next steps involve durable materials, efficient Tritium production, and cost effective engineering. Fusion is not a replacement for wind and solar but a complementary baseload source that can fill the gaps of variable renewables. This poster summarizes the 2026 status, outlines remaining challenges, and sketches the roadmap toward commercial fusion power in Europe —a key element for a climate neutral future.

Eyes in the Sky: Discovering the Universe with Space Telescopes

Maria - Daria Tatu, Universitatea "Lucian Blaga" din Sibiu

The poster demonstrates how space telescopes overcome Earth's atmospheric limitations—such as turbulence, weather, and light absorption—to revolutionize modern astrophysics. By operating above the atmosphere, these observatories unlock a multi-wavelength view of the universe that is impossible from the ground.

The work explores the physics of the electromagnetic spectrum, mapping specific cosmic phenomena to distinct wavelengths. It highlights the achievements of three iconic telescopes: Hubble (visible/UV structural details), the James Webb Space Telescope (infrared views of early galaxies and exoplanets), and Chandra (high-energy X-ray events). Finally, it previews next-generation missions like Euclid and the Nancy Grace Roman Space Telescope, which are designed to map dark sectors.

The Fastest Descent: The Brachistochrone

Marta Torregrosa Montesinos, Universitat de València

Johann Bernoulli posed a problem: to determine the fastest path between two points, A and B—where A is higher than B but not directly above it—under the influence of a downward gravitational force. The answer is the brachistochrone. This poster briefly summarizes how the first individuals to solve the puzzle—Johann Bernoulli himself, Jakob Bernoulli, Isaac Newton, Gottfried Leibniz, and the Marquis de L'Hôpital—arrived at the solution. The equation for the brachistochrone (an inverted cycloid) will be presented, along with its derivation using the principle of least action—a method that, while not the one originally employed, is far simpler.

Finally, the poster will discuss modern applications of the brachistochrone, the problem's significance in the development of the calculus of variations, and another interesting property of the brachistochrone: tautochronism.

Day lenght outside JYU physics laboratory

Peetu Vartiainen, Jyväskylän yliopisto

We measured the lenght of days for a week using simple circuitry and code outside of our physics laboratory.

History of black Holes

Sara Zamorano Rico, Universitat de València

A brief summary of the theoretical development of black holes: from the first prediction under Einstein's Theory of General Relativity in 1916 to the mathematical proof of their existence by Roger Penrose with his Penrose Singularity Theorem in 1965.

6 List of participants

Students

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Rishikesh Prajapati	University of Delhi

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Elena González	Universitat de València
Kiara Hervella	Universitat de València
Vicent J. Martínez	Universitat de València
Italo Moletto-Lobos	Universitat de València
Sergio Portillo	Universitat de València
Inês Rainho	Universitat de València
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Panu Ruotsalainen	Jyväskylän yliopisto
Arturs Brekis	Latvijas Universitāte
Varis Karitans	Latvijas Universitāte
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Violeta Matos	Agencia Estatal de Meteorología (AEMET)
Antonio Turiel	Institut de Ciències del Mar - CSIC
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Patricia Oliva	Universidad de Alcalá
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