Universidad Autónoma de Madrid

LIST OF 4-YEARS PhD PROJECTS

Faculty of Economics

Supervisor Info	Project Title	Project Abstract
Supervisor: Carlos Manuel Fernandez Marquez Email: carlosm.fernandez@uam.es	Detecting and Mitigating the Impact of AI-Generated Product Reviews	This research examines the growing risks of AI-generated product reviews in digital marketplaces, where consumer trust and brand reputation depend heavily on authenticity. As generative AI becomes increasingly persuasive, distinguishing genuine from synthetic reviews poses new challenges. The thesis comprises three studies: (1) the stylistic manipulation of reviews using fine-tuned LLMs and its effects on perception, authenticity, and manipulative intent; (2) the evaluation of platform-level interventions, such as credibility scores and feedback prompts; and (3) an agent-based model capturing long-term dynamics of adversarial AI content and user trust. Together, they inform platform governance in evolving digital ecosystems.
Supervisor: Maria del Pilar Poncela Blanco Email: pilar.poncela@uam.es	Bridging Accuracy and Interpretability in Time Series Forecasting through Arttifical Intelligence	The fast-paced progress of Large Language Models (LLM) has fueled increasing interest in their use for time series analysis. However, their capacity to handle complex reasoning over temporal data in practice is still largely unexplored. This project aims to advance the modeling and forecasting of time series by developing LLM-based methods that combine predictive accuracy with interpretability, opening new avenues for decision-making in economics, finance, and the social sciences. References: Bryan Lim, Sercan Ö. Arık, Nicolas Loeff, Tomas Pfister, Temporal Fusion Transformers for interpretable multi-horizon time series forecasting, International Journal of Forecasting, Volume 37, Issue 4, 2021, Pages 1748-1764, ISSN 0169-2070, https://doi.org/10.1016/j.ijforecast.2021.03.012.
Supervisor: Ricardo Molero Simarro Email: ricardo.molero@uam.es	Income Inequality and Economic Growth	Analysis of the evolution of income inequality at the global level or within national economies (specifically, China or Spain), its possible causes, and its consequences, particularly in relation to economic growth. References: https://doi.org/10.1007/s11205-020-02286-y https://doi.org/10.1016/j.chieco.2016.11.006 https://doi.org/10.1080/02692171.2015.1016404 https://doi.org/10.1093/cje/bew017 ISBN 9780367592745
Supervisor: Jacobo Gomez Conde Co-supervisor: Ana Gisbert Clemente Email: jacobo.gomez@uam.es	Control systems design: antecedents and consequences	This project investigates how organizations design management control systems. It will analyze key antecedents and assess their impact on control choices. The project will also evaluate the consequences of these designs on performance, decision-making, and

		organizational behavior. The goal is to develop practical insights for configuring effective control systems in dynamic environments. References: https://doi.org/10.1016/j.mar.2024.100903 https://doi.org/10.1080/09638180.2022.2063152 https://doi.org/10.1080/00014788.2021.1986365 https://doi.org/10.1016/j.mar.2021.100781
Supervisor: Yérali Gandica Email: yerali.gandica@uam.es	Agent-based model (ABM) for dynamics during social demonstrations	This doctoral project investigates the abrupt transition occurring in social network structures during mass demonstrations, specifically how hashtags shift from forming modular communities to hierarchical nested structures [1,2]. Whilst this phenomenon has been characterised through network metrics such as modularity and nestedness, the underlying causes remain unknown. The primary objective is to develop an agent-based model operating on scale-free networks with communities, similar to real social networks, capable of reproducing this near-instantaneous change observed in empirical data from various demonstrations [3]. The model will be calibrated using available real data to understand this universal social phenomenon emerging from the strong interconnection amongst people committed to a common objective. The project's success would represent a significant advancement in understanding collective social dynamics. At least four publications in high-impact journals and participation in national and international conferences annually throughout the doctorate are expected. References: [1] Mariano G. Beiró, Ning Ning Chung, Lock Yue Chew and Yérali Gandica, “Signs of criticality in social explosions”. Sci Rep 14, 3263. https://doi.org/10.1038/s41598-024-53657-1 [2] Daniel Rico and Yérali Gandica, “An entropic analysis of social demonstrations”. Entropy 2024, 26(5), 363. https://doi.org/10.3390/e26050363 [3] Floriana Gargiulo and Yérali Gandica, “The Role of Homophily in the Emergence of Opinion Controversies”. Journal of Artificial Societies and Social Simulation (JASSS) 20(3)8 DOI: 10.18564/jasss.3448
Supervisor: Yérali Gandica Email: yerali.gandica@uam.es	Agent-based models (ABM) for analysing cultural propagation	In this doctoral project, we aim to develop a more realistic version of Axelrod’s model of cultural dissemination [1]. This model has been extensively studied in the literature to explore the formation of social structures in large metropolitan areas as opposed to those in smaller towns. However, to date, it has predominantly been analysed on static networks. In contrast, this project will investigate the dynamics of cultural dissemination as networks grow—a process that more accurately reflects real-world conditions [2]. Furthermore, we will incorporate an additional feature grounded in reality: the notion that opinions are not equidistant. For instance, sports-related views may be more closely aligned than political or religious beliefs. Machine learning techniques will also be employed to compare the clustering emerging from the interplay of dynamics with the community structure as understood in network science [3]. The ultimate goal is to confront the theoretical findings with empirical data drawn from real social networks. Each stage of the project will be carried out in collaboration with international scientific partners. For example, we will be working closely with Professor Peter Holme. At least four publications in high-impact journals and participation in national and international

		conferences annually throughout the doctorate are expected. References: [1] Cluster size entropy in the Axelrod model of social influence: Small world networks and mass media. Yérali Gandica, A. Charmell, J. VillegasFebres and I. Bonalde. Physical Review E. 84 , 046109. [2] Yérali Gandica and Guillaume Deffuant, “Bounded confidence model on growing populations”. Advances in Complex Systems, 2450009 (2024). doi.org/10.1142/S0219525924500097. [3] Floriana Gargiulo and Yérali Gandica, “The Role of Homophily in the Emergence of Opinion Controversies”. Journal of Artificial Societies and Social Simulation (JASSS) 20(3)8 DOI: 10.18564/jasss.3448

Universidad Autónoma de Madrid

Faculty of Law

Supervisor Info	Project Title	Project Abstract
Supervisor: Juan Ignacio Criado Grande Email: ignacio.criado@uam.es	Opening the Black-Box of Algorithm-mediated Public Governance. Artificial Intelligence Implications in Governments, Public Services, and People (#AIPublicGov)	This project proposes a systematic and empirical analysis about the implementation of artificial intelligence (AI) systems in the public sector with the aim of generating theory. We will comprehensively address the impact of AI at three levels: macro (policy and institutional design), meso (public organizations and services), and micro (the relationship between AI and public employees and citizens). Previous research suggests that developments and applications of AI in the context of the public sector might generate new opportunities and has the potential to transform governments and public administrations and their interaction with citizens, but also presents potential challenges for privacy, inclusion, and diversity, as well as the control of personal data, among others. All these aspects will be empirically studied from the perspective of Political Science and Public Administration. References: Criado, J. I., Sandoval-Almazán, R., & Gil-Garcia, J. R. (2025). Artificial intelligence and public administration: Understanding actors, governance, and policy from micro, meso, and macro perspectives. Public Policy and Administration, 40(2), 173-184. https://10.1177/09520767241272921 Criado, J. I., Alcaide-Muñoz, L., & Liarte, I. (2025). Two decades of public sector innovation: building an analytical framework from a systematic literature review of types, strategies, conditions, and results. Public Management Review, 27(3), 623-652. https://10.1080/14719037.2023.2254310 Criado, J. I., & Guevara-Gomez, A. (2024, June). Who evaluates the algorithms? An overview of the algorithmic accountability ecosystem. In Proceedings of the 25th Annual International Conference on Digital Government Research (pp. 19-28). https://10.1145/3657054.3657247 Criado, J. I., & de Zarate-Alcarazo, L. O. (2022). Technological frames, CIOs, and Artificial Intelligence in public administration: A socio-cognitive exploratory study in Spanish local governments. Government Information Quarterly, 101688. https://10.1016/j.giq.2022.101688
Supervisor: Jesús Alfaro Águila-Real Co-supervisor: Enrique Gandía Pérez Email: enrique.gandia@uam.es	Between Clan and Code: Corporate Law and Family Traditions in Contemporary China	The proposed project examines contemporary corporate law in China, focusing on the joint stock limited company (股份有限公司). It analyzes the structure, powers, and duties of directors, the protection of minority shareholders, and the role of the Party in corporate governance. The central issue is whether this model constitutes a Western transplant or reflects local traditions, such as lineage culture (宗族) and family firms. The research assesses their imprint on governance soft law, statutory practice, and case law, seeking to determine the extent to which distinctive Chinese elements influence the legal framework of corporate organizations. References: ALFARO, J., "Cultura empresarial y gobierno corporativo", en el blog Almacén de Derecho, 26 de abril de 2016 (https://almacendederecho.org/cultura-empresarial-y-gobierno-corporativo). HUANG, L. (et al.), "Clan Culture and Risk-Taking of Chinese Enterprises", China Economic Review, 2022, vol. 72, issue C (https://doi.org/10.1016/j.chieco.2022.101763). LIU, F., "In the name of the family: The effect of CEO clan culture background on firm internationalization", Journal of Business Research Volume 161, June 2023, 113837 (https://doi.org/10.1016/j.jbusres.2023.113837). ZHANG, G. (et al.), "Clan Culture and Corporate Social Responsability in Chinese Family

		Firms", The Singapore Economic Review, Vol. 69, No. 01, pp. 119-139 (2024) (https://doi.org/10.1142/S0217590823500054).

Universidad Autónoma de Madrid

Faculty of Medicine

Supervisor Info	Project Title	Project Abstract
Supervisor: Isabel Lastres Becker Email: isabel.lastres@uam.es	Unraveling the Role of Pyroptosis in ALS: A Novel Therapeutic Avenue for Neurodegeneration	Amyotrophic lateral sclerosis (ALS) is a devastating neurodegenerative disease characterized by progressive motor neuron loss, muscle atrophy, and neuroinflammation. While TDP-43 aggregation is a hallmark of ALS pathology, increasing evidence suggests that neuroinflammatory processes play a pivotal role in disease progression. Among these, pyroptosis—a highly inflammatory form of programmed cell death—has emerged as a potential driver of neuronal dysfunction. However, its role in ALS remains poorly understood. In this study, we aim to characterize the involvement of pyroptosis in ALS by examining the interplay between TDP-43 pathology, NLRP3 inflammasome activation, and GASDERMIN D (GSDMD)-mediated cell death. References: doi: 10.1016/j.bbi.2025.03.008. doi: 10.3390/antiox13091072. doi: 10.3390/biom12091200. doi: 10.1021/acs.jmedchem.1c01255.
Supervisor: Miguel Saenz de Pipaon Marcos Co-supervisor: Marta Miret Garcia Email: miguel.saenzdepipaon@uam.es	Neurodevelopmental outcomes in very preterm infants	Very preterm infants are at risk of neurodevelopment delays. These adverse outcomes are associated with factors such as gestational age, intrauterine growth, and in early weeks after birth. Nutrition may also play a role, particularly regarding duration and composition of parenteral nutrition, consumption of the own mother's milk, and protein and caloric intake.Every year, approximately 100 infants born before 32 weeks of gestation are discharged from the Neonatology unit at Hospital La Paz. After discharge, they are followed in the outpatient's clinic until 7 years of age. Neurodevelopment assessments are conducted routinely and at different time points.The aim of this PhD thesis will be to analyze the neurodevelopmental outcomes in very preterm infants and the factors that might be associated. References: doi: 10.1038/s41390-023-02622-1, doi:10.1159/000489388, doi: 10.2217/epi-2017-0082, doi: 10.1186/s12937-015-0091-3.
Supervisor: David Martinez Gomez Email: d.martinez@uam.es	Exploring Late-Life Energy Expenditure Dynamics and REgulatoRy Mechanisms: A Doubly Labeled Water Study (ELDER)	The ELDER project (Exploring Late-Life Energy Expenditure Dynamics and Regulatory Mechanisms: A Doubly Labeled Water Study) is the first study in Spain to comprehensively examine daily total energy expenditure (TEE) and its key componentsresting metabolic rate (RMR) and activity energy expenditure (AEE)in older adults aged 75 years and above. Using the gold-standard Doubly Labeled Water (DLW) technique, the study aims to provide the most precise measurements of energy metabolism in free-living conditions. This research addresses a critical knowledge gap by investigating the clinical, behavioral, and physiological factors that regulate energy dynamics in late life. The study aligns with Spain's strategic priorities for health research, contributing to personalized medicine and public health strategies. Leveraging the well-established Seniors-ENRICA-2 cohort, which has undergone repeated assessments over the years, the project will collect data from 390 participants through a multidisciplinary approach. Key objectives include understanding how activity patterns, body composition, thermoregulation, and allostatic load influence energy balance. References: 10.1001/jamanetworkopen.2024.46802 10.1249/MSS.0000000000003699

		10.1016/j.ajcnut.2025.04.027 10.1016/j.xinn.2025.101045
Supervisor: Silvia Gómez Sebastián Email: silvia.gomezs@uam.es	Re-directing oncolytic virus to target MM via CAR T antigens	BCMA directed CAR T cell therapies are approved for multiple myeloma (MM) due to the high expression of BCMA on malignant plasma cells and minimal presence on healthy tissues, making it an effective target. Yet their impact is limited, among others, because of resistance, complex manufacturing, and high costs. Oncolytic viruses (OVs), including herpesvirus (HSV) based products, are also being approved. OVs are genetically manipulated to selectively infect tumour cells and improve their safety. One approach is to modify OVs´ tropism by manipulating proteins implicated in viral entry. In herpesviruses gD is one of the key proteins in viral entry and retargeting herpesvirus by modifying this glycoprotein has been achieved in prior work. Combining BCMA targeting with a versatile oncolytic virus (OV) platform—specifically a porcine herpesvirus (PRV) with simple genetic control and no human pathogenicity—offers an evolved strategy. Unlike personalized and costly CAR T therapies, this approach provides an off the shelf, safe, and highly specific option for MM, overcoming key CAR T limitations. By integrating clinically validated CAR T ligands into a flexible OV platform, we aim to develop a novel therapy with potential to treat MM and that even could overcome barriers to treat solid tumours. References: (1) doi: 10.1016/j.virusres.2020.197896. (2) doi: 10.1038/sj.mt.6300021. (3) doi: 10.1016/j.jinf.2020.11.025. (4) doi: 10.1371/journal.pone.0096562
Supervisor: Alberto Ortiz Arduan Co-supervisor: Maria Dolores Sanchez-Niño Email: alberto.ortiz@uam.es	Delaying biological aging: focus on kidney gerosuppressive functions	Chronic kidney disease (CKD) is among the 6 fastest growing causes of death in China (PMID: 38762325). In CKD, the loss of kidney gerosuppressive functions drives accelerated biological body aging and premature death from multiple cardiovascular and non-cardiovascular causes. The project will use a systems biology approach to identify novel biomarkers and therapeutic targets that can be developed into preventive or early treatment strategies for CKD and aging. References: 1: doi: 10.1016/j.kint.2025.04.005.. doi: 10.1681/ASN.2021030383. doi: 10.1016/j.kint.2022.02.028. doi: 10.1016/j.kint.2022.11.023.
Supervisor: Maria Susana Guerra Garcia Email: susana.guerra@uam.es	Decoding ISG15: Unlocking Next-Gen Vaccines Against Monkeypox	Our project explores the dual role of ISG15 in poxvirus biology and vaccinology. We have demonstrated that ISG15 and its variants function as potent genetic vaccine adjuvants, enhancing innate immune activation and improving the quality of adaptive and memory responses against diverse pathogens, including HIV, SARS-CoV-2, and Zika. We now aim to extend these studies to monkeypox virus (MPXV), investigating how ISG15 modulates viral replication and host antiviral responses. Detailed characterization of ISG15's mechanism of action may inform the rational design of novel MPXV vaccines and provide insights into virus–host interactions critical for controlling viral spread. References: 1. Paniz-Mondolfi A, et al., 2023. MPXV genomic & ultrastructural analysis reveals pathogenicity insights. J Med Virol, 95:e28878. DOI:10.1002/jmv.28878 2. García-Arriaza J, et al., 2025. ISG15 enhances immune responses in MVA

		vaccines against Zika & SARS-CoV-2. Vaccines, 13:696. DOI:10.3390/vaccines13070696 3. Falqui M, et al., 2023. MVA vector expressing ISG15 boosts IFN-I & HIV-1 CD8 responses. Front Cell Infect Microbiol, 13:1187193. DOI:10.3389/fcimb.2023.1187193 4. McGrail JP, et al., 2024. Comparative genomics of 2022 MPXV outbreak vs Clade II. J Med Virol. DOI:10.1002/jmv.70023
Supervisor: David Fernandez de Sevilla Garcia Co-supervisor: Pablo Varona Matínez Email: david.fernandezdesevilla@uam.es	Artificial Intelligence in the Regulation of Fear Circuits	The thesis project will be interdisciplinary and will encompass the automated control of non-invasive optical stimulation, as well as data analysis using supervised and unsupervised machine learning tools. Its implementation will lead to the development of a novel non-invasive neurotechnology, open-source software, and the publication of high-impact scientific articles on the application of AI in the field of neuroscience, ensuring a fruitful professional future for the graduating PhD student. References: 1) DOI: 10.1016/j.lfs.2025.123982, 2) DOI: 10.7554/eLife.67267,3) DOI: 10.1117/1.NPh.11.2.024308, 4) https://doi.org/10.1016/j.neucom.2024.127378
Supervisor: Francisco Clasca Cabre Email: francisco.clasca@uam.es	The cognitive thalamus: input-output architectures of the lateral thalamic nucleus.	The project aims at producing high-resolution quantitative data, at cellular and subcellular resolution levels on the architecture of the input and output circuits of neurons in the Lateral (Dorsal+Posterior) nuclear complex in mice (LD-LP). Neurons in LD-LP are known to act as a communication nodes in the brain networks that support complex cognitive functions such as visuospatial perception, navigation, attention, and spatial memory. However, the cellular wiring of inputs and outputs of the LP-LD neurons remains poorly defined. The project will use single and micropopulation cell tracing, ex-vivo electrophysiology and optogenetics, and electron microscopic methods. https://doi.org/10.1523/JNEUROSCI.1096-24.2024, https://doi.org/10.1093/med/9780197676158.003.0012
Supervisor: Jaime Tejedor Fraile Email: Valle	Alfa2 agonists in the treatment/prevention of progression of myopia	There is an increasing incidence of myopia in children of eastern and western countries, due to the use of screen devices (blue light), near work, and less intense natural light exposure. Although different types of aspheric lenses glasses and low dose atropine have been used to prevent the progression of myopia, it causes side effects difficult to tolerate. Different studies in animal models have demostrated that alfa2 agonists inhibit induction of myopia. We aim to investigate the efficacy of 0.025% alfa2 agonists in myopic children 6-14 years old in a phase IIa clinical trial approved by the European Medicines Agency, by instilling one drop q24h and measuring the progression of axial length and refractive error. References: 1. https://doi.org/10.1167/iovs.17-22562 2. doi:10.1001/jamaophthalmol.2023.5467 3. doi:10.1001/jamaophthalmol.2023.2855
Supervisor: Alvaro Llorente Berzal Co-supervisor: David Ramiro Cortijo Email: alvaro.llorente@uam.es	Experimental investigation of extreme preterm birth: analysis of cardiovascular, metabolic and neurobehavioural implications	Extreme preterm birth refers to birth at gestational age less than 28 weeks. Despite extreme prematurity represents a low percentage of total preterm births, technological and medical advances have astoundingly decreased death rates in this risk population. Through a rat model of extreme prebirth we will analyse short- and long-term consequences in cardiovascular and metabolic disease as well as behavioural and

		neurological outcomes. The PhD candidate will learn how to handle and administer active compounds and perform several behavioural analyses. He will also learn molecular techniques such as Western blotting, immunohistochemistry, confocal microscopy, among others References: Boullon L, Finn DP, Llorente-Berzal Á. Sex differences in the affective-cognitive dimension of neuropathic pain: Insights from the spared nerve injury rat model. J Pain. 2025 Feb;27:104752. doi: 10.1016/j.jpain.2024.104752. Ruvira S, Rodríguez-Rodríguez P, Cañas S, Ramiro-Cortijo D, Aguilera Y, Muñoz-Valverde D, Arribas SM. Evaluation of Parameters Which Influence Voluntary Ingestion of Supplements in Rats. Animals (Basel). 2023 May 31;13(11):1827. doi: 10.3390/ani13111827. Ramiro-Cortijo D, Singh P, Herranz Carrillo G, Gila-Díaz A, Martín-Cabrejas MA, Martin CR, Arribas SM. Association of maternal body composition and diet on breast milk hormones and neonatal growth during the first month of lactation. Front Endocrinol (Lausanne). 2023 Mar 2;14:1090499. doi: 10.3389/fendo.2023.1090499. Rocha R, Andrade L, Alves T, Sá S, Pereira PA, Dulce Madeira M, Cardoso A. Behavioral and brain morphological analysis of non-inflammatory and inflammatory rat models of preterm brain injury. Neurobiol Learn Mem. 2021 Nov;185:107540. doi: 10.1016/j.nlm.2021.107540.
Supervisor: Alicia Gonzalez Martin Email: alicia.gonzalezm@uam.es	Functional analysis of microRNAs and their target genes in immune tolerance, cancer and autoimmunity	Our research aims at understanding the cellular and molecular basis of cancer and autoimmune diseases with a central focus on immune tolerance. Our immune system continuously faces the challenge of protecting the organism from a large variety of invading pathogens and arising tumors without attacking our own tissues. This exquisitely regulated specificity of recognition is achieved through a series of immune tolerance mechanisms that operate in different immune cell subsets, including T and B cells. Defects in immune tolerance constitute the basis for the development of autoimmune diseases, including lupus erythematosus, rheumatoid arthritis, type 1 diabetes and multiple sclerosis. On the other hand, immune tolerance is central to the failure of tumor immunosurveillance and certain cancer immunotherapies. Despite intensive study, the mechanisms underlying immune tolerance are poorly understood. Specifically, the role of microRNAs (miRNAs) in these mechanisms remains largely unexplored. miRNAs are endogenously encoded small RNAs 19–23 nucleotides in length that regulate the expression of their target genes by pairing through imperfect sequence complementarity with their target messenger RNAs (mRNAs) and promoting degradation and/or translational repression of the mRNA. Hundreds of miRNAs are expressed in the immune system, and they have essential roles in regulating the development and function of lymphocytes. Expression-profiling studies have revealed that many miRNAs are dysregulated in lymphocytes from patients with autoimmune diseases, and mouse genetic studies have established causative roles for a few of those miRNAs in regulating autoimmunity. The present project focuses on studying the role of specific miRNAs and their target genes in immune tolerance. Uncovering the mechanisms governing immune tolerance is key for understanding autoimmune diseases and tumor progression and for the development of new therapeutic strategies for the treatment of these diseases.

		References: DOI: 10.1038/ni.3385 DOI: 10.1016/j.semcancer.2019.04.004 DOI: 10.7554/eLife.42995 DOI: 10.1038/ncomms12207
Supervisor: Francesc Garcia Gonzalo Email: francesc.garcia@uam.es	Molecular mechanisms underlying primary cilia dysfunction in ciliopathies	Primary cilia are cell type-specific antennae whose transduction of chemical, mechanical or optical signals is essential for human embryonic development and postnatal life. Cilia-dependent processes in our bodies include, among others: vision, hearing, smell, cognition, motor control, kidney function, food intake, and the development of skeleton, heart and nervous system. Ciliopathies are genetic diseases caused by cilia malfunction. Most ciliopathies are rare diseases affecting multiple organs. In our lab, we study the molecular mechanisms of ciliopathies such as Joubert-Boltshauser syndrome (JBTS) and Ellis van Creveld syndrome (EvC). References: 10.3389/fcell.2023.1190258; 10.7554/eLife.78383; 10.26508/lsa.202000746;
Supervisor: Jesus Miguel Hernandez Guijo Email: jesusmiguel.hernandez@uam.es	Non-excitatory amino acid transporters as a new molecular target involved in cerebral injury after ischemic stroke.	Stroke remains a major cause of death and disability worldwide, yet current therapeutic strategies are scarce and largely ineffective. Based on strong preliminary data, our laboratory proposes a novel mechanism whereby non-excitatory amino acids accumulate in the ischemic penumbra through specific transporters, triggering cytotoxic edema and driving infarct progression. Supported by high-impact publications, completed and ongoing doctoral theses, and new international collaborations, this project aims to validate these findings and explore their translational potential as innovative therapeutic targets to limit brain damage and improve outcomes in ischemic stroke. References: DOI:10.4103/NRR.NRR-D-24-00536 DOI:antiox12101844 DOI:10.1007/s12975-023-01192-y DOI:10.1002/glia.24241
Supervisor: Maria Francisca Cano Abad Email: maria.cano@uam.es	Search for new targets and potential drugs for drug-resistant epilepsy	This project aims to identify new therapeutic targets for drug-resistant epilepsy (DRE), a condition affecting up to one-third of patients despite available antiseizure drugs. By integrating multi-omics data (genomics, transcriptomics, proteomics) and constructing protein-protein interaction networks, we hypothesize that specific differentially expressed proteins drive DRE pathogenesis. Their discovery will enable the development of novel, disease-modifying and personalized therapies. Advanced proteomic approaches, such as proximity extension assays, will provide high-resolution molecular insights, while data integration will distinguish causal targets from secondary changes, ultimately guiding precision drug discovery and repurposing strategies to improve outcomes in refractory epilepsy. References: 1.- doi: 10.1002/med.21710.; 2.- DOI: 10.1007/s11302-025-10103-9; 3.- DOI: 10.1016/j.neulet.2021.136275; 4,- doi: 10.3390/cells9030664.

Supervisor: Maria Isabel Sanchez Perez Email: is.perez@uam.es	Novel Therapeutic Combinations Targeting Cancer Stem Cells in Gastric and Pancreatic Cancer: Evaluation of Metal-Based Compounds and Metabolic Strategies	This predoctoral fellowship offers an opportunity to investigate innovative therapeutic approaches against gastric and pancreatic cancers, two of the most aggressive malignancies worldwide. The project focuses on targeting cancer stem cells, a subpopulation responsible for tumor initiation, progression, therapy resistance, and relapse. The candidate will explore novel combinations of metal-based compounds with metabolic strategies to enhance therapeutic efficacy and overcome resistance mechanisms. Through an interdisciplinary approach integrating chemistry, cell biology, and oncology, this research aims to provide insights into new treatment options. The fellowship is ideal for motivated students seeking advanced training in translational cancer research.
Supervisor: Mercedes Sotos Prieto Email: mercedes.sotos@uam.es	Diet, Lifestyle and Precision Medicine in Healthy Aging and Chronic Disease Prevention	Our research group at Universidad Autónoma de Madrid investigates how diet and lifestyle shape healthy aging and chronic disease prevention. Using large prospective cohorts such as ENRICA, UK Biobank, and other US large cohorts, we study the impact of Mediterranean, plant-based, and Planetary Health Diet patterns on frailty, intrinsic capacity, cardiovascular disease, diabetes, and mortality. We integrate epidemiology with omics biomarkers and digital health tools to advance precision medicine and public health. Our work aims to generate evidence for sustainable dietary recommendations and transferable interventions that promote both human and planetary health. References: doi: 10.1016/j.scitotenv.2025.178924. doi: 10.1016/j.ajcnut.2024.12.005. doi: 10.1093/eurjpc/zwae282. doi: 10.1001/jamanetworkopen.2024.1107.
Supervisor: Modesto Redrejo Rodriguez Email: modesto.redrejo@uam.es	Unveiling the Evolutionary Power of piPolBs: Ancient Enzymes Bridging Genome Stability and Antiviral Defense	Primer-independent DNA polymerases (piPolBs) are unique B-family enzymes capable of both priming and replicating DNA, encoded by patchily distributed genetic mobile elements called pipolins. Beyond their fundamental interest, piPolBs have inspired successful biotechnological applications such as whole-genome amplification, underlining their relevance from multiple perspectives. Recent preliminary data suggest piPolBs enhance genome stability through primase activity and translesion synthesis. Moreover, we currently hypothesize that their ab initio (untemplated) DNA synthesis may also act as an antiviral strategy, similar to recent reports on defense-associated reverse transcriptases. Using piPolB mutants from diverse bacteria and analyzing pipolin-associated genes, we aim to uncover novel mechanisms linking DNA repair and microbial defense. We seek students interested in molecular microbiology, genetic engineering, and bioinformatics to join an innovative project exploring the evolutionary connection between bacteria genome maintenance and immunity. 期待你的加入，一起创造新的发现！ More info: https://rnrlab.github.io/ References: https://doi.org/10.1093/nar/gkae891; https://doi.org/10.1093/nargab/lqad073; https://doi.org/10.1093/nar/gkac467; https://doi.org/10.1016/j.celrep.2017.10.039

Supervisor: Fernando de la Cuesta Marina Email: fernando.delacuesta@uam.es	Application of nanovesicles from medicinal plants for the treatment of accelerated vascular aging	Plant nanovesicles (PNVs) have been shown to hold very promising therapeutic potential to alleviate inflammation in a plateau of degenerative pathologies. PNVs from different medicinal plant parts, including fruits, roots and leaves, have been isolated with considerable yield and have shown anti-inflammatory properties in different pathological settings. In our group, we have been optimising the isolation and storage of PNVs from different sources (tea, ginger, curcuma and red cabbage). The project will test the biosafety and efficacy of PNVs to modulate cell senescence and inflammation in vascular models in vitro, and in vivo, in a mouse model of vascular aging. References: 1: doi: 10.1002/jev2.70147, doi: 10.1016/j.lfs.2025.123529. doi: 10.14336/AD.2024.0405. : doi: 10.1186/s12964-019-0449-9.
Supervisor: Silvia M. Arribas Rodríguez Co-supervisor: Vanesa Benitez Garcia Email: silvia.arribas@uam.es	Development of a food prototype based on okara, a soybean by-product, targeting premenopausal women	Okara is an underutilized by-product of soybean processing. Its elevated levels of protein and isoflavones render it an appropriate product to mitigate menopause-related changes. During the premenopausal period, the decline of ovarian hormones results in several physiological alterations, including the reduction of muscle and bone mass and cardiovascular dysregulation. The proposed research aims to design and test a food prototype utilizing okara to alleviate symptoms in premenopausal women. This project will be led by a multidisciplinary research team of experts in food science and technology, human physiology, and women's health, in collaboration with the Obstetrics and Gynecology Service of Hospital Universitario La Paz. References: 1)DOI: 10.3390/nu14245280 2) DOI: 14:1090499 3)DOI: 10.3390/foods12142708 4)DOI: 10.1113/JP287097
Supervisor: Ramon Diaz Uriarte Email: r.diaz@uam.es	Simulation-based inference and interpretable deep learning for evolutionary accumulation and cancer progression models: causal inference, target discovery, and phylogenetic integration.	This project proposes to advance methods in evolutionary accumulation and cancer progression models (EvAMs) by developing novel methods for causal inference ---with a focus on therapeutic target identification---, integrating phylogenetic information from multi-region sequencing data and cohorts of intra-tumor phylogenies, addressing selection and observation biases and including the role of covariates, and creating comprehensive, user-friendly software tools. We propose to use deep learning and AI approaches with simulation-generated data, and include methods for domain adaptation, while emphasizing interpretability to support AI safety and alignment. Applications include cancer progression and antimicrobial resistance. References: 1. https://doi.org/10.1109/ACCESS.2025.3558392 2. https://doi.org/10.1093/bioinformatics/btae737 3. https://doi.org/10.1093/bioinformatics/btac710 4. https://doi.org/10.1371/journal.pcbi.1009055
Supervisor: Luis del Peso Email: luis.peso@uam.es	Beyond Cell Culture: Characterizing Early In Vivo Transcriptional Adaptations to Hypoxia	Oxygen is essential for the survival and function of mammalian tissues, as aerobic metabolism is required to sustain physiological processes. Disruptions to oxygen homeostasis are central to the pathogenesis of prevalent diseases, including cancer, obesity, and cardiovascular, cerebrovascular, and respiratory conditions. Cellular responses to hypoxia are orchestrated by Hypoxia-Inducible Factors (HIFs), which regulate gene expression to restore homeostasis through metabolic reprogramming and enhanced oxygen delivery. However, much of the current understanding of cellular responses to hypoxia is derived from in vitro studies, leaving key aspects, particularly the role of HIFs in the early transcriptional response, poorly characterized in vivo. This

		raises concerns about the extrapolation of in vitro findings to in vivo systems. In line with this, preliminary data from our research suggest significant differences between in vivo and in vitro transcriptional responses to hypoxia. Additionally, the transcriptional response to intermittent hypoxia, which underlies pathologies such as Obstructive Sleep Apnea (OSA), remains poorly understood compared to sustained hypoxia. This project aims to fill these gaps in knowledge and uncover the molecular mechanisms driving hypoxia responses in vivo. Specifically, we will address the following objectives: 1. Investigate the role of HIFs in the early transcriptional response to sustained and intermittent hypoxia, and explore the contribution of epigenetic adaptations, particularly DNA methylation, which is regulated by oxygen availability. 2. Examine the contribution of other transcription factors in the hypoxic response, with a focus on the YAP/TAZ pathway. Our preliminary data suggest that YAP1 is activated in heart and lung of mice exposed to short-term hypoxia, which may have implications in vascular remodeling. 3. Explore the crosstalk between hypoxia and xenobiotic stress responses, specifically the competition for ARNT binding between HIF and Aryl Hydrocarbon Receptor (AHR) transcription factors. This interaction may influence drug metabolism and metabolic processes during hypoxia. By integrating genetic models, transcriptomic and genomic profiling, and bioinformatic approaches, this research will provide critical insights into the transcriptional and epigenetic adaptations to intermittent and sustained hypoxia in vivo. By describing transcriptional regulation in intact tissues, our work aims to advance the understanding of hypoxia-associated diseases and identify novel therapeutic opportunities, including the potential benefits of hypoxia preconditioning. References: doi: https://doi.org/10.1101/2025.09.18.676807 doi: https://doi.org/10.1101/2025.07.28.667192

Universidad Autónoma de Madrid

Faculty of Philosophy

Supervisor Info	Project Title	Project Abstract
Supervisor: Mario Esteban Rodriguez Email: mario.esteban@uam.es	The ideational foundations of China's global governance initiatives under Xi Jinping	This project examines the ideational underpinnings of China's global governance initiatives under Xi Jinping, focusing on the Global Development Initiative, the Global Security Initiative, the Global Civilization Initiative, the Global AI Governance Initiative, and the Global Governance Initiative. These programs reflect Beijing's ambition to promote alternative visions of international order and present itself as a provider of global public goods. Moving beyond conventional analyses of power politics and material interests, the project highlights their normative and discursive dimensions. Drawing on primary sources, it integrates AI-driven critical discourse analysis with interpretive approaches, combining natural language processing to detect discursive patterns with contextual interpretation rooted in Chinese political culture and international relations theory. References: https://doi.org/10.1080/10670564.2018.1433476 https://doi.org/10.1080/13629395.2022.2035136 https://doi.org/10.1080/10670564.2021.1945739
Supervisor: Ivan Gonzalez Pujol Email: ivan.gonzalezp@uam.es	Rethinking Theory and Practice in East Asian International Relations	The PhD project will study relations among East Asian countries, their interactions with other countries/regions, or the internal factors shaping their foreign policies. It should be theoretically innovative, preferably engaging with non-mainstream perspectives that (re)interpret concepts such as power, (inter)dependence, hierarchy, and regime differences…. It should ground the analysis in empirical evidence to advance theoretical claims. Projects addressing the external effects of East Asian foreign policies will only be accepted if they are used to provide empirical support for explaining interstate relations or the domestic drivers of foreign policy. References: 10.20991/allazimuth.1480020 ; 10.1093/irap/lcae002 ; 10.1080/13642987.2025.2474999 ; 10.15366/relacionesinternacionales2024.57.005
Supervisor: Taciana Fisac Email: taciana.fisac@uam.es	Research on Chinese grammar, with special attention to topic-comment structure and verbal aspect.	Building on Yuen Ren Chao's proposal that Chinese is not a subject-predicate language but rather a topic-comment one, and on further developments by LaPolla, Sheng Jiaxuan, and more recently by Fisac, the Ph.D. candidate should focus on research aimed at exploring in greater depth the topic-comment structure and/or the category of verbal aspect in the Chinese language. Aspect is a grammatical category that has been largely neglected and poorly applied in the study and teaching of Chinese grammar, and it requires much deeper investigation—particularly what Fisac refers to as "aspectual conjugation. References: Fisac, Taciana, Claves de la gramática china. Bellaterra, 2023. https://dialnet.unirioja.es/servlet/libro?codigo=948200 Fisac, Taciana & Moratto, Riccardo, Fundamental Structures of the Chinese Language. Topic-Comment and Other Key Structures. Routledge, 2024 doi.org/10.4324/9781003439271 Fisac, Taciana & Moratto, Riccardo, Strutture fondamentali della lingua cinese. BUP, 2023. http://hdl.handle.net/10486/713314
Supervisor: Antonio Sanchez Martinez Email: antonio.sanchezm@uam.es	Artisanal Epistemology in a Comparative Perspective	This project proposes a study of artisanal cultures in the field of the history of scientific knowledge from a comparative perspective between China and the European world during the Late Middle Ages, the Renaissance and the early modern age. References: 1. Antonio Sánchez, "Cosmography, maritime culture, and practical knowledge in the early modern Spanish empire", en Rodrigo Cacho Casal and Caroline Egan (eds.), The

		Routledge Hispanic Studies Companion to Early Modern Spanish Literature and Culture, Londres, Routledge, 2022, pp. 79-2022. 2. Henrique Leitão y Antonio Sánchez, "Zilsel's thesis, maritime culture and Iberian science in early modern Europe", Journal of the History of Ideas, 78, 2 (2017): 191-210. DOI:10.1353/jhi.2017.0010 3. Henrique Leitão y Antonio Sánchez, "Too much to tell: narrative styles of the first descriptions of the natural world of the Indies in sixteenth century Iberian texts", History of Science, 55, 2 (2017): 167-186.https://doi.org/10.1177/007327531771286 4. Antonio Sánchez, "Science by Regimento: Standardising Long-distance Control and New Spaces of Knowledge in Early Modern Portuguese Cosmography", Early Science & Medicine, 21, 2-3 (2016): 133-155.DOI: 10.1163/15733823-02123p03
Supervisor: Elena Duce Pastor Email: elena.duce@uam.es	Poverty in Ancient greek families from a Gender perspective	In this project, the PhD applicant will focus on how poverty is shown in ancient sources and how it affects the lives of vulnerable populations, specifically women and children. Those populations had no access to political privileges, could not vote or protest. Literary sources were written by an elite and focus on problems of status. They care about citizens only when they are interested. However, it is possible to trace problems of support in orphaned children, widows, and relatives, especially in crises such as war. The student will study different Greek poleis, such as Athens or Sparta. References: Dmitriev, : Sviatoslav. "War Orphans and Orphans of Democracy in Classical Athens: The Decree of Theozotides and the Prytaneion Decree Reconsidered." Noreña, Carlos and From Document to History and Papazarkadas, Nikolaos (Eds.) Epigraphic Insights into the Greco-Roman World, Brill, 2019, pp. 37–55. https://doi.org/10.1163/9789004382886_004 Cudjoe, Richard V. The Social and Legal Position of Widows and Orphans in Classical Athens. University or Glasgow (PhD), 2000. (ONLINE https://theses.gla.ac.uk/2101/) Taylor, Claire. Poverty, Wealth and Well-Being. Experiencing Penia in Democratic Athens. Oxford University Press, 2017. ISBN 9780198786931 Vélissaropoulos-Karakostas, Julie. "Merchants, Prostitutes and the New Poor." Cartledge, P. Cohen E. E. y Foxhall L. (Ed) Money, Labour and Land, Approaches to the Economies of Ancient Greece, Routledge, 2002, pp. 130–39. ISBN 9780203996300
Supervisor: Diego Chapinal Heras Email: diego.chapinal@uam.es	Mante-IA - Mantic and Artificial Intelligence. Analysis of the oracular responses from ancient Greece by means of NLP tools	Mante-IA aims to delve into the oracular activity of ancient Greek civilization, primarily its responses. This project will compile all the evidence of responses and will identify discourse patterns and other elements that could have been present in this kind of phenomenon. In order to do that, we will employ Natural Language Processing tools, as a useful and innovative approach that can get better outputs than conventional methods. References: Chapinal-Heras, D. La Voz de los Dioses. Los Oráculos y la Adivinación en el Mundo Griego, Barcelona – Madrid, Ático de los Libros. 2023. ISBN: 9-788419-703019 Chapinal-Heras & Díaz-Sánchez, C., "AI applications in Hellenic studies. A survey", Tabanque, Vol. 36, 2024, 49-71. https://doi.org/10.24197/trp.36.2024.49-71 Chapinal-Heras & Díaz-Sánchez, C., "A review of AI applications in human sciences research", Digital Applications in Archaeology and Cultural Heritage, Vol. 32, 2024, e00323. https://doi.org/10.1016/j.daach.2023.e00288 Díaz-Sánchez, D. & Chapinal-Heras, D., "Use of Open Access AI in teaching classical antiquity. A methodological proposal", The Journal of Classics Teaching, Vol. 25, Nº 49, 2023, 17-21. https://doi.org/10.1017/S2058631023000429

Supervisor: Carlos Javier Carlos Morales Email: carlos.carlos@uam.es	Tends of Globalization: Trade Relations between China and the Hispanic World in the Age of Transitions (1644-1749)	The period of political and dynastic transition, both in China (from Ming Dynasty to Qing Dynasty) and in Spain (from the Habsburgs to the Bourbons), between 1644 and 1749, brought about significant changes in trade policies, directly impacting the economic routes of silver, silk, and ceramics. These political and dynamic transformations impacted the dynamics and quantities of these goods, reflecting not only economic adaptations but also the geopolitical changes of the time. This research has foru mains objectives. 1. To situate trade between the Philippines and China within the political context of the transition of dynasties in China and the change of ruling houses in Spain. 2. To analyze how these political transformations affected trade policies and, consequently, trade relations. 3. To examine the adaptations and responses of Filipino and American merchants to these challenges. 4. To determine whether these dynamics impacted the consumption patterns of the court of Madrid. References: doi: 10.1523/JNEUROSCI.1463-21.2022.
Supervisor: Carlos Sanchez Garcia Email: carlos.sanchezg@uam.es	Remote Sensing Applied to Land Use and Land Cover Change Detection in the Salamanca–Zamora-Portugal Border Región	This project aims to analyze the spatiotemporal dynamics of land use and land cover in the border regions of Salamanca and Zamora with Portugal, known as the Hispano-Lusitanian Raya. The research will apply remote sensing techniques combined with geospatial analysis to detect, quantify, and interpret landscape transformations. By integrating multi-source satellite imagery and cartographic data, the study seeks to assess land change drivers and their implications for regional planning and environmental management. The outcomes will contribute to a better understanding of borderland dynamics and provide tools for sustainable territorial governance. References: 1 - https://doi.org/10.1016/j.geosus.2022.08.002. 2 - https://doi.org/10.1016/j.catena.2024.108416 3 - https://doi.org/10.3390/land13040407 4 - https://doi.org/10.3390/land14081655
Supervisor: Jesus Vega Encabo Email: jesus.vega@uam.es	Epistemology of AI: from epistemic opacity to ethical issues	AI tools are deeply transforming our knowledge production practices, both in scientific research and in many everyday contexts. It is well known that these systems are highly epistemically opaque. Not only are there few users who can design specific tools for concrete research applications, but the very functioning of these tools is opaque. They share with many of the computational tools used in science a high degree of epistemic opacity. This project investigates the specific forms that this opacity takes, how it affects knowledge production practices, and whether, in certain contexts, this leads to specific ethical problems. References: https://doi.org/10.5840/techne202598214 https://www.tandfonline.com/doi/full/10.1080/0020174X.2024.2370520 www.taylorfrancis.com/chapters/edit/10.4324/9781003003465-14/understanding-value-intellectual-autonomy-jesús-vega-encabo https://link.springer.com/article/10.1007/s11229-019-02233-6
Supervisor: Maria Carmen Hidalgo Giralt	Foodification and Urban Transformation: Critical	This line of research examines foodification, understood as the urban transformation driven by the expansion of food-related services —such as bars, cafés, and restaurants— from a critical urban geography perspective. Through comparative analysis across different contexts, it

Co-supervisor: Diego Barrado Timón Email: carmen.hidalgog@uam.es	Geographies of Food, Space, and Power	explores the relationships between food, space, and power, analyzing how food culture operates as a tool for the reconfiguration of cities. The aim is to understand the social, economic, and spatial implications of foodification, as well as its connections to globalisation dynamics, the production of urban space, and discourses on authenticity and sustainable urban development. References: (1) https://doi.org/10.3280/rgioa4-2022oa14991 (2) https://doi.org/10.3280/rgioa4-2022oa14997 (3) https://doi.org/10.1016/j.cities.2020.102746 (4) https://doi.org/10.1111/1468-2427.13212
Supervisor: Diego Antonio Barrado Timon Co-supervisor: Carmen Hidalgo Giratl Email: diego.barrado@uam.es	Infrastructures of Hospitality: People, Precarity and the Shadow Politics of Care in Tourist Cities	In global tourist cities, “hospitality” has become a core branding value. However, the image of hospitality is maintained by labor and people in the shadows—Airbnb hosts, temporary workers, migrant tour guides, and informal volunteers. This study adopts the lens of care infrastructure to examine how “people as infrastructure” sustain the operations and experiences of cities under conditions of welfare retrenchment and outsourced governance through informal labor, emotional ties, and mutual aid networks. Building on Power’s (2022) concept of shadow care infrastructures, the research reveals how “care” becomes both commodified and deinstitutionalized in tourist cities, acting as a hidden force in sustaining urban economies. References: - doi.org/10.1016/j.cities.2020.102662 - doi.org/10.1177/03091325221109837 - L145doi.org/10.1080/14036096.2025.2483741
Supervisor: Antonio Moreno Sandoval Email: antonio.msandoval@uam.es	Digital humanities with AI: translations of Don Quixote into Chinese.	The LLI-UAM is developing a project (GRESEL) to apply an IA technique known as RAG (Retrieval Augmented Generation) for use in the analysis of literary works. We have already integrated the version of Don Quixote developed at the UAM by Sevilla and Rey, along with a complete dictionary of headwords, forms and characters. The research proposal aims to incorporate Chinese translations into the system and develop a lexical, syntactic, and cultural comparison between the two languages. References: 1. Ueda y Moreno-Sandoval (coord) (en prensa) Lexicografía del Quijote. 2. LYNEAL tool: https://h-ueda.sakura.ne.jp/lyneal/quijote.htm) 3. GRESEL project: https://www.lllf.uam.es/wordpress/gresel/ 4. Sevilla, Florencio y Rey, Antonio (1996): Don Quijote de la Mancha I y II, Madrid, Alianza Editorial con la colaboración del Centro de Estudios Cervantinos

Universidad Autónoma de Madrid

Faculty of Psychology

Supervisor Info	Project Title	Project Abstract
Supervisor: Ela I. Olivares Carreño Co-supervisor: Jaime Iglesias Dorado Email: ela.olivares@uam.es	Neurocognitive markers of neurodegenerative diseases	Perceptive functions are studied by means of neuropsychological tests concerning memory, language and executive functions in Parkinson and Alzheimer diseases. Neurophysiological recordings are carried out in both resting conditions and in response to visual stimuli as faces and objects to target evoked signals that denote neurodegeneration. Also, we studied brain oscillations to investigate default neural networks in the aging brain. Moreover, both neuropsychological and neurophysiological activities are longitudinally analysed and integrated to define perceptive early markers and their progression along the ventral pathway in these neurodegenerative diseases. References: NeuroImage [doi: 10.1016/j.neuroimage.2025.121039] Cortex [doi: 10.1016/j.cortex.2025.08.004] Frontiers in Aging Neuroscience [doi: 10.3389/fnagi.2022.893818] Cortex [doi: 10.1016/j.cortex.2020.10.017]
Supervisor: Mario Carretero Rodriguez Email: mario.carretero@uam.es	MakingHistories. www.making-histories.eu	A project to promote an interdisciplinary and dialogical conception of the production of knowledge on historical culture and education, in a growing context of globalisation. The central aim of this project is the creation of an international and interdisciplinary network of institutions to produce new knowledge in order to enhance the role of historical representations in today's democratic and reflective societies. A total of 18 institutions from Europe, Australia, Canada, Korea, Israel and Latin America will participate. This project will produce research articles, books, and a digital professional development course, generating a dialogical vision in history teaching. The project is funded with 540,000 euros and is coordinated by M. Carretero. (UAM, Spain) References: (2025-in press). Rodriguez-Moneo, M., & Carretero, M. History education: present and future challenges. Current Opinion in Psychology. (2022) Carretero, M., Wagoner, B., & Manjarrez, E. P. (Eds.) Historical reenactment: new ways of experiencing history. Berghahn Books. (2022) Carretero, M., Cantabrana, M. and Parellada, C. (Eds.). History Education in the Digital Age. Springer. (2017) Carretero, M., Berger, S. and Grever, M. (Eds.) Palgrave Handbook of Research in Historical Culture and History Education. Palgrave MacMillan
Supervisor: Manuela Costa Email: manuela.costa@uam.es	Cross-Species Investigation of Sharp-Wave Ripples in Emotional Memory	This project examines how hippocampal sharp-wave ripples (SWRs) support memory retrieval and hippocampal–cortical communication across humans and nonhuman primates. Combining intracranial EEG, high-density electrophysiology, and behavioral measures, it will examine the mechanisms by which SWR-related processes support emotional memory. By integrating neural, eye-tracking, and autonomic data, the study

		aims to uncover shared markers of memory–emotion dynamics across species. Findings will advance translational models of affective memory and inform therapeutic strategies for memory-related disorders. References: Buzsáki, G. (2015). Hippocampal sharp wave–ripple: A cognitive biomarker for episodic memory and planning. Hippocampus, 25(10), 1073–1188. https://doi.org/10.1002/hipo.22488 Norman, Y., Yeagle, E. M., Khuvis, S., Harel, M., Mehta, A. D., & Malach, R. (2019). Hippocampal sharp-wave ripples linked to visual episodic recollection in humans. Science, 365(6454), eaax1030. doi: 10.1126/science.aax1030 Costa, M., Lozano-Soldevilla, D., Gil-Nagel, A. et al. Aversive memory formation in humans involves an amygdala-hippocampus phase code. Nat Commun 13, 6403 (2022). https://doi.org/10.1038/s41467-022-33828-2 Costa, M., Pacheco-Estefan, D., Gil-Nagel, A. et al. Human hippocampal reactivation of amygdala encoding-related gamma patterns during aversive memory retrieval. Nat Commun 16, 6820 (2025). https://doi.org/10.1038/s41467-025-61928-2

Universidad Autónoma de Madrid

Faculty of Sciences

Supervisor Info	Project Title	Project Abstract
Supervisor: Antonio Benayas Co-supervisor: Daniel Jaque García Email: antonio.benayas@uam.es	Spectroscopic Signatures of Nanoparticle Degradation in Living Cells by FLIM	This project explores the degradation of luminescent nanoparticles in biological environments through single-particle experiments using the state-of the-art Fluorescence Lifetime Microscopy (FLIM). By analyzing changes in luminescence decay and lifetime, it monitors how different intracellular conditions affect nanoparticle stability. References: https://doi.org/10.1002/adma.202107764 https://pubs.acs.org/doi/full/10.1021/acsnano.4c13955
Supervisor: Gastón María García López Email: gaston.garcia@uam.es	Deciphering the Ultrafast Electronic Processes of Advanced Functional Materials Under High Energy Ion Irradiation	The student will work at the Centre for the Microanalysis of Materials (CMAM), an ion accelerator with ultrashort pulsing capabilities, and will perform experiments using ion beam induced luminescence (IBIL), an in-situ optical technique used to study fundamental properties of intrinsic and irradiation-induced optical centers1-3. Project activities include: IBIL measurements, materials characterization, and developing time-resolved capabilities4 (including fs-laser excitation). The aim of the project is to understand short-time-scale physical processes occurring during ion-matter interactions in conventional optical materials such as silicates, fluorites, and III-V semiconductors, as well as advanced sensing and quantum materials such as diamond, gallium oxide, and perovskites. https://doi.org/10.1016/j.vacuum.2024.113951 https://doi.org/10.1016/j.apmt.2024.102494 https://doi.org/10.1016/j.actamat.2022.117829 https://doi.org/10.1088/1402-4896/adb5d4
Supervisor: Javier del Pino Gutierrez Co-supervisor: Faculty of Sciences Email: Miguel Bello Gamboa		
Supervisor: Manuel Pazos Don Pedro Co-supervisor: David Ruano Gallego Email: manuel.pazosd@uam.es	Mechanistic and Therapeutic Insights into Preseptal Growth in Gram-Negative Bacteria	By integrating molecular biology and biochemistry approaches with advanced microscopy techniques, our goal is to elucidate the molecular mechanisms underlying the biogenesis of the bacterial cell envelope—including the peptidoglycan layer and both membranes—with a particular focus on the preseptal stage. Using Escherichia coli and/or Salmonella enterica as model organisms, we aim to gain a deeper understanding of the critical role that cell envelope architecture and integrity play in the physiology and pathogenicity of Gram-negative bacteria. Understanding these processes at the molecular level will provide fundamental insights into bacterial growth and may open new avenues for the development of antimicrobial strategies targeting envelope biogenesis. References: • https://doi.org/10.1371/journal.pgen.1011626 • https://doi.org/10.1038/s41586-022-04834-7 • https://doi.org/10.1128/mbio.02796-20 • https://doi.org/10.1038/s41467-018-07559-2
Supervisor: Laura Formentini . Email: laura.formentini@uam.es	Fatty Acid Oxidation Impairment in Systemic Homeostasis (FISH)	Mitochondrial fatty acid oxidation (FAO) is emerging as a promising therapeutic target in complex pathologies, as metabolic disorders and cancer. Using models of mitochondrial dysfunction (mice with defects in fatty acid oxidation, LowFAO), we will study how environmental factors (age, sex, diets) affect metabolism at the cellular, tissue, and organism levels, identifying new mitochondrial aspects that limit cellular homeostasis. References: 1) doi: 10.1038/s42255-023-00956-y

		2) doi: 10.1038/s41419-022-05016-z. 3) doi: 10.15252/embj.2019103812. 4) doi: 10.1038/s41467-020-17384-1.
Supervisor: Tania Garcia Mendiola Email: tania.garcia@uam.es	Multiplex smart biosensors for the early diagnosis of autism spectrum disorder(AUTISMBIOSENS)	The main aim of the AUTISMBIOSENS project is to design, develop, validate, and transfer to the manufacturing and business sectors cutting-edge methodologies to solve a current significant problem by multidisciplinary research, particularly focused on achieve an early autism spectrum disorder (ASD) diagnosis by detecting new emerging biomarkers associated with this disorder. We propose new methodologies based on multiplex smart electrochemical biosensors, prepared using new environmentally friendly biopolymers and Covalent Organic Frameworks (COFs). These biosensors are simple, fast and low cost and will represent an advance in terms of diagnosing, stratify patients and design the most precise and effective treatments. References: https://doi.org/10.1016/j.bios.2025.118014, https://doi.org/10.1007/s00604-025-07084-2,https://doi.org/10.1039/d4nr05258g,https://doi.org/10.1021/acssensors.4c00981
Supervisor: Maria Yañez Mo Email: maria.yannez@uam.es	Membrane nanodomains connecting mitochondrial turnover and the cellular secretome	Our group is interested in deciphering the intercellular communication between tumors and the immune cells, to unravel new targets for immunotherapy. We have recently reported that deleting a membrane protein that generates membrane nanodomains impact on mitochondrial turnover through autophagy and that results in changes in the tumor secretome. In this project we aim to study how these changes in tumor cell metabolism are translated to the interplay with the immune system. References: 1 doi: 10.1002/jev2.70166 2 doi: 10.20517/evcna.2025.14 3 doi: 10.1002/jev2.12082
Supervisor: Juan Garcia-bellido Capdevila Email: juan.garciabellido@uam.es	Dynamical Captures in LIGO-Virgo-KAGRA interferometers of Gravitational Waves	The aim of the PhD project is to explore the regime of dynamical captures and close hyperbolic encounters in dense clusters of primordiqal black holes that may constitute the bulk of the dark matter in the Universe. We will use numerical techniques and will compare the predicted mass and spin distributions with observations of gravitational waves performed with the LIGO-Virgo-KAGRA interferometers. References: Spin induction from scattering of two spinning black holes in dense clusters Jorge L. Rodríguez-Monteverde, Santiago Jaraba, Juan García-Bellido Physics of the Dark Universe 47, February 2025, 101776 https://doi.org/10.1016/j.dark.2024.101776 Primordial black hole clusters, phenomenology & implications José Francisco Nuño Siles, Juan García-Bellido Physics of the Dark Universe 47, February 2025, 101789 https://doi.org/10.1016/j.dark.2024.101789 Black hole induced spins from hyperbolic encounters in dense clusters Santiago Jaraba, Juan García-Bellido

		Physics of the Dark Universe 34, December 2021, 100882 https://doi.org/10.1016/j.dark.2021.100882 Observational evidence for primordial black holes: A positivist perspective B.J. Carr, S. Clesse, J. García-Bellido, M.R.S. Hawkins, F. Kühnel Physics Reports 1054, 26 February 2024, Pages 1-68 https://doi.org/10.1016/j.physrep.2023.11.005
Supervisor: Weiguang Cui Email: weiguang.cui@uam.es	The evolution of Galaxy clusters and its impacts	Galaxy clusters are the largest gravitationally bound structures in the universe, comprising hundreds to thousands of galaxies, vast quantities of hot intracluster gas, and significant amounts of dark matter. Studying the formation and evolution of galaxy clusters provides critical insights into the large-scale structure of the cosmos, the behavior of dark matter and dark energy, and the processes governing galaxy formation and interaction. This project aims to investigate the evolutionary history of galaxy clusters from their initial formation in the early universe to their current observed states. Benefited from the300 galaxy cluster project (Cui+18), especially its recent development (Onions+25), which include early-formed clusters in its sample, this study will explore how these massive structures grow through hierarchical merging and accretion, how the properties of member galaxies evolve within the cluster environment, and how feedback mechanisms (such as active galactic nuclei and supernovae) influence both intra-cluster gas and star formation by comparing the early- and late-formed clusters. References: doi:10.1093/mnras/sty2111 doi:10.1038/s41550-021-01404-1 doi:10.1093/mnras/stac1402 doi:10.1093/mnras/stae2115 doi:10.1093/mnras/staf1293
Supervisor: Maria Reguera Blazquez Email: maria.reguera@uam.es	Heritable Root and Stress-Response Traits in Quinoa and Amaranth: Physiological, Molecular, and Epigenetic Adaptation to Combined Heat and Drought	This project explores the adaptive strategies of quinoa (Chenopodium quinoa) and amaranth (Amaranthus spp.) under simultaneous heat and drought stress. Focus is placed on root system architecture, physiological performance, and heritable traits that drive resilience. Whole-Genome Bisulfite Sequencing (WGBS) will be applied to uncover DNA methylation patterns associated with stress adaptation. By integrating physiological, molecular, and epigenetic data, the study will identify key mechanisms and heritable markers of tolerance. Special attention will be given to the transmission of adaptive traits across generations. Outcomes will contribute to breeding strategies for climate-resilient emerging crops. References: https://doi.org/10.1186/s40793-025-00673-x https://doi.org/10.1016/j.envexpbot.2023.105350 https://doi.org/10.1038/s41598-023-32114-5 https://doi.org/10.1016/j.jafr.2025.102197
Supervisor: Diego Llusia Genique Email: diego.llusia@uam.es	Bioacoustics, artificial intelligence and citizen science: new tools for monitoring biodiversity	In the last two decades, the study of biodiversity has undergone a remarkable change. Acoustic monitoring (PAM) is revolutionizing traditional surveys and expanding our capacity to investigate communities and animal behaviour. By integrating audio sensors and artificial intelligence (AI), we are now able to automatically record animal acoustic activity at large time and spatial scales. This project aims to develop and apply these techniques for anuran

		and bird species from East Asia, by (i) reviewing the state-of-the-art; (ii) generating datasets of species calls; (iii) developing AI models for automated call recognition; and (iv) demonstrating how PAM is a valuable method for global change research. The PhD student will be highly trained in bioacoustics and artificial intelligence, an emerging field in ecology. References: Sugai, L. S. M., Silva, T. S. F., Ribeiro Jr, J. W., & Llusia, D. (2019). Terrestrial passive acoustic monitoring: review and perspectives. BioScience, 69(1), 15-25. https://academic.oup.com/bioscience/article/69/1/15/5193506 Llusia, D., Márquez, R., Beltrán, J. F., Benítez, M., & Do Amaral, J. P. (2013). Calling behaviour under climate change: geographical and seasonal variation of calling temperatures in ectotherms. Global change biology, 19(9), 2655-2674. https://onlinelibrary.wiley.com/doi/full/10.1111/gcb.12267 Gao, X., Jin, C., Llusia, D., & Li, Y. (2015). Temperature-induced shifts in hibernation behavior in experimental amphibian populations. Scientific Reports, 5(1), 11580. https://www.nature.com/articles/srep11580.pdf Cañas, J. S., Toro-Gómez, M. P., Sugai, L. S. M., Benítez Restrepo, H. D., Rudas, J., Posso Bautista, B., ... & Ulloa, J. S. (2023). A dataset for benchmarking Neotropical anuran calls identification in passive acoustic monitoring. Scientific Data, 10(1), 771. https://www.nature.com/articles/s41597-023-02666-2.pdf
Supervisor: Daniel Farias Tejerina Email: daniel.farias@uam.es	Activation of Greenhouse Gases for Clean Energy Applications: A Combined Molecular Beams and XPS Study	Sequestration and recycling of greenhouse gases have become one of the greatest environmental challenges. One straightforward solution is the reforming of methane with carbon dioxide (dry reforming of methane, DRM), which converts CO2 and CH4 into syngas, essential ingredients to produce organic fuels. Our project aims at studying the DRM process with atomic scale detail, by monitoring the interaction of monochromatic CO2 and CH4 molecular beams with oxide surfaces. We have recently demonstrated that this can be achieved using a unique system that was recently installed at UAM. This system combines variable-energy molecular beams and XPS in the same setup. References: [1] https://doi.org/10.1039/D3CP05071H [2] https://doi.org/10.1021/acs.jpclett.9b00158
Supervisor: Sara Cogliati Email: sara.cogliati@uam.es	Unraveling mitochondrial mechanisms in estradiol-cardiac protection: exploring therapeutic approaches for heart failure.	This PhD thesis investigates the role of mitochondria in estradiol-mediated cardiac protection and explores therapeutic approaches. We will use a heart failure (HF) model induced by chronic pressure overload via transverse aortic constriction (TAC) in fertile and postmenopausal female mice. Menopause will be simulated by ovariectomy (OVX) in 8-week-old mice, with TAC performed after 4 weeks when estrogen levels decline, causing uterine atrophy and cycle cessation. The study will compare two mouse strains with distinct electron transport chain organization. References: [1] doi: 10.1113/JP285516 [2] doi: 10.1038/s42255-022-00655-0. [3] doi: 10.1042/BST20210460. [4] doi: 10.1126/sciadv.aba7509
Supervisor: Dirk Ortgies Email: dirk.ortgies@uam.es	Targeted infrared fluorescence imaging of myocardial infarction	The principal cause of death in most countries are cardiovascular diseases. Therefore fast, precise and cost-effective diagnosis and imaging of ischemic events is needed.[1] The treatment after such an event – a heart attack – would greatly benefit from earlier diagnosis and visualization.[2,3] In this thesis rare-earth-doped nanoparticles, which are not affected by the endogenous autofluorescence of tissues when time-gated imaging in the partially transparent near-

		infrared is employed,[4] will be targeted as contrast and diagnostic agents to the infarcted heart. Towards that goal their functionalization with commercially available cardiovascular drugs will be studied in vitro, ex vivo and in 3D cell cultures. References: [1] 10.1002/adom.201800626 [2] 10.1007/s12274-019-2280-4 [3] 10.1002/smll.201907171 [4] 10.1021/acsnano.7b09189
Supervisor: Beatriz Fuensanta López Corcuera Co-supervisor: Francisco Zafra Gómez Email: beatriz.lopez@uam.es	Physiopathological aspects of glycine transporters in glycinergic neurotransmission: hyperekplexia and pain	Glycine is the main inhibitory neurotransmitter in caudal central nervous system and exerts sensorimotor control and nociceptive processing. The dysfunction of glycinergic inhibition leads to two main diseases: hyperekplexia and pathological pain. We study, at the cellular and molecular levels, physiology and pathologies of glycine transporters involved in glycinergic neurotransmission to provide therapeutic tools. We also extend our expertise to other neurotransmitter transporters. doi: 10.3390/ijms26146753, doi: 10.1111/jnc.16181, 10.1038/s42003-021-02718-6, 10.1016/j.neuropharm.2021.108543
Supervisor: Maria Dolores Martin Fernandez Email: dolores.martin@uam.es	Quantum fluids of light for nanophotonic technologies	In semiconductor microcavities, it is possible to achieve a condensation of particles, called polaritons, similar to atomic Bose-Einstein condensation. These polariton condensates can be manipulated by optical means and can be made to move along a circuit, rotate in a vortex shape, etc. The PhD will study the motion dynamics of these condensates in one-dimensional microcavities (waveguides), both in real and reciprocal space, imprint vortices, turn around circuit bends, etc. A similar kind of study can be performed simultaneously on organic and/or perovskite based microcavities. References: DOI: 10.1002/adom.202400420 DOI: 10.1021/acsphotonics.1c00746 DOI: 10.1103/PhysRevLett.126.075302 DOI: 10.1002/adom.202000650
Supervisor: Sandra Gomez Email: sandra.gomezr@uam.es	Benchmarking nonadiabatic molecular dynamics	This PhD project benchmarks nonadiabatic molecular dynamics methods to simulate coupled electronic and nuclear motions in excited states within the framework of computational theoretical chemistry. It covers trajectory-based surface hopping, quantum wavepacket dynamics, and Gaussian-based approaches such as multiple spawning. The aim is to systematically assess their accuracy, efficiency, and applicability across representative molecular systems. The project focuses on capturing phenomena such as electronic decoherence, energy transfer, and photochemical pathways. Collaboration with researchers in Paris and Marseille, France, enriches the project's international scope. Comparisons with experimental data will validate and guide improvements to existing methods. The work aims to establish best practices for reliable simulations of ultrafast molecular processes relevant to photophysics, photochemistry, and materials science. It will contribute to advancing computational tools for complex nonadiabatic dynamics in diverse chemical environments. References: (1) DOI: 10.1039/D5CP02117K (2) DOI: 10.1021/acs.jctc.5c01002

		(3) DOI: 10.1021/acs.jpca.5c02171 (4) DOI: 10.1063/5.0197895
Supervisor: Luca Merlo Email: luca.merlo@uam.es	Exploring Hidden Particles: New Frontiers in Axion and ALP Physics	Axion and ALP physics is currently one of the most active research areas, both theoretically and experimentally. This project focuses on studying axion/ALP properties across different energy regimes, with the aim of identifying solutions to the Strong CP problem and other open questions in the Standard Model of particle physics. The project can take many directions, depending on the student's research interests and the needs of the community. Possible avenues include formal studies of axion/ALP model building at zero or finite temperature, as well as more applied analyses at flavor facilities and colliders. The student will be integrated into the research group at IFT/UAM, which maintains active international collaborations. References: (1) doi:10.1140/epjc/s10052-017-5111-3; (2) doi:10.1007/JHEP10(2017)168; (3) doi:10.1007/JHEP09(2022)210; (4)doi:10.1007/JHEP03(2024)094
Supervisor: Maria Salome Rodriguez Morgade Email: salome.rodriguez@uam.es	Synthesis and supramolecular organization of subporphyrazines as fluorogenic, photoactivatable and photosensitizing materials	This project exploits Subporphyrazines (SubPzs) as scaffolds for engineering smart, activatable fluorophores and photosensitizers. SubPz photophysical, chemical, redox, and supramolecular properties are finely tunable via chemical manipulation or external stimuli. Objectives include (i) fluorophores enabling subcellular membrane/organelle localization with concomitant singlet-oxygen photosensitization for cellular imaging and advanced therapeutics, (ii) stimuli-responsive probes exhibiting polarity-, viscosity-, pH-, or redox-dependent fluorescence/photosensitization and (iii) photoswitchable near-infrared absorbers, activated by benign green-to-red light, for advanced tissue-compatible phototherapeutics. These systems will be studied for real-time subcellular visualization, morphological monitoring, detection of pathophysiological dysfunctions and precision therapies. References: 1. DOI: org/10.1016/j.ejmech.2024.117214 2. DOI: 10.1021/acs.orglett.3c04320 3. DOI: 10.1002/anie.202011197 4. DOI: 10.1021/acs.joc.9b02658
Supervisor: Mercedes Regadio Garcia Co-supervisor: - Email: mercedes.regadio@uam.es	Bio-Hybrid Barriers for Enhanced Landfill Containment	Landfill barriers are passive and degrade over time, allowing leachate to escape. This research topic focuses on developing bio-hybrid liners that integrate microorganisms with inorganic matrices to form adaptive and self-healing barriers. These living systems will trap pollutants, repair damage and adjust their properties in response to evolving waste compositions and environmental conditions. By combining microbiology, materials science, and environmental engineering, landfill containment can evolve from passive waste isolation into active resource management. Performance will be evaluated through laboratory column tests, geochemical modeling, and simulations to optimize and predict long-term behavior while advancing sustainable waste management and circular economy goals DOI: https://doi.org/10.1016/j.jenvman.2018.05.039 DOI: https://doi.org/10.1007/s11356-025-36412-5 DOI: https://doi.org/10.1080/01490451.2020.1786866 DOI: https://doi.org/10.1016/j.cej.2025.166611
Supervisor: Salvatore Assenza . Email: salvatore.assenza@uam.es	Multiscale simulation and theory of biomacromolecules in	We study the physics of biomacromolecules like nucleic acids, proteins, lipids, and their complexes and aggregates, to assess their role in biocellular processes or their exploitation to develop novel nanomaterials, often in collaboration with experimentalists. We employ

	biocellular processes and nanotechnology	soft-condensed matter theory and molecular simulations at scales ranging from atomistic to coarse-grained models at different levels of resolution. The PhD project will be framed within this general approach, focusing on a system which will be decided together with the PhD candidate. Examples of our current interests are e.g. physics of RNA secondary structure, amyloids, structure and flexibility of DNA, molecular chaperones. References: 1. ACS Nano 18, 21376 (2024), https://doi.org/10.1021/acsnano.4c05857 2. Adv. Sci. 11, 2402740 (2024), https://doi.org/10.1002/advs.202402740 3. Nanoscale 15, 6738 (2023), https://doi.org/10.1039/D2NR06324G 4. J. Chem. Theory Comput. 18, 3239 (2022), https://doi.org/10.1021/acs.jctc.2c00138
Supervisor: Amadeo Lopez Vazquez de Parga Email: al.vazquezdeparga@uam.es	Study of van der Waals heterostructures of quantum materials by means of scanning tunneling microscopy	References: "Probing the phase transition to a coherent 2D Kondo lattice", Small 20, 2303275 (2024) DOI: 10.1002/smll.202303275 "Electron delocalization in a 2D Mott insulator", Nature Communications 15, 10272 (2024) DOI: 10.1038/s41467-024-54747-4 "Unveiling the interlayer interaction in a 1H/1T-TaS2 van der Waals heterostructure", Nano Letters 24, 10805 (2024) DOI: 10.1021/acs.nanolett.4c02068 "Engineering a spin-orbit bandgap in graphene-tellurium heterostructures", Advanced Functional Materials 35, 2425154 (2025) DOI: 10.1002/adfm.202425154
Supervisor: José Alberto Baeza Herrera Co-supervisor: Luisa Calvo Hernández Email: josealberto.baeza@uam.es	Hydrogen production from the thermocatalytic decomposition of ammonia in the aqueous phase	Hydrogen production from the thermocatalytic decomposition of ammonia in the aqueous phase is an emerging strategy to generate clean fuel with reduced carbon emissions. Ammonia, a hydrogen-rich compound, can serve as an efficient carrier and storage medium. Its catalytic decomposition in water offers a promising alternative to conventional hydrogen production routes, as it can be performed under relatively mild conditions and integrated with existing systems. The process relies on advanced catalysts to enhance conversion, enabling sustainable hydrogen generation for energy applications, contributing to a greener energy landscape References: https://doi.org/10.1016/j.cej.2022.136301 https://doi.org/10.1016/j.cej.2023.141770, https://doi.org/10.1016/j.cej.2023.146860, https://doi.org/10.1016/j.biortech.2024.130572
Supervisor: Iolanda Di Bernardo Email: iolanda.dibernardo@uam.es	Designing and Probing Correlated Quantum Materials	Aim of this project is the synthesis and investigation of quantum materials hosting exotic electronic properties arising from strongly correlated electrons. Using molecular beam epitaxy we will synthesize high-quality ultra-thin films and heterostructures, enabling precise control over crystallinity and interface design. Characterization will be performed with scanning tunnelling spectroscopy and microscopy to probe local density of states, surface morphology, and emergent quantum phenomena at the atomic scale. The goal is to unravel the interplay between material structure and correlated electronic states in novel quantum materials, and harness their potential as platforms for the new generation of low energy electronic devices. References: DOI: 10.1021/acsnano.5c08005
Supervisor: Patricia Haro Gonzalez Co-supervisor: Daniel Jaque García Email: patricia.haro@uam.es	Optical Trapping Meets FLIM: Real-Time Sensing with Single Luminescent Nanoparticles	Join a pioneering PhD project that combines optical trapping with FLIM for the first time. You will isolate single luminescent nanoparticles and use their lifetime as a remote sensor of biological and physical processes. This unique setup enables real-time monitoring of

		nanoparticle transformations inside living cells. Be part of a cutting-edge journey at the intersection of photonics, nanomedicine, and advanced microscopy. References: doi.org/10.1002/smtd.202400718 doi.org/10.1002/smll.202308534 10.1021/acsphotonics.4c00702 10.1021/ph500371z
Supervisor: Rocio Gomez Lencero Co-supervisor: Jesús Page Utrilla Email: rocio.gomez@uam.es	Evolutionary analysis of the nucleocytoplasmatic relationships during mammalian spermatogenesis	This project investigates the evolutionary dynamics of nucleocytoplasmic interactions during mammalian spermatogenesis, with emphasis on meiosis—chromosome pairing, recombination, and segregation—and the role of the cytoskeleton in spermatozoa formation. We explore how molecular signals and structural dynamics between nucleus and cytoplasm shape germ cell differentiation, chromatin remodeling, and sperm maturation. Using mouse models and diverse mammalian species, our evolutionary approach uncovers conserved and divergent mechanisms of reproductive success. Outcomes range from advancing knowledge on infertility and aneuploidies to assessing environmental genotoxic impacts, with special attention to the evolution of sex chromosomes across mammalian species, including humans. References: DOI: https://doi.org/10.1101/2025.06.19.660582 DOI: 10.3390/cells12010142 DOI: https://doi.org/10.15252/embr.202051030 DOI: 10.1242/jcs.259546
Supervisor: Ruben Perez Perez Email: ruben.perez@uam.es	Molecular Identification Based on Atomic Force Microscopy and Deep Learning	This PhD project will contribute to the effort in our theoretical group to develop a fully automated Atomic Force Microscopy (AFM)-based analytical technology capable of determining the structure and chemical composition of organic molecules with a level of precision and sensitivity beyond the reach of traditional spectroscopic techniques, including nuclear magnetic resonance (NMR), mass spectrometry (MS), and X-ray diffraction. This technology merges the unparalleled spatial resolution of AFM with functionalized tips with advanced Deep Learning (DL) models, enabling molecular identification and structural characterization at the single-molecule level for compounds produced through on-surface chemistry or conventional solution synthesis. References: https://doi.org/10.1021/acs.jcim.1c01323 https://doi.org/10.1021/acsami.3c01550 https://doi.org/10.1038/s41524-023-01179-1 https://doi.org/10.1186/s13321-024-00921-1
Supervisor: Maria Pilar Amo Ochoa Email: pilar.amo@uam.es	Copper(I)- and Manganese(II)-Based Organic–Inorganic Hybrid Metal Halides: Structure, Photocatalytic Performance, and Sensing Applications"	Organic–inorganic hybrid metal halides (OIHMH) based on Cu(I) and Mn(II) represent an emerging class of materials, less explored than Pb(II) or Sn(II) perovskites, yet highly promising for optoelectronics, photocatalysis, and luminescence. These systems often adopt low-dimensional (0D, 1D, 2D) architectures with diverse metal–halide clusters. They exhibit strong photoluminescence and room-temperature phosphorescence due to spin–orbit coupling in heavy halides (Cl, Br, I). Our research focuses on their photocatalytic activity in dye degradation and CO_2 reduction to alcohols, as well as in sensor design for antibiotic and heavy-metal detection in water, emphasizing synthetic control for particle size and processable suspensions. References: M. Murillo, J. Álvarez Conde, R. Wannemacher, J. Cabanillas-Gonzalez, J. Gonzalez-Platas, U. R. Rodriguez-Mendoza, A. Liang, R. Turnbull, D. Errandonea, J. I. Martínez and P. Amo-Ochoa, Cu(I)-I-pyrazine coordination polymer with pressure-induced

		phase transition and opto-electronic response à la carte depending on mechanical stimuli, temperature, and CuI content. J. Mater. Chem. C, 2022, 10, 18004-18016. DOI: 10.1039/D2TC04127H1D M Murillo, A García-Hernan, J López, J Perles, I Brito, P Amo-Ochoa*. The flexibility of CuI chains and the functionality of pyrazine-2-thiocarboxamide keys to obtaining new Cu (I)-I coordination polymers with potential use as photocatalysts for … Catalysis Today , 2023, 418, 114072. https://doi.org/10.1016/j.cattod.2023.114072 García-Hernán, Andrea; Brito-Santos, Gabriela; de la Rubia, Elena; Aguilar-Galindo, Fernando; Castillo, Oscar; Lifante-Pedrola, Ginés; Sanchiz, Joaquín; Guerrero-Lemus, Ricardo; Amo-Ochoa, Pilar. Determining Factors to understand the external quantum efficiency values. Study carried out with Copper(I)-I and 1,2-bis(4-pyridyl) ethane coordination polymers as downshifters in photovoltaic modules" Inorg. Chem. 2024, 63, 10, 4646–4656. DOI: 10.1021/acs.inorgchem.3c04232 Low-cost, robust, and transportable devices based on Cu(I)-I cluster hybrid luminescent compound as tetracycline sensors for contaminated waters. Authors: Elena De La, Rubia, Ricardo Garsed, Fernando Aguilar-Galindo, Andrea García-Hernán, Gines Lifante-Pedrola, Pilar Amo-Ochoa, Journal of Materials Chemistry B, 2025, DOI: 10.1039/D5TB00353A
Supervisor: David Ruano Gallego Co-supervisor: Manuel Pazos Don Pedro Email: david.ruanog@uam.es	Synthetic biology in the probiotic Escherichia coli Nissle 1917 for the inducible and controlled expression of the Type 6 Secretion System.	Finding alternative therapies to antibiotics to treat intestinal bacterial infections is crucial. The use of beneficial strains such as the probiotic Escherichia coli Nissle 1917 (EcN) is a promising strategy. The effects of EcN can be enhanced by controlling the expression of its Type VI Secretion System (T6SS), a system that allows it to eliminate competing bacteria. The project will use synthetic biology techniques to genetically engineer and test EcN for this purpose. References: 1. https://doi.org/10.1126/science.abc9531 2. https://doi.org/10.1021/acssynbio.5b00080 3. https://doi.org/10.1186/s12934-019-1094-0 4. https://doi.org/10.1371/journal.ppat.1008031
Supervisor: Carolina Belver Coldeira Co-supervisor: María Ariadna Álvarez Montero Email: carolina.belver@uam.es	Removal of persistent organochlorides (POCs) and pharmaceuticals in aqueous streams	Emerging pollutants, understood as those that have gone unnoticed until recently, constitute a social problem of great importance due to their impact on health and the environment. These pollutants include industrial chemicals, particularly persistent organochlorides (POCs), and pharmaceuticals. Their removal from wastewater represents a significant scientific and technological challenge due to their high stability and resistance to degradation into harmless compounds, their bioaccumulative character, their relatively low concentration in wastewater, and their toxicity (often endocrine disruptors) even at low doses. In this context, advanced oxidation processes (AOPs), especially when assisted by light, emerge as promising technologies to overcome these limitations. The development of efficient and sustainable catalysts with optimized structural, surface, and electronic properties is crucial to enhance the degradation of these pollutants and ensure the non-toxicity of the transformation products. The fundamental objective of this project is to design and implement novel photo-assisted catalytic systems that enable the efficient, sustainable, and economically viable removal of emerging pollutants from aqueous streams.

		References: https://doi.org/10.1016/j.apcatb.2025.125566 https://doi.org/10.1016/j.apcatb.2025.125673 https://doi.org/10.1016/j.jece.2023.109744 https://doi.org/10.1016/j.cej.2023.141889
Supervisor: Pedro Jose de Pablo Gomez Email: p.j.depablo@uam.es	Physical virology of individual virus particles: mechanics, uncoating and genome release	Virus particles must be stable enough to protect the genome during transmission but prepared to release the viral nuclei acids at the right time and place. This requires the virus capsid to be disassembled to deliver the genome into the host (uncoating). Disassembly can be mimicked in vitro by using physicochemical cues, such as mechanical and pH attacks. This project aims to study virus uncoating in native conditions (liquid) using single-molecule techniques, (Atomic Force Microscopy and Total Internal Reflection Microscopy. We propose measuring the mechanical properties of individual virus particles, inducing virus disassembly in vitro and monitoring the genome release at the nanoscale in real time. References: https://doi.org/10.1126/sciadv.ade9910 https://www.pnas.org/doi/full/10.1073/pnas.2307717120 https://doi.org/10.1103/PhysRevX.11.021025 https://doi.org/10.1039/D3NH00195D
Supervisor: Samuel Andrea Giuliani Email: samuel.giuliani@uam.es	Nuclear structure calculations for r-process nucleosynthesis	This PhD project focuses on advancing the theoretical description of the rapid neutron-capture process (r-process) through microscopic nuclear structure calculations. Nuclear properties of neutron-rich nuclei will be computed within the energy density functional framework. Machine learning algorithms will be developed to emulate complex calculations, enabling large-scale predictions with quantified uncertainties. These nuclear inputs will be incorporated into r-process simulations to assess their impact on abundance patterns. References: https://doi.org/10.1103/PhysRevC.102.045804 https://doi.org/10.1103/PhysRevC.109.044305. https://doi.org/10.1103/PhysRevC.101.044307. https://doi.org/10.48550/arXiv.2412.03243.
Supervisor: Manuel Ignacio Marques Ponce Email: manuel.marques@uam.es	Optical manipulation beyond the optical trapping	The manipulation of objects using light evolved from an exceptional new technique worthy of the 2018 Nobel Prize into a standard technique used in laboratories around the world. This technique is commonly used for trapping microparticles (J. Phys. Photonics, 2023, 5, 022501). However, other possibilities are presently emerging, such as nanoscopic, gravitational-like, induced interactions; magnetic monopole generation; and collective active diffusion. This thesis proposal will focus on the theoretical and computational study of these new fields and will benefit from the close collaboration with experimental partners working with the thesis supervisor. References: Scattering Forces from the Curl of the Spin Angular Momentum of a Light Field, Silvia Albaladejo, Manuel I. Marqués, Marine Laroche and Juan José Sáenz, Phys. Rev. Lett. 102, 113602 (2009) DOI: https://doi.org/10.1103/PhysRevLett.102.113602 Giant Enhanced Diffusion of Gold Nanoparticles in Optical Vortex Fields, Silvia Albaladejo,

		Manuel I. Marqués, Frank Scheffold and Juan Jose Sáenz, Nano Lett. (2009), 9, 10, 3527–3531 DOI: https://doi.org/10.1021/nl901745a Light Induced Inverse-Square Law Interactions between Nanoparticles: “Mock Gravity” at the Nanoscale J. Luis-Hita1, M. I. Marqués, R. Delgado-Buscalioni, N. de Sousa, L. S. Froufe-Pérez, F. Scheffold and J. J. Sáenz Phys. Rev. Lett. 123, 143201 (2019), DOI: https://doi.org/10.1103/PhysRevLett.123.143201 Magneto-optical Particles in Isotropic Spinning Fields Mimic Magnetic Monopoles Manuel I. Marqués, Shulamit Edelstein, Pedro A. Serena, Beatriz Castillo López de Larrinzar and Antonio Garcia-Martín, Phys. Rev. Lett. 133, 046901(2024) DOI: https://doi.org/10.1103/PhysRevLett.133.046901
Supervisor: Carlos Anton Solanas Email: carlos.anton@uam.es	Quantum fluids of light with perovskite polaritons	The project investigates quantum fluids of light formed by exciton–polaritons in perovskite microcavities, where strong light–matter coupling gives rise to collective quantum phenomena such as condensation and superfluidity.[1] Using open Fabry–Perot cavities and engineered metasurfaces,[2] the work will explore ultrafast polariton transport, nonlinear interactions, and spin control with dopants.[3] These systems enable the realization of room-temperature optical switches, logic gates, and polariton lasers, paving the way toward next-generation photonic devices. References: [1] 10.1038/s41563-021-01000-8 [2] 10.1038/s41467-021-24925-9 [3] 10.1021/acsnanoscienceau.4c00047
Supervisor: Jose Manuel Conde Alonso Email: jose.conde@uam.es	Cancellative sparse domination in Calderón-Zygmund theory	This is a project in harmonic analysis. The main goal is to advance in the theory of sparse domination, a novel technique in the area that has lead to a quantitative reinterpretation of singular integral The project will be carried over at the Analysis research group. So far, sparse domination techniques have not been able to include cancellation, and understanding that difficulty is the focus of the project. More information about the research topics of the proposal can be consulted on the webpage of the supervisor: https://sites.google.com/view/josecondealonso/ References: [1] DOI: 10.1007/s00208-024-02961-2 [2] DOI: 10.4007/annals.2023.198.3.5 [3] DOI: 10.1016/j.matpur.2022.05.011 [4] DOI: 10.1016/j.aim.2019.01.007
Supervisor: Luis Miguel Robledo Martin Email: luis.robledo@uam.es	Understanding nuclear fission from a microscopic perspective	Understanding fission of atomic nuclei as well as the properties of fission fragments is a challenge for modern quantum many body theories. The problem will be addressed by using modern microscopic methods like the time dependent generator coordinate method (TDGCM) combined with symmetry restoration of the underlying mean field states of the HFB kind. Physics at the scission line that determines fission fragment properties, emitted neutrons, etc as well as the disappearance of entanglement will be analyzed. Modern and performing finite range and density dependent nuclear energy density functionals will be used for the calculations. References: 1) DOI 10.1088/0034-4885/79/11/116301 2) DOI: https://doi.org/10.1103/PhysRevC.97.034323

		3) DOI: https://doi.org/10.1103/PhysRevC.99.034603 4) DOI: https://doi.org/10.1103/PhysRevC.90.054311
Supervisor: Macarena Muñoz Garcia Co-supervisor: Zahara Martínez de Pedro Email: macarena.munnoz@uam.es	Development and Intensification of Advanced Oxidation Processes for Micropollutants and Micronanoplastics Removal: From Kinetic Modeling to Real-Water Applications	Our research group is internationally recognized in environmental engineering, with extensive experience in Advanced Oxidation Processes (AOPs) for water treatment. This PhD project will focus on the degradation of emerging micropollutants, cyanotoxins, and micro/nanoplastics, building on our pioneering work on magnetic catalysts, kinetic modeling, and patented microplastic separation methods. The selected candidate will investigate advanced catalytic materials and sustainable treatment technologies, with emphasis on mechanistic insights and real-water applications. This project offers excellent opportunities for high-impact publications, professional development, and industrial collaborations, within a dynamic international team and a supportive environment that fosters both academic excellence and personal growth. References: - doi.org/10.1016/j.apcatb.2024.124751 - doi.org/10.1016/j.jece.2023.110581 - doi.org/10.1016/j.chemosphere.2022.136809 - doi.org/10.1016/j.jwpe.2025.108648
Supervisor: Maria Cristina Gutierrez Sanchez Co-supervisor: Emiliano Martinez Periñan Email: cristina.gutierrezs@uam.es	Innovation in Electrochemical Biosensors Using Advanced Nanomaterials for Biomarker Identification.	Innovation in electrochemical biosensors using advanced nanomaterials has transformed biomarker detection, enabling faster, more sensitive, and more specific diagnoses. Thanks to their exceptional properties, such as high conductivity, large surface area, and functionalization capabilities, nanomaterials significantly improve sensor performance, enabling the detection of ultra-low concentrations of analytes. These technologies favor the development of portable, low-cost devices for early point-of-care diagnosis, driving advances in personalized medicine and disease monitoring. Their versatility and efficiency position these biosensors as key tools in modern biomedicine. References: https://doi.org/10.1016/j.talanta.2023.124614 https://doi.org/10.1016/j.snb.2021.130096 https://doi.org/10.1007/s12274-020-3030-3 https://doi.org/10.1016/j.carbon.2019.12.053
Supervisor: Emiliano Martinez Periñan Co-supervisor: Maria Cristina Gutierrez Sanchez Email: emiliano.martinez@uam.es	Covalent Organic Frameworks-Based Nanomaterials for Oxygen Reduction Reactions (ORR) electrocatalysts development.	Oxygen reduction reaction (ORR) is an essential process in different areas such as biological respiration, energy conversion, and hydrogen peroxide generation. Platinum group metal (PGM) based electrocatalysts have been traditionally used to electrocatalyze ORR. Platinum reserves and production worldwide are very limited nowadays. Another drawback is the high amounts of electrocatalyst needed in the fabrication of cathode electrodes, increasing the cost. As an alternative to ORR electrocatalysts, covalent organic frameworks (COFs) are emerging as a powerful alternative. The project will design new COFs materials and the development of metal free ORR electrocatalysts and their application in fuel cell design. References: https://doi.org/10.1002/anie.202313940 https://doi.org/10.1002/smll.20240208. https://doi.org/10.1021/acssuschemeng.2c05826 https://doi.org/10.1039/C9CC06479F
Supervisor: Gerardo Pulido Reyes Co-supervisor: Francisca Fernández	Exploring the Bioremediation of Plastic Waste in the Environment.	This research focuses on microbial strategies for biodegrading plastic waste in the environment. By isolation of potential biodegraders from bacterial biofilms growing in plastics (the so-called plastisphere) and further analyzing biodegradation pathways and

Piñas Email: gerardo.pulido@uam.es		optimizing conditions for microbial activity, we aim to enhance the efficiency of plastic waste removal. It also evaluates ecological impacts and scalability of bioremediation techniques, contributing to sustainable water management and pollution reduction. References: https://doi.org/10.1016/j.enceco.2025.07.017; https://doi.org/10.1016/j.seppur.2023.125816; https://doi.org/10.1016/j.jhazmat.2022.130271; https://doi.org/10.1016/j.jhazmat.2022.129011;
Supervisor: Jose Garcia Email: jose.garciac@uam.es	Planar symmetric molecules for optoelectronic applications in materials chemistry and chemical biology	The project builds upon previous knowledge and projects of the researcher. It is focused on the areas of scientific interest, such as nanoscience, materials and photonics .On one hand, the PhD candidate would deal with molecular design and supramolecular chemistry studies, taking advantage of the knowledge of the research group as well as the director. Addtionally, and thanks to previous experience and the facilities available, a wide scope of applications is planned, covering not only materials chemistry, but also cellular biology. References: The Journal of organic Chemistry 2024 - 10.1021/acs.joc.4c02669 Advance Optical Materials 2024 - 10.1002/adom.202402127 Chemical Science 2022 - 10.1039/d1sc05208j JACS 2020 - 10.1021/jacs.0c04942
Supervisor: Gema Maria de la Torre Email: gema.delatorre@uam.es	Reactions in confined espaces: molecular cages and nanostructured materials	Many researchers have pursued the development of catalysts that emulate the capabilities of reactive cavities in biological systems. Coordination cages have drawn considerable attention as artificial catalysts for mimicking the reactivity of enzymes, since they can reversibly encapsulate substrate molecules, increasing their local concentration and resulting in a pronounced acceleration of the reaction. The proyect involves the preparation of coordination molecular cages based on porphyrinoid chromophores (i.e. phthalocyanines and sunphthalocyanines), and the development of photocatalyzed reactions under confinement, both in organic and aqueous solvents. The developmente of nanostructured covalent organic frameworks based on these chromophores for the developmente of photocatalyzed reactions is also envisioned. References: DOI: 10.1002/adsc.202301336 DOI 10.1002/anie.202311255 DOI 10.1039/D2SC01931K DOI 10.1021/acs.jmedchem.2c01940
Supervisor: Isabel Draper y Diaz de Atauri Co-supervisor: Francisco Lara Email: isabel.draper@uam.es	Deciphering the true diversity of Orthotrichaceae (mosses) in China: an integrative taxonomic approach	Orthotrichaceae is a highly diverse and widespread moss family. We study its diversity, distribution, and evolution using integrative approaches, and have described over 40 new taxa (https://www.orthotree.net). We have obtained samples from unexplored regions worldwide, including China. Many recent collections remain to be studied and will enhance understanding of the true Orthotrichaceae diversity in China, which is likely underestimated. The student will lead analyses of stored samples and help investigate poorly known areas in the country. The integrative approach combines advanced biometric analyses with taxonomy based on NGS and biogeographic modeling. References: DOI https://doi.org/10.3389/fpls.2024.1451005 DOI https://doi.org/10.1111/jse.13040 DOI https://doi.org/10.3389/fpls.2022.882960

		DOI https://doi.org/10.3389/fpls.2021.629035
Supervisor: Giorgio Cinacchi Email: giorgio.cinacchi@uam.es	dense packings and phase behaviour of hard-particle systems: concavity and higher dimensions	Systems of hard particles are basic model systems to investigate states of matter. While dense packings and phase behaviour of systems of hard convex particles in two and three dimensions have been much investigated, dense packings and phase behaviour of systems of hard concave particles in two and three dimensions and of systems of hard non-spherical particles in higher dimensions have been much less investigated. This project will attempt to contribute to filling this gap in (soft) condensed matter physics. References: doi:10.1063/1.5036657 doi: 10.1063/5.0110120 doi: 10.1063/5.0153596
Supervisor: Juan Jose Nogueira Perez Email: juan.nogueira@uam.es	Computational Design of Photoswitchable Psychedelic Drugs	Psychedelic compounds show neural activity immediately after a single dose by acting as agonists for 5-hydroxytryptamine receptors (5-HTR). These compounds could be used in therapies to treat depression. A precise spatial control of the drug to minimize side effects can be achieved by introducing photoswitchable groups, such as azobenzene derivatives, into the structure of psychedelic species. In this project, two of the key steps of the mode of action of photoswitchable psychedelic species will be modelled by molecular dynamics, free-energy calculations, and QM/MM approaches: (i) the binding of the photoswitchable drug to the 5-HT2A receptor and (ii) its photoisomerization mechanism. References: 10.1039/D5CP01252J 10.1002/anie.202413000 10.1021/acs.biochem.3c00598 10.26434/chemrxiv-2022-gkwnf
Supervisor: Rafael Sanchez Rodrigo Co-supervisor: Pablo Burset Atienza Email: rafael.sanchez@uam.es	Nonlinear thermal control in hybrid quantum devices	Nonlinear effects are crucial for designing key components of quantum technology like rectifiers, diodes, and transistors. While often overlooked, neglecting nonlinearities can result in violations of gauge invariance or in the omission of quantum-coherent effects. This thesis will theoretically address nonlinearities in charge and heat currents, focusing in multiterminal coherent conductors. Building on our extension of nonlinear theories for weakly interacting conductors [1], we aim to study more complex systems with interactions and hybrid junctions including superconductors [2]. Our goal is to define quantum-coherent thermal diodes [3] and transistors and optimize quantum heat engines [4]. References: [1] https://doi.org/10.1103/PhysRevLett.134.186301 [2] https://doi.org/10.1002/andp.202500197 [3] https://doi.org/10.1103/PhysRevLett.131.096001 [4] https://doi.org/10.1103/PhysRevB.106.115419
Supervisor: Guillermo Rey Ley Email: guillermo.rey@uam.es	Harmonic Analysis in the multiparameter setting	There are many problems in Harmonic Analysis which are completely open in the multiparameter setting. In the thesis, the student will study the strong maximal function and its generalizations in various spaces, and characterize its boundedness. This will touch open very interesting open problems such as Zygmund's conjecture. References: https://doi.org/10.1016/j.aim.2019.01.007

		https://doi.org/10.1016/j.aim.2013.12.030 https://doi.org/10.1007/s00208-015-1320-y https://doi.org/10.1090/proc/15222
Supervisor: Roberto Gimenez Conejero Email: roberto.gimenez@uam.es	Topological aspects of singular varieties	We will to study the topology of singular points of algebraic varieties (complex varieties in $\mathbb{C}^n$) or algebraic maps. In other words, what happens when a homeomorphism of $\mathbb{C}^n$ to itself maps one variety to another or, for maps, when two complex maps are the same after a continuous change of coordinates. There are many things that can be studied (see references) and we can change the topic. One open problem is the following: We know that the "Milnor number" is invariant under homeomorphisms for varieties of codimension one. The same problem is open for other kind of varieties. References: https://doi.org/10.48550/arXiv.2309.12958 https://doi.org/10.48550/arXiv.2402.13941 https://doi.org/10.48550/arXiv.1810.08673 https://doi.org/10.1007/978-3-030-34440-5
Supervisor: Linda Angela Zotti . Co-supervisor: Edmund Leary Email: linda.zotti@uam.es	Electron transport through molecular junctions	The unstoppable race toward the miniaturization of devices goes far beyond simple downscaling. At the nanoscale, such miniaturization opens up an immense range of new possibilities thanks to exotic manifestations of various physical processes. A field of great importance for emerging nanotechnologies is molecular electronics. In this project, electronic transport through metal-molecule-metal junctions will be studied. In particular, antiaromaticity, thermopower and spin-filtering properties will be examined. This will provide the basis for future work on how molecules can be employed in electronic devices, an issue of major technological importance in the coming decade. References: 1) https://doi.org/10.1039/D3TC04266A 2) https://doi.org/10.1021/acs.jpclett.3c02702 3) https://doi.org/10.1002/anie.202218640 4) https://doi.org/10.1002/chem.202400935
Supervisor: Leyre Marzo Puerta Email: leyre.marzo@uam.es	Design of a new family of N-heterocyclic carbene organocatalysts and development of new visible light-mediated transformations in organic synthesis	This doctoral thesis will focus on the development of a new family of N-heterocyclic carbene (NHC) organocatalysts and their employment in the development of new visible light-mediated photochemical transformations and activation modes in organic synthesis. The expertise of the group in the photochemical reactivity of key intermediates in NHC organocatalysis will enable the successful achievement of this objective. The new catalysts will allow the development of cascade processes and multicomponent reactions in organic synthesis beyond the state of the art. In addition, they will be implemented in electro-photocatalytic approaches, unlocking the complete capabilities of NHC catalysis in synthesis. References: 1.- I. MacLean, D. J. Grenda, E. Echávarri, S. Muth, P. Nuernberger, L. Marzo*, “Photochemical Insights on Acyl Azolium Salts Enable the Design of a Tandem Hydrogen Atom Transfer/Halogen Atom Transfer Acylation of Alkyl Bromides and

		Chlorides." *, J. Am. Chem. Soc. 2025, 147, 31324. DOI: 10.1021/jacs.5c10923 2.- L. Marzo* "Recent advances in organic synthesis using light-mediated N-heterocyclic carbene catalysis" Eur. J. Org. Chem. 2021, 4603-4610. DOI: 10.1002/ejoc.202100261 3.- B. Carli, N. Salaverri, L. Martínez-Fernández, M. Goicuría, J. Alemán*, L. Marzo* "PCET Ring Opening of Cycloalkanols followed by a Giese Radical Addition Enabled by an EDA Complex." Org. Lett. 2024, 26, 4542–4547 DOI: 10.1021/acs.orglett.4c01443 4.- I. MacLean, M. J. García, S. Cabrera*, L. Marzo*, J. Alemán*, "Electrochemically driven green synthesis to unlock sustainable routes to β-keto spirolactones" Green Chem. 2024, 26, 6553-6558. DOI: 10.1039/d4gc01127a
Supervisor: Alfredo Levy Yeyati Co-supervisor: Eduardo Lee Email: a.l.yeyati@uam.es	Protected qubits based on multiterminal Josephson-Andreev junctions	The aim of this combined theoretical/experimental project is to explore multiterminal Josephson junctions defined on 2D hybrid superconducting platforms, with the final goal of implementing qubits protected with respect to different noise sources. For that purpose, we will follow ideas put forward by us in a recent publication [1]. We will fabricate and simulate multiterminal Josephson junctions based on hybrid superconductor-semiconductor devices and characterize them by DC measurements [2]. We will then proceed to integrate these junctions into the hybrid geometries discussed in [1] and characterize their performance as qubits using cQED techniques [3,4]. References: [1] https://doi.org/10.1103/PRXQuantum.5.020340 [2] https://doi.org/10.1038/s41467-023-38533-2 [3] DOI: 10.1126/science.abf0345 [4] https://doi.org/10.1103/PhysRevX.9.011010
Supervisor: Ines Corral Perez Email: ines.corral@uam.es	Design and Theoretical Characterization of Hypoxia-Sensitive Fluorescent Probes for Cancer Imaging	This project focuses on the development and computational characterization of hypoxia-sensitive fluorescent probes for the early detection of solid tumors. Hypoxia is a hallmark of tumor progression, and exploiting the activity of oxygen-sensitive reductase enzymes enables selective detection of these environments. The student will investigate chromophores bearing bioreductive groups (e.g., nitroarenes, azo compounds, quinones) as turn-on, photoconvertible, or ratiometric probes, as well as thermally activated delayed fluorescence dyes for enhanced imaging contrast. The project will combine ab initio multiconfigurational calculations with semiclassical dynamics and classical molecular dynamics to characterize the photophysics and photochemistry of these probes in realistic biological environments. References: Chem. Rev. 2024, 124, 11, 7106–7164 (https://doi.org/10.1021/acs.chemrev.3c00776) Chem. Rev. 2017, 117, 9, 6160–6224 (https://doi.org/10.1021/acs.chemrev.6b00525) J. Am. Chem. Soc. 2022, 144, 18, 8185–8193 (https://doi.org/10.1021/jacs.2c01197)
Supervisor: Ruben Mas Balleste Co-supervisor: Alicia Moya Cuenca Email: ruben.mas@uam.es	Light against pollution: next generation of photocatalytic organic materials for global water purification	This thesis project develops advanced photocatalytic porous organic materials and hybrid systems with inorganic semiconductors to address global water contamination. These light-driven technologies aim to eliminate organic pollutants, microplastics, heavy metals, and pathogens sustainably and at low cost. Designed for scalability, these photocatalytic systems can offer transformative solutions for industrial and decentralized water treatment, enabling access to safe hydric resources, especially in underserved regions. The work will be carried out within a young and dynamic research group with strong scientific output, offering an ideal environment to launch a successful academic career (www.pimpamchemistry.com). References:

		[1] DOI: https://doi.org/10.1039/D4NR05363J [2] DOI: https://doi.org/10.1021/acsaenm.5c00044 [3] DOI: https://doi.org/10.1021/acs.chemmater.4c03161 [4] DOI: https://doi.org/10.1002/solr.202300768
Supervisor: Rafael Orive Illera Email: rafael.orive@uam.es	Bridging Mathematics and Machine Learning for the Next Generation of Synthetic Models	This project focuses on creating a new hybrid mechanics-data modeling methodologies that effectively incorporate observed dynamic data (see [2]). Our approach introduces a unique blend of expertise in partial differential equations, dynamical systems, control theory and machine learning (see [1,2,3,4]). This multidisciplinary approach allows us to develop innovative methods for generating robust synthetic models that accurately capture complex dynamics and respond well to real-world data inputs. More information can you see in: https://dcn.nat.fau.eu/zuazua/ https://cmc.deusto.eus/codefel/ References: [1] A. Álvarez-López, R. Orive-Illera, E. Zuazua. Cluster-Based Classification with Neural ODEs via Control. Journal of Machine Learning, Vol. 4 (2025), Iss. 2: pp. 128–156. https://doi.org/10.4208/jml.241114 [2] L. Liverani, M. Steynberg, E. Zuazua. HYCO: Hybrid-Cooperative Learning for Data-Driven PDE Modeling. arXiv:2509.14123 (2025). https://doi.org/10.48550/arXiv.2509.14123 [3] D. Ruiz-Balet, E. Zuazua. Neural ODE control for classification, approximation, and transport. SIAM Review 65, Iss. 3 (2023). https://doi.org/10.1137/21M1411433 [4] Y. Song, Z. Wang, E. Zuazua. FedADMM-InSa: An inexact and self-adaptive ADMM for federated learning. Neural Networks 181 (2025),106772. https://doi.org/10.1016/j.neunet.2024.106772
Supervisor: Jose Manuel Moreno Maroto Email: josemanuel.moreno@uam.es	Next-Generation Eco-Efficient Materials from Industrial Residues	The PhD candidate will join a young, highly productive research team with excellent conditions for both independent and collaborative work. Under the leadership of Prof. Moreno, a new research line has been launched using waste and clays to develop an innovative material that is mechanically resistant, lightweight, decontaminating, and far less energy-demanding to produce than conventional counterparts. The candidate will further advance this line of research, which has already been enthusiastically received by the scientific community. References: Please, take a look at: https://scholar.google.es/citations?hl=es&user=3N8z9ygAAAAJ https://www.researchgate.net/profile/Jose-Manuel-Moreno-Maroto?ev=hdr_xprf https://orcid.org/0000-0002-6312-1075 https://www.researchgate.net/profile/Raul-Fernandez-12 4 papers on this topic to be highlighted: - Moreno-Maroto, J.M.; Alonso-Azcárate, J. (2024) Hydrothermal zeolitization: Towards a paradigm shift for producing stronger and more sustainable construction materials. Constr. Build. Mater. 427, 136269. https://doi.org/10.1016/j.conbuildmat.2024.136269

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Supervisor: Beatriz Pardo Merino Email: beatriz.pardo@uam.es	"Role of AGC1/Aralar, the mitochondrial aspartate-glutamate carrier, in brain myelination and neurological disorders as epilepsy or autism: using conditional tissue-specific AGC1-KO mouse models"	Aralar/AGC1 deficiency is a rare human disease presenting neurological and muscular affectation (postnatal hypomyelination, epilepsy, hypotonia, disturbed neurodevelopment). Global Aralar-KO mice with short lifespan well recapitulates the human phenotype. We investigate the physiopathological role of Aralar/AGC1 in specific brain cell types and muscle. For this, we have generated oligodendroglial- and neuron-specific Aralar-KO mice. To answer relevant questions as: (a) the role of neuronal Aralar in the phenotype of the global Aralar-KO mice (b) the involvement of muscular- and neuronal-Aralar in motor coordination deficits and hypotonia, or (c) the contribution of oligodendroglial and neuronal Aralar to postnatal myelination and demyelination-remyelination processes. References: doi: 10.1038/s42255-024-01055-2. doi: 10.3390/ijms23010528. doi: 10.1523/JNEUROSCI.1463-21.2022. doi: 10.1523/JNEUROSCI.0711-20.2020.
Supervisor: Raul Fernandez Martin Co-supervisor: José Manuel Moreno Maroto Email: raul.fernandez@uam.es	Immobilisation of low and intermediate level radioactive waste in novel cement matrices	The project will focus on investigating magnesium phosphate cements, calcium sulphoaluminates and alkali-activated materials as alternative binders to conventional Ordinary Portland Cement for the encapsulation of low- and intermediate-level radioactive waste, including spent ion-exchange resins and aluminium metal. The study will assess material's compatibility and their interactions, along with the long-term durability performance and environmental impact of these innovative cementitious systems. References: doi:10.1016/j.apgeochem.2024.106105 doi:10.3390/ma16020679 doi:10.3390/min14010103 doi:10.3390/ma17061263
Supervisor: Felix Juan Zamora Abanades Email: felix.zamora@uam.es	Designing Next-Generation COF Membranes: From Gel Chemistry to Pressure-Tuned Porosity for Advanced Separation	We propose a four-year PhD project on covalent organic frameworks (COFs) prepared via monomer substitution in the gel phase. Gels will be converted into aerogels and subsequently compressed into ultra-thin membranes, enabling precise control of macroporosity and mechanical stability. Structural evolution will be studied through FIB-SEM tomography and advanced image analysis, generating hierarchically porous COFs with tunable flow and selectivity. Membranes will be evaluated in gas separation, organic solvent nanofiltration, and ultrafiltration of dyes and biomolecules. Conducted in collaboration with KAUST and NUS, this project offers students training in chemistry, materials processing, FIB-SEM, and membrane science within a dynamic international team.

		References: 1) Jesús Á. Martín-Illán, José Antonio Suárez, Julio Gómez-Herrero, Pablo Ares, Daniel Gallego-Fuente, Youdong Cheng, Dan Zhao, Daniel Maspoch and Félix Zamora*. Ultra-Large Free-Standing Imine-based Covalent Organic Framework Membranes Fabricated via Compression. Adv. Sci. 2022, 2104643. DOI: 10.1002/advs.202104643 2) Ke Tian Tan, Samrat Ghosh, Zhiyong Wang, Fuxiang Wen, David Rodríguez-San-Miguel, Jie Feng, Ning Huang, Wei Wang, Felix Zamora, Xinliang Feng, Arne Thomas, Donglin Jiang. Covalent organic frameworks. Nat.Rev. Prim. Meth. 3:1 (2023) DOI: 10.1038/s43586-022-00181-z 3) Sergio Royuela, Semih Sevim, Guillermo Hernanz, David Rodríguez-San-Miguel, Carlos Franco, Salvador Pané, Josep Puigmartí-Luis* and Félix Zamora* 3D Printing of Covalent Organic Frameworks: A Microfluidic-Based System to Manufacture Binder-Free Macroscopic Monoliths. Adv. Funct. Mater. 2023, 2314634. DOI: 10.1002/adfm.202314634. 4) J. Á. Martín-Illán, L. Sierra, A. Guillem-Navajas, J. A. Suárez, S. Royuela, D. Rodríguez-San-Miguel, D. Maspoch, P. Ocón, F. Zamora*. β-Ketoenamine-Linked Covalent Organic Frameworks Synthesized via Gel-to-Gel Monomer Exchange Reaction: From Aerogel Monoliths to Electrodes for Supercapacitors. Adv. Func. Mater. 2024, 2403567. DOI: 10.1002/adfm.202403567 Félix Zamora Orcid Code: 0000-0001-7529-5120 WEB PAGE: www.nanomater.es
Supervisor: Fatima Aparicio Hernandez Co-supervisor: David González Rodríguez Email: fatima.aparicio@uam.es	Water-soluble Self-assembled Nanotubes	The mosaic tobacco virus and the aquoporin protein are fascinating examples of self-assembled functional systems found in Nature. Driven by their nanometer dimensions, scientists are increasingly being attracted to the challenge of designing related nanoscale assemblies. Potential applications of these materials include molecular sieving for advanced separation, selective encapsulation, catalysis, sensing, and biomedical uses as transporters or ion channels. We are particularly interested in creating water-soluble tubular nanostructures with tunable pore size and shape from π-conjugated monomers equipped with complementary binding units. Noncovalent interactions between these groups yield supramolecular macrocycles that stack on top of each other affording self-assembled nanotubes. References: 1. DOI: 10.1002/anie.202509156. 2. DOI: 10.1002/chem.202302279. 3. DOI: 10.1002/anie.202006877. 4. DOI: 10.1002/chem.202402365.
Supervisor: Miguel Angel Ramos Ruiz Co-supervisor: Nuria Gordillo García Email: miguel.ramos@uam.es	Creation of NV colour centres in diamond using MeV ions	Diamond crystals with negatively charged nitrogen–vacancy (NV-) centers are promising systems for quantum magnetic sensing at the nanoscale with ultra-high sensitivity. Our goal is to exploit the possibilities at CMAM of ion-beam implantation in the MeV energy range as a precise and controlled way to create these NV- centers in synthetic diamond crystals, characterizing NV- and neutral NV0 centers both before and after annealing with Photoluminescence Spectroscopy and other techniques. Furthermore, this project also includes working on a related prototype to develop quantum sensors allowing to measure the magnetic field of biological systems. References: https://doi.org/10.1016/j.diamond.2024.111838

		https://doi.org/10.1016/j.carbon.2023.04.004 https://doi.org/10.1016/j.carbon.2017.07.076 https://doi.org/10.1140/epjp/s13360-021-01085-9
Supervisor: David Gonzalez Rodriguez Email: david.gonzalez.rodriguez@uam.es	Polar Self-assembled Molecular Materials	Columnar nanostructures and liquid crystals, in which the morphology and the relative arrangement of individual π-conjugated molecules can be controlled, are an important class of self-assembled organic materials that are making great impact in several optoelectronic technologies like transistors, solar cells, ferroelectric switches or light-emitting diodes. In collaboration with different groups, this project focuses on the self-assembly of π-conjugated molecules into non-centrosymmetric columnar supramolecular polymers and liquid crystalline materials. These systems may present switchable (ie. ferroelectric) or permanent polarization that can be coupled to charge transport or magnetic properties, a highly valuable feature for future flexible organic optoelectronics. References: DOI: 10.1021/jacs.4c09637 DOI: 10.1021/jacs.0c07291. DOI: 10.1126/sciadv.1701017 DOI: 10.1002/adma.201500238
Supervisor: Alvaro Alonso Caballero Email: alvaro.alonsoc@uam.es	Mechanochemical modulation of bacterial motility in plant-colonizing Pseudomonas. PilY1 protein as a drug-tunable target in plant-bacteria symbiotic and pathogenic interactions	We aim to understand and control the mechanochemical switches that regulate motility and biofilm formation in plant-colonizing Pseudomonas. These bacteria establish beneficial and pathogenic associations with crops, where protein PilY1 plays key roles in mechanosensing, motility, and biofilm formation. Using single-molecule manipulation and microbiological assays, we will investigate how ligand binding and mechanical forces affect PilY1 nanomechanics, ultimately influencing colonization strategies. This knowledge will guide the identification of natural compounds that modulate PilY1 function, with potential applications in agriculture. We seek a highly motivated student willing to participate in this interdisciplinary project at the intersection of biology, physics, and chemistry. References: 1. https://doi.org/10.26508/lsa.202403111 2. https://doi.org/10.1016/j.bpj.2024.02.020 3. https://doi.org/10.1038/s41557-020-00586-x 4. https://doi.org/10.1038/s41467-018-05107-6
Supervisor: Alberto de Juan Garrudo Email: alberto.dejuan@uam.es	Biomimetic Molecular Containers for Advanced (Photo)catalytic Applications	Biomimetic molecular containers offer a powerful strategy to reproduce the functional complexity of natural systems, creating confined environments that enhance selectivity and reactivity. Porphyrins, inspired by their fundamental role in photosynthesis and enzymatic redox processes, provide versatile scaffolds with exceptional photophysical properties for the design of such architectures. Their integration into molecular containers opens new opportunities for light-driven catalysis, where confinement effects can boost efficiency and mimic natural catalytic centers. This project aims to develop porphyrin-based molecular containers as advanced photocatalytic platforms, bridging natural enzymatic models with artificial systems, with applications in sustainable energy conversion and environmental remediation. References: 1- R. Ham, C. J. Nielsen, S. Pullen, J. N. H. Reek, Chem. Rev. 2023, 123, 5225−5261

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Supervisor: Saul Velez Centoral Email: saul.velez@uam.es	Orbitronics: a twist in electronics	Current electronic technologies exploit the electron's spin, but they depend on heavy metals and rare earth elements with a high environmental impact. This project proposes an emerging and more sustainable alternative: the use of the electron's orbital angular momentum, which can be even more efficient than spin. The student will explore the generation, diffusion, and interaction of orbital moments in magnetic devices based on light materials (Cu,Ti,Cr,C), learn how to distinguish orbit effects from spin, and investigate them in real devices. The work will involve the use of advanced electronic transport techniques, magneto-optical imaging with sub-micrometric resolution, and high-frequency measurements at the frontier of research in condensed matter physics. References: [1] https://doi.org/10.1038/s41565-022-01144-x [2] https://doi.org/10.1103/PhysRevLett.126.257201 [3] https://doi.org/10.1038/s41467-019-12676-7 [4] https://doi.org/10.1126/science.aaq1704
Supervisor: Sandra Rodriguez Gonzalez Co-supervisor: Cristina Sanz Sanz Email: sandra.rodriguez@uam.es	Theory-Guided Development of Stable and Efficient SOEC Air Electrodes	This project aims to design cobalt-free air electrodes for solid oxide electrolysis cells (SOECs) using a computational framework. Combining density functional theory (DFT), reactive molecular dynamics (ReaxFF), and kinetic Monte Carlo simulations (CASM), we will explore phase stability, oxygen non-stoichiometry, and degradation mechanisms at the atomic level. Electronic descriptors (e.g., eg* occupancy, O-2p band center, charge transfer energy) will guide the rational design of compositions. Ab initio thermodynamics and microkinetic modeling will predict electrochemical performance and long-term stability. The project supports sustainable energy goals by replacing critical raw materials with abundant alternatives like strontium. https://h2ecotech.es/ References: (1) https://doi.org/10.1039/D1CP02452C; (2) https://doi.org/10.1039/d1cp03353k; (3) https://doi.org/10.1038/s41929-023-01088-y; (4) https://doi.org/10.48550/arXiv.2309.11761
Supervisor: Ana Maria Justel Eusebio Co-supervisor: Antonio Quesada del Corral Email: ana.justel@uam.es	Advanced Data Science for Microbial Transport Studies in Antarctica	MICROAIRPOLAR is a multidisciplinary project focused on understanding how microorganisms travel through the air in polar regions. To trace their origin, the project develops unsupervised classification algorithms for mixed finite and infinite-dimensional data using functional data analysis. Numerical models simulate microbial colonization scenarios and help identify potential interplanetary transport route networks. Genetic diversity is assessed through multivariate techniques applied to high-throughput sequencing data. This research is crucial for studying invasive microbial species in deglaciated areas affected by climate change, with implications for biogeography, environmental and human health. References: [1] DOI:10.1038/s41467-025-55997-6; [2] DOI: 10.1214/25-AOAS2041; [3] DOI: 10.1016/j.scitotenv.2021.146653; [4] DOI: 10.1007/s11634-017-0290-1

Supervisor: Juan Terron Cuadrado Co-supervisor: Ana Rosario Cueto Gómez Email: juan.terron@uam.es	"Search for Higgs production in association with a photon and decaying via H→γγ using the full Run 3 of pp collisions at sqrt(s)=13.6 TeV with the ATLAS detector"	A search will be conducted for Higgs production in association with a photon and decaying via H→γγ using pp collisions at sqrt(s)=13.6 TeV collected with the ATLAS experiment at the Large Hadronic Collider at CERN. This mode has not yet been observed and offers a rich phenomenology to explore since the Vector-Boson-Fusion becomes the leading production mode. It is expected that the use of the full Run 3 will allow to achieve evidence for the first time. Furthermore, the measurements will be used to challenge the Standard Model by investigating anomalous couplings like WWHγ using the Effective Field Theory framework. References: "A detailed map of Higgs boson interactions by the ATLAS experiment ten years after the discovery", ATLAS Collaboration, G. Aad et al. Published in: Nature 607 (2022) 7917, 52-59 DOI: https://doi.org/10.1038/s41586-022-04893-w "Measurement of the properties of Higgs boson production at sqrt(s)=13 TeV in the H→γγ channel using 139fb−1 of pp collision data with the ATLAS experiment", ATLAS Collaboration, G. Aad et al. Published in: JHEP 07 (2023) 088 DOI: https://doi.org/10.1007/JHEP07(2023)088 "Measurement of the Higgs boson mass with H → γγ decays in 140 fb−1 of sqrt(s)=13 TeV pp collisions with the ATLAS detector", ATLAS Collaboration, G. Aad et al. Published in: Phys.Lett.B 847 (2023) 138315 DOI: https://doi.org/10.1016/j.physletb.2023.138315 "Interpretations of the ATLAS measurements of Higgs boson production and decay rates and differential cross-sections in pp collisions at sqrt(s) = 13 TeV", ATLAS Collaboration, G. Aad et al. Published in: JHEP 11 (2024) 097 DOI: https://doi.org/10.1007/JHEP11(2024)097
Supervisor: Álvaro Navarro Castilla Email: alvaro.navarrocastilla@uam.es	Two sides of the same coin: behavioral plasticity of the European rabbit (Oryctolagus cuniculus) at the crossroads of conservation and population control	The European rabbit represents a paradox: it is a keystone species threatened in parts of its native range, yet a destructive invasive elsewhere. This project will explore the behavioral responses of rabbits to ecological factors (e.g., competition, predation risk, social interactions) and to gradients of human influence (e.g., land use, infrastructure). The research aims to unravel the mechanisms that enable rabbits to adapt and thrive under shifting conditions, providing valuable insights and tools for conservation and management, potentially transferable to Asiatic regions where lagomorph species are both endangered and conflictive. References: [1] https://doi.org/10.1016/j.ecolind.2018.10.016 ; [2] https://doi.org/10.1093/cz/zox048 ; [3] https://doi.org/10.4404/hystrix-28.2-12332 ; [4] https://doi.org/10.1016/j.mambio.2013.08.004
Supervisor: Mariola Tortosa Manzanares Email: mariola.tortosa@uam.es	Enantioselective Synthesis of Benzene Bioisosteres	An increasing interest in employing sp3-hybridized scaffolds has been observed in medicinal chemistry since they provide tridimensionality and well-defined exit vectors that give access to novel unexplored chemical space, leading to a higher success in drug discovery programs. Among them, some polycyclic bridged skeletons have been identified as suitable saturated bioisosteres of aromatic rings which represent the common two-dimensional moieties that are routinely employed in drug discovery programs. The aim of this project is to provide novel catalytic strategies for the synthesis of enantioenriched

		phenyl bioisosteres, enabling unprecedented approaches for the construction of new drug analogues with improved physicochemical properties. References: 1) P. Garrido-Garcia, I. Quiros, P. Milan-Rois, S. Ortega-Gutiérrez, M. Martín-Fontecha, L. A. Campos, A. Somoza, I. Fernandez, T. Rigotti, M. Tortosa,* Enantioselective photocatalytic synthesis of bicyclo[2.1.1]hexanes as orthodisubstituted benzene bioisosteres with improved biological activity. Nat. Chem. 2025, 17, 734-745 DOI: 10.1038/s41557-025-01746-7 2) I. Quirós, M. Martín, M. Gomez-Mendoza, M. J. Cabrera-Afonso, M. Liras, I. Fernández, L. Nóvoa, M. Tortosa,* Isonitriles as Alkyl Radical Precursors in Visible Light Mediated Hydro- and Deuterodeamination Reactions. Angew. Chem. Int. Ed. 2024, e202317683. DOI: 10.1002/anie.202317683 3) L. Nóvoa, L. Trulli, A. Parra, M. Tortosa,* Stereoselective Diboration of Spirocyclobutenes: A Platform for the Synthesis of Spirocycles with Orthogonal Exit Vectors. Angew. Chem. Int. Ed. 2021, 60, 11763–11768. DOI: 10.1002/anie.202101445 4) M. Guisán-Ceinos, A. Parra, V. Martín-Heras, M. Tortosa,* Enantioselective Synthesis of Cyclobutylboronates via a Copper-Catalyzed Desymmetrization Approach. Angew. Chem. Int. Ed. 2016, 55, 6969–6972. DOI: 10.1002/anie.201601976
Supervisor: Diana Martin Garcia Co-supervisor: David Villanueva Bermejo Email: diana.martin@uam.es	Effect of rearing and processing conditions on the development of edible insects ingredients for health	Insects were recently approved for food and feed in EU due to their remarkable nutritional value, but little is known about how rearing and processing conditions affect their health-promoting properties. This PhD, within the national ENTOMOTIVE (PID2022-136238OB-I00) and European DiBaN (101162517) projects will explore how diet and environmental conditions of farming influence the nutritional composition and bioactivity of insects to design innovative, health-oriented ingredients. The work includes production, characterization, and evaluation of insect bioactivity using advanced, environmentally clean technologies, covering from dietary interventions to optimization of rearing and processing, with emphasis on circular economy and insect-based bioconversion of agrifood by-products. The student will join the INGREEN group (Healthy Food Ingredients) of the Food Science Research Institute (CIAL, UAM-CSIC). References: https://doi.org/10.1016/j.foodres.2025.117013 https://doi.org/10.1016/j.foodchem.2025.144667 https://doi.org/10.3390/insects16020171 https://doi.org/10.1163/23524588-00001417
Supervisor: Andres de la Escosura Navazo Email: andres.delaescosura@uam.es	Systems chemistry approaches for the development of smart active materials	The use of molecular systems with dynamic bonds and an adaptive, stimuli-responsive character in the field of systems chemistry will enable to create smart active materials mimicking certain properties of living cells. In the proposed thesis project, the student will direct this strategy to the developement of nanomaterials with catalytic and photoswitching behavior. The thesis will comprise two main tasks: Task 1 will be devoted to the design, synthesis and study of self-healing and adaptive nanozymes, while Task 2 will focus on arylazopyrazole-functionalized building blocks for the control with light of the nanozymes´ self-assembly process and properties. References: DOI: https://doi.org/10.1002/anie.202006014. DOI: https://doi.org/10.1073/pnas.2015285118.

		DOI: https://doi.org/10.1002/anie.202206900. DOI: https://doi.org/10.1039/D4TB00041B.
Supervisor: Alicia Gil Ramírez Co-supervisor: Miguel Rebollo Hernanz Email: alicia.gil@uam.es	AI-driven precision neuro-nutrition: sustainable valorisation of cocoa and coffee by-products bioactives for cognitive enhancement and neuroplasticity support.	This proposal integrates the concepts of nutritional cognitive enhancement and precision neuro-nutrition to explore the neuromodulatory potential of sustainable cocoa shell and coffee pulp extract by-products rich in antioxidant, anti-inflammatory, and antihypertensive compounds. Using microwave-assisted extraction and AI-driven chemometric models, the study aims to identify bioactive profiles and molecular patterns associated with neuroplasticity, cognitive performance, and emotional regulation. Through biochemical assays, cell cultures, and in vivo studies, it seeks to characterize how these extracts and their synergistic mixtures contribute to neurocognitive health, promoting sustainable innovation and precision-based nutritional strategies for optimizing mental performance and emotional well-being across the lifespan. References: DOI: 10.1016/j.seppur.2021.118779. DOI: 10.3390/foods13183006. DOI: 10.1016/j.fufo.2024.100461. DOI: 10.1016/j.foodres.2024.115433.
Supervisor: Fernando Martín García Email: fernando.martin@uam.es	Attosecond coupled electron-nuclear dynamics in molecules and condensed matter	The project is closely related to our ongoing research on “The ultimate Time scale in Organic Molecular optoelectronics, the ATTOsecond (https://tomatto.eu/), to obtain real-time images of electronic motion as an effective path to fully understand and control the early stages of photoinduced electron transfer (ET) and charge transfer (CT) processes occurring in molecules. Investigations of ET/CT induced by atto- and few-femtosecond visible (VIS) and ultraviolet (UV) light are fundamental to develop more efficient organic opto-electronic materials. This research will be conducted in collaboration with experimental groups. More info at https://campusys.qui.uam.es References: DOI: 10.34133/ultrafastscience.0108 DOI: 10.1038/s41557-024-01620-y DOI: 10.1038/s41467-024-53183-8 DOI: 10.1038/s41567-024-02406-2
Supervisor: Alicia Palacios Cañas Email: alicia.palacios@uam.es	Computational tools for XUV/X-Ray Ultrafast Science: MPI-base high-performance computing and novel Qiskit-based quantum computing implementations	This project aims to exploit the new capabilities of free electron lasers (FELs) and X-ray FELs facilities to explore non-linear phenomena in atoms and molecules. These coherent light sources provide ultra-brilliant few-fs pulses with unprecedented intensities, enabling the observation of high-order processes that remained experimentally inaccessible until now. Our group has a long trajectory developing numerical and computational tools to obtain accurate descriptions of light induced electron-electron and electron-nuclear interactions. The project will be performed in close collaboration with international experimental groups and contribute on our two main software-developing areas currently under development: GPU-based and Qiskit-based quantum computing algorithms. References: https://doi.org/10.1038/s42005-025-02123-z https://doi.org/10.1103/PhysRevLett.133.123201 https://doi.org/10.1038/s41467-023-40120-4 https://doi.org/10.1038/s41467-022-28783-x

Supervisor: Jorge Bedia Garcia-matamoros Co-supervisor: Elena Díaz Nieto Email: jorge.bedia@uam.es	Synthesis of biofuels from biomass waste by hydrothermal liquefaction	Hydrothermal liquefaction (HTL) stands out as a highly promising process for transforming wet biomass into biocrude and other valuable chemical products. This conversion is carried out under high temperature and pressure conditions, using water—sometimes combined with organic solvents and catalysts—as the reaction medium. The resulting slurry from the liquefaction contains biocrude, an aqueous fraction, and solid residues, which can subsequently be processed into bio-oil, biochar, biogas, and various chemical compounds. This project aims to evaluate the feasibility of HTL by exploring different types of biomass waste feedstocks, reaction parameters, and catalytic systems. References: https://doi.org/10.1016/j.biombioe.2025.108349, https://doi.org/10.1016/j.rser.2025.115974, https://doi.org/10.1016/j.biortech.2025.133067, https://doi.org/10.1039/D0GC04092D
Supervisor: Tomas Torres Cebada Email: tomas.torres@uam.es	Subphthalocyanines: Nonplanar Aromatic Chiral Porphyrinoids	Owing to their remarkable structural and photophysical properties—such as strong UV–vis/NIR absorption, efficient charge transport, and broad chemical versatility—subphthalocyanines (SubPcs) rank among the most versatile porphyrinoid systems [1]. Their distinctive non-planar geometry enables diverse advanced applications, including polar superstructures, thermotropic liquid crystals, and non-fullerene acceptors in molecular photovoltaics, particularly as singlet fission materials [2]. Moreover, their enantiopure derivatives [3] hold great promise for chiral technologies [4]. https://orcid.org/0000-0001-9335-6935 References: [1] https://doi.org/10.1039/D2CS00280A [2] https://doi.org/10.1021/jacs.2c13353 [3] https://doi.org/10.1021/jacs.2c06377 [4] https://doi.org/10.1039/D5SC01660F
Supervisor: Javier del Pino Gutierrez Co-supervisor: Miguel Bello Gamboa Email: j.delpino@uam.es	Topological and Variational Methods for Open Quantum Many-Body Systems	Understanding driven-dissipative many-body systems, such as superconducting circuits, nanomechanical arrays and Rydberg atom lattices, is key to advancing emerging quantum technologies. These platforms show rich physics: multistability, dynamical phase transitions and topological effects far from equilibrium [1, 2, 3, 4]. Their typically mixed nature (e.g. finite-dimensional atomic modes coupled to infinite-dimensional photonic ones) and the exponential growth of the many-body Hilbert space make simulation hard: most approaches either treats the few-excitation limit exactly [3,4] or uses mean-field approximations for many excitations [2]. Even then, theory has focused mainly on steady states and local bifurcations, leaving the global dynamical structure of the nonlinear mean-field equations largely unexplored. This PhD project will bridge these gaps by developing a toolbox that connects classical and quantum regimes. It will combine flow-topological methods [2] to chart and classify the global dynamical organisation of mean-field and semiclassical models with advanced variational techniques, such as superpositions of Gaussian states and tensor networks, to capture quantum correlations and dissipation beyond mean field. References: [1] https://doi.org/10.1038/s41586-022-04609-0 [2] https://doi.org/10.1126/sciadv.adt9311 [3] https://doi.org/10.1126/sciadv.aaw0297 [4] https://doi.org/10.1103/PhysRevLett.134.173601

Supervisor: Nestor Parga Carballeda Email: nestor.parga@uam.es	Learning from the Brain: Neural Principles for Artificial Intelligence	A PhD project is offered in NeuroAI, an emerging field at the interface between neuroscience and artificial intelligence (AI). The PhD student will use modern AI techniques to investigate fundamental questions in neuroscience, such as how decisions emerge within neural circuits from rewards or sensory evidence. He will also develop new AI algorithms inspired by biological principles of neural computation. The project combines machine learning, computational methods, mathematical modeling, and the analysis of electrophysiological data recorded from animals performing decision-making tasks. It offers an excellent opportunity to advance our understanding of both brain function and artificial intelligence. References: 1) https://doi.org/10.1126/science.1179850 2) https://doi.org/10.1016/j.neuron.2015.04.014 3) https://doi.org/10.1073/pnas.2113311119 4) https://doi.org/10.1016/j.celrep.2024.114412 Search in Google Scholar: "author:parga author:nestor"
Supervisor: Carmen Morant Zacares Co-supervisor: Celia Polop Jorda Email: c.morant@uam.es	Advanced Nanomaterial Architectures for Next-Generation Solid-State Energy Storage	This thesis investigates the synthesis and integration of engineered nanomaterials to enhance the performance and stability of solid-state batteries. Hybrid nanostructures and vapor-deposited films will be developed with precise control over composition and morphology to optimize ionic transport and mechanical resilience. Electrochemical measurements and post-mortem AFM analyses are performed in glovebox environments to preserve pristine interfaces and study degradation mechanisms. Complementary experiments at large-scale facilities, such as synchrotrons, provide nanoscale structural and mechanical insights. The research aims to link synthesis parameters with electro-chemo-mechanical behavior, enabling robust, high-energy, and long-lifetime solid-state energy storage systems. References: https://doi.org/10.3390/nano14231911 https://doi.org/10.1002/batt.202500167 https://doi.org/10.1016/j.ensm.2024.103658 https://doi.org/10.3390/nano10030515
Supervisor: Yago Ascasibar Sequeiros Co-supervisor: Barbara Catinella (ICRAR, Australia) Email: yago.ascasibar@uam.es	Revealing the cosmic baryonic cycle in nearby galaxies with WALLABY	Atomic hydrogen (HI) traces the cold gas that fuels star formation in galaxies. This thesis, to be carried out in close collaboration between the UAM and the International Centre for Radio Astronomy Research (ICRAR), will exploit the data obtained by the Widefield ASKAP L-band Legacy All-sky Blind surveY (WALLABY), in combination with ancillary multi-wavelength observations, to investigate the relation between HI properties and those of the stellar population (e.g. stellar and gas mass, surface density, dynamics, environment, and star formation rate on different timescales), trying to disentangle the main mechanisms that regulate the cosmic baryon cycle. References: https://doi.org/10.1007/s10509-020-03831-4 https://doi.org/0.1017/pasa.2025.30 https://doi.org/10.1093/mnras/stad557 https://doi.org/10.48550/arXiv.2503.15315
Supervisor: Maria Angeles Martin Cabrejas Co-supervisor: Yolanda Aguilera Gutierrez Email: maria.martin@uam.es	Development of food prototypes based on cocoa by-products for individuals with particular physiological requirements	The cocoa production chain generates a variety of by-products, highlighting the cocoa shell. This material, traditionally considered waste, is increasingly recognized as a valuable resource for the food, pharmaceutical, and cosmetic industries. Rich in dietary fiber, bioactive compounds, and nutrients, cocoa shells exhibit antioxidant, hypolipidemic, and anti-inflammatory activities. Their incorporation into novel formulations supports circular economy strategies and contributes to global sustainability goals. This research will

		investigate the physicochemical properties, health advantages, and safety of new formulations based on cocoa shell for individuals with particular physiological requirements, emphasizing their potential to drive technical innovation and the creation of functional ingredients. References: https://doi.org/10.1016/j.indcrop.2025.121835, https://doi.org/10.1016/j.fufo.2024.100461, https://doi.org/10.1016/j.foodres.2024.115037, https://doi.org/10.1016/j.crfs.2024.100930
Supervisor: Carolina Canora Catalan Email: carolina.canora@uam.es	Volcano-tectonic interactions. Earthquakes, hydrothermal fluids and volcanic activity in El Salvador.	Interactions between earthquakes and volcanoes refer to the complex ways in which earthquakes and volcanic activity influence each other. These interactions can arise through various geological and geophysical processes, often involving magma movement, changes in stress in the Earth's crust, and fluid migration. In El Salvador, there are examples of volcanic eruptions triggered by earthquakes, such as the series that took place in 1917. However, the mechanisms governing this interaction are unknown. The project investigates past seismic events that have been triggered by or have triggered an eruption, with the ultimate aim of determining the volcano-tectonic risks in the country. References: https://doi.org/10.1016/j.jsames.2020.103038 DOI: 10.5209/rev_JIGE.2014.v40.n3.43559 DOI: 10.1785/0220130150 DOI: 10.1785/0120090377
Supervisor: Francisco Heras Muñoz Email: fran.heras@uam.es	Valorization of wastes to sustainble hydrogen by hydrothermal and thermo-catalityc processes	Hydrogen is increasingly recognized as a strategic energy vector in the decarbonization of industrial and transport sectors. This doctoral project focuses on developing advanced catalysts for its production via aqueous phase reforming. The work addresses fundamental and applied challenges, including catalyst deactivation, regeneration strategies, and kinetic characterization under realistic operating conditions. The objective is to improve catalytic performance and process efficiency through rational design and mechanistic understanding. The research is embedded in a broader effort to advance sustainable hydrogen production technologies based on renewable feedstocks and robust catalytic systems. References: https://doi.org/10.1016/j.ijhydene.2025.151175 https://doi.org/10.1016/j.enconman.2024.118999 https://doi.org/10.1016/j.ijhydene.2024.03.182 https://doi.org/10.1016/j.biortech.2024.130572
Supervisor: Fernando Aguilar-galindo Rodriguez Co-supervisor: Sergio Díaz-Tendero Email: fernando.aguilar-galindo@uam.es	Computational modeling of complex materials and processes with applications in catalysis and Nanoscience	This project focuses on the computational modeling of complex materials and processes with applications in catalysis and nanoscience. Density Functional Theory (DFT) will be employed to obtain atomic-scale structures and electronic properties, such as band gaps and charge distributions. The study aims to identify and characterize materials relevant to catalytic and energy-related processes. Additionally, simulated Scanning Tunneling Microscopy (STM) images will be generated to connect theoretical predictions with experimental observations, providing deeper insight into the structure–property relationships that govern material performance. This project will be carried out in close collaboration with experimental research groups. References: https://doi.org/10.1038/s41467-024-50823-x

		https://doi.org/10.1021/acs.nanolett.5c00263 https://doi.org/10.1002/cssc.202402694 https://doi.org/10.1021/acs.chemmater.5c01152
Supervisor: David Gomez Castro Email: david.gomezcastro@uam.es	Fractional-in-time Aggregation-Diffusion Equations	Over the last two decades, Aggregation-Diffusion equations have been widely studied. This family of models cover a variety of applications from diffusive models like the heat equation and the Porous-Medium Equation to biological models like the Keller-Segel problem or, more recently, the training of Artificial Neural Networks. The interpretation of these equations as gradient-flows allows their use to minimize functionals. In recent years, many modelers have turned to fractional time derivatives like the Caputo derivative, that incorporate memory. The aim of this thesis will be to develop theoretical and numerical studies of the fractional-in-time Aggregation-Diffusion equation. References: • J. A. Carrillo, M. DiFrancesco, A. Figalli, T. Laurent, D. Slepčev. Global-in-time weak measure solutions and finite-time aggregation for nonlocal interaction equations. Duke Math. J. 156 (2). 2011 https://doi.org/10.1215/00127094-2010-211 • M. Allen, L. Caffarelli, and A. Vasseur. Porous medium flow with both a fractional potential pressure and fractional time derivative. Chinese Annals of Mathematics, Series B 38.1 (2017). https://doi.org/10.1007/s11401-016-1063-4 • J.A. Carrillo, D. Gómez-Castro, Y. Yao, C. Zheng. Asymptotic Simplification of Aggregation-Diffusion Equations Towards the Heat kernel. Arch Rational Mech Anal 247, 11 (2023). https://doi.org/10.1007/s00205-022-01838-5 • D. Gómez-Castro. Beginner's guide to aggregation-diffusion equations. SeMA Journal 81, 531–587 (2024). https://doi.org/10.1007/s40324-024-00350-y
Supervisor: Erving Clayton Ximendes Email: erving.ximendes@uam.es Co-Supervisor: Daniel Jaque	INflammation detection and diagnosis by bioorthogonal CLIck-chemistry and infrared NAnothermometers (INCLINA)	Temperature plays a crucial role in biological systems, as it regulates cell activity and serves as a natural indicator of disease. Inflammation alters blood flow and metabolism, leading to local temperature changes, as seen in COVID-19, where severe inflammation can cause organ damage and complications. Current diagnostic methods include detecting inflammatory markers and imaging techniques such as X-ray, ultrasound, and MRI. However, these approaches often lack sensitivity for early detection or involve high costs and ionizing radiation. Therefore, developing a safe, sensitive, and affordable imaging technology for early inflammation diagnosis would greatly enhance patient care and quality of life. References: Kosuge, H. et al. Potential of Gold Nanoparticles for Noninvasive Imaging and Therapy for Vascular Inflammation. Molecular Imaging and Biology 24, 692-699 (2022). https://doi.org/10.1007/s11307-021-01654-5 7 Abdesselem, M. et al. Real-time in vivo ROS monitoring with luminescent nanoparticles reveals skin inflammation dynamics. Biomed. Opt. Express 14, 5392-5404 (2023). https://doi.org/10.1364/BOE.501914 Shen, Y., Lifante, J., Fernández, N., Jaque, D. & Ximendes, E. In Vivo Spectral Distortions of

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Supervisor: Mariola Ramirez Herrero Co-supervisor: Luisa E. Bausá López Email: mariola.ramirez@uam.es	Engineering Light–Matter Coupling in 2D–Ferroelectric Hybrid Platforms	This project explores fundamental mechanisms of light–matter interaction within hybrid systems combining engineered ferroelectric crystals and 2D-materials. Building on the group's contributions to integrated nanophotonics—where it has generated fundamental knowledge and demonstrated innovative designs for coherent optical sources with sub-diffractive confinement—the thesis aims to advance understanding of photonics properties and light–matter coupling in hybrid heterostructures. By integrating diverse materials without complex processing, the research seeks to uncover novel physical phenomena and enable new on-chip photonic architectures. The project contributes to emerging fields such as quantum technologies, ultrasensitive detection, and advanced photonic integration. References: (1) https://doi.org/10.1039/D5MH00680E (2) https://doi.org/10.1002/lpor.202300817 (3) https://doi.org/10.1002/adom.202400624 (4) https://doi.org/10.1002/adma.201901428
Supervisor: Riccardo Marin Co-supervisor: Daniel Jaque Garcia Email: daniel.jaque@uam.es	Luminescent nanocomposites: from sensing to data encryption.	Within this project, you will develop the next generation of polymeric luminescent nanocomposite materials to be used as smart coatings for safety and sensing purposes. The project will entail preparation of Earth-abundant luminescent nanoparticles, surface modification to impart compatibility with the polymeric matrix, and study of the optical properties of the nanocomposite under varying conditions of, e.g., temperature, pressure, oxygen level, and pH. Biocompatibility tests will inform optimization of the nanocomposite surface, thus achieving materials with a real potential to be deployed in real-life applications.
Supervisor: Irene Garcia Higuera Co-supervisor: Federico Mayor Menéndez Email: irene.garciah@uam.es	Unraveling the role of GRK2 in macrophage-mediated inflammation during obesity and type 2 diabetes	Activated macrophages are key drivers of the systemic chronic inflammation associated to obesity that results in insulin resistance and type 2 diabetes. The G protein-coupled receptor kinase 2 (GRK2) is a signalling hub known to be upregulated in key metabolic tissues in such conditions. Using mouse models of GRK2 deletion, we have previously established its role as an obesogenic, pro-diabetic, and pro-inflammatory factor. We now want to further address its relevance in macrophage activation and unravel the underlying molecular mechanisms through a combination of omics approaches, cellular assays and in vivo studies, with a special interest in metabolic rewiring. References: 1- https://doi.org/10.1016/j.coemr.2020.09.004,.https://doi.org/10.1186/s12915-021-00966-w, https://doi.org/10.1007/s00018-019-03442-5, https://doi.org/10.1186/s12915-021-00966-w
Supervisor: Jose Ramon Ares Fernandez Email: joser.ares@uam.es	Overcoming barriers to turning hydrides into energy materials	The purpose of this work is to explore hydrides as energy materials. In particular, we aim to investigate the potential for overcoming the thermodynamic and kinetic limitations of hydride formation reactions, enabling their use in various applications. To this end, the host group possesses extensive experience in the advanced synthesis (bulk, thin film and 2D) and characterization of hydrides from multiple families, alongside multiple collaborations (currently running two European projects). This will enable the student to acquire a solid

		foundation in this fascinating area. References: Esmeralda Muñoz-Cortes, Fabrice Leardini, Marcello Conte, Adolfo del Campo, Eduardo Flores, Jose Ramon Ares and Roman Nevshupa "Exploring tribochemical transduction pathways for dehydrogenation of molecular hydrides" RSC Mechanochem., (2025), 2, 285–296 DOI: 10.1039/d4mr00072b D. Abejón, P. Prieto, Joonkon Kim, A. Redondo-Cubero, M.L. Crespillo, F. Leardini, I.J. Ferrer, G.García, J.R. Ares "Isothermal hydrogen absorption process of Pd-capped Mg films traced by ion beam techniques and optical methods" J. Magnesium Alloys (2024) 12 (9) p3675 DOI: 10.1016/j.jma.2024.09.019 L. Pasquini, K. Akaki, E.Akiba, Mark D Allendorf, E. Alvares, Josè R Ares et al " Magnesium- and intermetallic alloys-based hydrides for energy storage: modelling, synthesis and properties " Prog. Energy 4 (2022) 032007 p1, DOI 10.1088/2516-1083/ac7190 Qiwen Lai, Yahui Sun, Ting Wang, Poojan Modi, Claudio Cazorla, Umit B. Demirci, Jose Ramon Ares Fernandez, Fabrice Leardini, and Kondo-François Aguey-Zinsou, "How to Design Hydrogen Storage Materials? Fundamentals, Synthesis, and Storage Tanks" Adv. Sust. Mater. (2019) 3, 9 p.1900043 DOI: 10.1002/adsu.201900043
Supervisor: Salvador López Martínez Email: salvador.lopez@uam.es	Dark solitons to Gross-Pitaevskii equations and systems	The Gross-Pitaevskii equation (GPE) describes the dynamics in Bose-Einstein condensates (BECs) and nonlinear optics, while coupled GPEs model mixtures of BECs and multimode optics. Nonlocal versions of these capture long range internal interactions. The analytical study of dark solitons in nonlocal GPEs and dark-bright solitons in GP systems have been addressed in [1,2,3] and [4], respectively. The goals of the thesis, always from a Nonlinear Analysis perspective, include: 1. Extending the results in [1,2,3,4] to higher dimensions. 2. Studying nonlocal GP systems. 3. Finding other physical soliton pairs such as dark-antidark or dark-dark. 4. Considering focusing interactions in [4]. References: [1] https://doi.org/10.1007/s00526-025-03000-x [2] https://doi.org/10.1080/03605302.2022.2070853 [3] doi: 10.3934/dcds.2020026 [4] https://arxiv.org/abs/2508.19216
Supervisor: María Eugenia Corrales Co-supervisor: Inés Corral Pérez Email: maria.corrales@uam.es	Time-Resolved Studies of Photoinduced Processes in Life's Molecular Building Blocks: From Isolated Nucleobases and Aromatic Amino Acids to Complex Environments	This PhD project will focus on the investigation of time-resolved photoinduced dynamics in polyatomic systems of biological relevance using femtosecond pump-probe schemes in combination with velocity map imaging (VMI). The experimental results will be supported by high-level ab initio calculations including the mapping of the topography of excited state potential energy surfaces and nonadiabatic semiclassical trajectories to obtain detailed information on the coupled nuclear and electronic dynamics involved.. Specifically, the research will focus on DNA canonical and modified nucleobases, and aromatic aminoacids providing fundamental insight into their excited-state dynamics and relaxation pathways. References: DOI: 10.1021/acs.jpclett.2c00052

Universidad Autónoma de Madrid

Supervisor: Johannes Feist Email: johannes.feist@uam.es	Quantum light-matter interactions on extreme scales	The project will theoretically investigate quantum light-matter interactions on extreme spatial and temporal scales to advance the frontiers of quantum technology. It will focus on subwavelength nanophotonic structures to confine light at nanometer scales and enable enhanced light-matter interactions. We will use advanced quantization techniques and multi-mode quantum optical models to design innovative quantum devices such as light sources, transducers, and sensors, pushing the boundaries of quantum nanophotonics. Particular focus will be placed on studying and controlling the temporal structure and correlations of quantum light pulses to enable new ways to probe ultrafast processes and progress towards ultrafast quantum technologies. References: [1] M. Lednev et al., PRX Quantum 6, 020361 (2025) https://doi.org/10.1103/z3cr-l7pw [2] G. Sandik et al, Nat. Mater. 24, 344 (2025) https://doi.org/10.1038/s41563-024-01962-5 [3] A. Ben-Asher et al., Phys. Rev. Lett. 130, 243601 (2023) https://doi.org/10.1103/PhysRevLett.130.243601 [4] I. Medina et al., Phys. Rev. Lett. 126, 093601 (2021) https://doi.org/10.1103/PhysRevLett.126.093601

Universidad Autónoma de Madrid

Faculty of Education Sciences

Supervisor Info	Project Title	Project Abstract
Supervisor: Oscar Luis Veiga Nuñez Co-supervisor: Jorge Enrique López de Vergara Méndez (EPS) Email: oscar.veiga@uam.es	Application of Artificial Intelligence and Machine Learning to the Analysis of Lifestyle and Health Determinants in School-Aged Children: Insights from the UP&DOWN Study	The project applies advanced artificial intelligence and machine learning techniques (1) to analyze over 15 million longitudinal records from the UP&DOWN study (2) on health, physical activity, and lifestyle in 2,200 children and adolescents. Its goals are: i) to identify hidden health profiles, ii) predict cardiometabolic risk iii) and classify activity patterns using supervised and unsupervised models (3,4). It combines the expertise of the EstiLIFE Group in child epidemiology (https://www.uam.es/uam/investigacion/grupos-de-investigacion/detalle/f1-202) and the HPCN group in high-performance computing (http://www.hpcn-uam.es/). The research aims to generate innovative knowledge to support early prevention of chronic diseases from childhood. References: (1) https://doi.org/10.1109/TNSM.2021.3053835 (2) https://doi.org/10.1186/1471-2458-14-400 (3) https://doi.org/10.1016/j.jshs.2020.05.006 (4) https://doi.org/10.3390/sports13080273

Universidad Autónoma de Madrid

Polytechnic School

Supervisor Info	Project Title	Project Abstract
Supervisor: Alberto Suárez Email: alberto.suarez@uam.es	Reaction-diffusion models for generative AI	Most current generative AI models for images based on time inversion of a stochastic differential equations consider noise only in the pixel intensity space. In these types of models, the intensity of a pixel at a given location can be identified with the concentration of a chemical species at that location. Changes of intensity can therefore understood as the result of an autocatalytic reaction. Carrying this analogy further, we propose to study the properties of a reaction-diffusion model, which, in addition to the reaction term, considers diffusion of the chemical (that is, the intensity associated to the light exposure) also in physical space. This extended model accounts for the functional nature of the data, such as continuity and underlying smoothness. Edges and in the image can be ascribed to discontinuities in a more general jump-diffusion process. The developments that result from this research will be applied to problems of practical interest in the medical and environmental sciences that involve one-dimensional functions, image, and video data. References: Yang Song, Jascha Sohl-Dickstein, Diederik P Kingma, Abhishek Kumar, Stefano Ermon, and Ben Poole "Score-Based Generative Modeling through Stochastic Differential Equations", International Conference on Learning Representations (2021) https://doi.org/10.48550/arXiv.2011.13456 Severi Rissanen, Markus Heinonen, Arno Solin. “Generative Modelling with Inverse Heat Dissipation” (ICLR 2023) https://arxiv.org/abs/2206.13397 Emiel Hoogeboom and Tim Salimans “Blurring Diffusion Models” (ICLR 2023) https://arxiv.org/abs/2209.05557 Hao-Chien Hsueh and Wen-Hsiao Peng and Ching-Chun Huang "Warm Diffusion: Recipe for Blur-Noise Mixture Diffusion Models", The Thirteenth International Conference on Learning Representations (ICLR 2025) https://openreview.net/forum?id=rdSVgnLHQB
Supervisor: Lara Quijano Sanchez Email: lara.quijano@uam.es	AI Truth Graph: Harnessing Natural Language Processing for Institutional Transparency and Trust	This PhD project explores the frontier of Artificial Intelligence and Natural Language Processing applied to governance and law. The candidate will develop a knowledge graph of institutional facts extracted from parliaments, courts, budgets, and public administrations. This graph will serve as the backbone for fact-checking systems, question answering tools, and automated generation of verified content, strengthening trust in public institutions. By combining information retrieval, graph theory, and open data visualization, the project creates a unique opportunity to work in a multidisciplinary environment, bridging computer science, law, and social sciences to design AI tools with real-world impact. References: https://aclanthology.org/2023.fever-1.4/ ; https://doi.org/10.1145/3412841.3442081 ; https://doi.org/10.18653/v1/2025.naacl-long.358 ; https://doi.org/10.1016/j.ipm.2020.102301
Supervisor: Jose Luis Garcia Dorado Co-supervisor: Francisco Javier Ramos	AI and Domain-Specific Language Models to Advance	The rapid expansion of communication infrastructures--driven by 5G deployment, cloud services, and massive traffic growth--creates unprecedented demands for monitoring and

de Santiago Email: jl.garcia@uam.es	Network Observability and Cybersecurity	management to ensure security, scalability, and service quality. Yet rising volumes, multi-service complexity, and cybersecurity threats are pushing traditional approaches beyond their limits. In this scenario, artificial intelligence emerges as a promising paradigm, with AI agents as a novel embodiment of its potential. These agents perceive network conditions, reason with domain-specific large language models (LLMs), and act through software interfaces, detecting anomalies, correlating events, and generating synthetic data, paving the way toward secure and efficient AI-assisted networks of the future. References: [1] DOI: https://doi.org/10.1016/j.eswa.2025.127072 [2] DOI: https://doi.org/10.1016/j.comnet.2022.109523 [3] DOI: https://doi.org/10.1109/ACCESS.2021.3073598 [4] DOI: https://doi.org/10.1016/j.comnet.2021.108357
Supervisor: Marcos Escudero Viñolo Co-supervisor: Luis Herranz Arribas (UPM) Email: marcos.escudero@uam.es	Fair and interpretable transfer and adaptation of visual generation models.	A key advantage of modern AI models is their high transferability and flexible adaptation. Focusing on modern visual generation (e.g., diffusion, flow matching), this PhD project will investigate how the adaptation of pretrained models impacts their fairness and interpretability. The research will develop frameworks to understand and assess how biases and interpretability evolve during adaptation, to then propose methods to mitigate and constrain possible harmful effects resulting from the adaptation. The overall goal is promoting fair and interpretable adapted models. The project will ground these ideas and techniques on common adaptation scenarios, including domain adaptation, continual learning, and unlearning. References: Wang, Y., Wu, C., Herranz, L., van de Weijer, J., Gonzalez-Garcia, A., Raducanu, B. (2018). Transferring GANs: Generating Images from Limited Data. In: Ferrari, V., Hebert, M., Sminchisescu, C., Weiss, Y. (eds) Computer Vision – ECCV 2018. ECCV 2018. Lecture Notes in Computer Science(), vol 11210. Springer, Cham. https://doi.org/10.1007/978-3-030-01231-1_14 K. Sirotkin, P. Carballeira and M. Escudero-Viñolo, "A study on the distribution of social biases in self-supervised learning visual models," 2022 IEEE/CVF Conference on Computer Vision and Pattern Recognition (CVPR), New Orleans, LA, USA, 2022, pp. 10432-10441, doi: 10.1109/CVPR52688.2022.01019. Wang, Y., González-García, A., Herranz, L., van de Weijer, J. (2021). "Controlling biases and diversity in diverse image-to-image translation", Computer Vision and Image Understanding, doi: https://doi.org/10.1016/j.cviu.2020.103082 Sirotkin, K., Escudero-Viñolo, M., Carballeira, P. et al. Improved transferability of self-supervised learning models through batch normalization finetuning. Appl Intell 54, 11281–11294 (2024). https://doi.org/10.1007/s10489-024-05758-7
Supervisor: Juan de Lara Jaramillo Co-supervisor: Esther Guerra Sánchez Email: juan.delara@uam.es	Smart DSLs: bridging generative AI and model-driven engineering	Large Language Models (LLMs) are impacting many disciplines, including software engineering. LLM-based assistants are used to help developers using programming languages like Python or Java. However, their use is more challenging in combination with model-driven engineering processes, which are based on Domain-Specific Languages (DSLs). This is so as those DSLs may have not been present in the training set of the LLM; and the DSLs may have a graphical syntax, making LLM-based assistance more difficult. In this thesis, you will work on novel concepts and mechanisms to bridge LLMs and model-

		driven engineering, enabling the automated incorporation of LLM-assistance into DSLs. References: http://doi.org/10.2200/S00751ED2V01Y201701SWE004 http://doi.org/10.1145/3640310.3674089 http://doi.org/10.1007/S10664-024-10483-3 http://doi.org/10.1007/S10270-025-01263-8
Supervisor: Ivan Cantador Gutierrez Email: ivan.cantador@uam.es	Enhancing Inclusion in Tourism Recommender Systems	This thesis will address the growing demand for greater inclusion in tourism recommender systems by incorporating features and needs of underrepresented traveler groups. Existing recommendation approaches often prioritize mainstream user profiles and common interests, overlooking the specific requirements of people with disabilities, older adults, or families, among many others. The thesis will propose algorithms that adapt recommendations by accounting for physical, cultural, and social barriers. By integrating inclusivity into system design, the research will seek to enhance user satisfaction, broaden participation in tourism, and foster equal opportunities, ensuring that all travelers can access, enjoy, and benefit from meaningful tourism experiences. References: [1] https://doi.org/10.1145/3614419.3644003 , [2] https://doi.org/10.1007/978-3-031-56066-8_31 , [3] https://doi.org/10.1007/s10664-024-10483-3 , [4] https://doi.org/10.1007/978-1-0716-2197-4_13
Supervisor: Daniel Hernandez Lobato Email: daniel.hernandez@uam.es	New Methods for Bayesian Deep Learning Based on the Linearized Laplace Approximation	Modern Deep Neural Networks (DNN) are accurate but fail to output a prediction confidence. Given an unseen instance, they may assign a wrong class with high probability. A Bayesian posterior of the network's weights can alleviate this since it enables computing a DNN's predictive distribution. The Bayesian posterior is intractable, but the Linearized Laplace approximation (LLA) has been shown to provide promising approximations. A limitation is, however, that LLA is too expensive in the case of modern DNNs. In this project, we will investigate extra approximations, on top of LLA, that allow to obtain predictive distributions in modern DNNs. References: * https://proceedings.mlr.press/v235/ortega24a.html * https://openreview.net/pdf?id=8aeSJNbmbQq * https://doi.org/10.1016/j.neucom.2020.09.076 * https://proceedings.mlr.press/v162/rodri-guez-santana22a.html
Supervisor: Jorge Enrique Lopez de Vergara Mendez Email: jorge.lopez_vergara@uam.es	Robust Non-Forgery Fingerprints for Internet Traffic Classification: Beyond JA4+ Evasion and Drift Attacks	This thesis proposes a novel framework for Internet traffic classification based on non-forgeable fingerprints that enhance and extend the JA4+ methodology [1, 2, 3]. While JA4+ effectively identifies encrypted connections through TLS and TCP features, it remains vulnerable to evasion and drift attacks. The proposed research introduces cross-layer fingerprinting that fuses transport, network, and temporal behaviors [4] with lightweight hashes derived from protocol dynamics. This hybrid approach aims to produce adaptive, explainable, and tamper-resistant classification models capable of maintaining accuracy and reliability under adversarial manipulation or rapidly evolving traffic patterns. References: [1] http://arantxa.ii.uam.es/~jlopezv/publicaciones/iccida25mft.pdf [2] http://arantxa.ii.uam.es/~jlopezv/publicaciones/ucami25ja4.pdf

		[3] https://doi.org/10.1007/s12243-025-01114-z [4] https://doi.org/10.1016/j.comnet.2022.109471
Supervisor: Pablo Carballeira Email: pablo.carballeira@uam.es	Adaptive Generative Optimization for Enhanced Cross-Domain Vision Systems	The project's objective is the optimization of Visual Artificial Intelligence systems for real-world scenarios, addressing limitations in adaptability, scalability, and data reliability. Robustness and flexibility of AI systems can be improved by increasing the diversity of training data, through the use of generative methods, tools for measuring the quality and diversity of generated data, and the development of training algorithms capable of producing models adaptable to different domains. The project will consider an active interaction between data generation and adaptation, where generative processes produce data customized to the target domain(s), and training strategies guide the generation of new data. References: K. Sirotkin, P. Carballeira and M. Escudero-Viñolo, "A study on the distribution of social biases in self-supervised learning visual models," 2022 IEEE/CVF Conference on Computer Vision and Pattern Recognition (CVPR), New Orleans, LA, USA, 2022, pp. 10432-10441, https://doi.org/10.1109/CVPR52688.2022.01019 Pablo Marcos, Roberto Alcover, Juan C. SanMiguel, Jose M. Martinez: "Open-Vocabulary Attention Maps with Token Optimization for Semantic Segmentation in Diffusion Models", 2024 IEEE/CVF Conference on Computer Vision and Pattern Recognition (CVPR), Seattle, WA, USA, 2024, pp. 1-12. https://doi.org/10.1109/CVPR52733.2024.00883 J. Montalvo.; Á. García-Martín; P. Carballeira; J.C. SanMiguel; Unsupervised Class Generation to Expand Semantic Segmentation Datasets. J. Imaging 2025, 11, 172. https://doi.org/10.3390/jimaging11060172 J. Montalvo, P. Carballeira and Á. García-Martín, "Synthmanticlidar: A Synthetic Dataset For Semantic Segmentation On Lidar Imaging," 2024 IEEE International Conference on Image Processing (ICIP), Abu Dhabi, United Arab Emirates, 2024, pp. 137-143, doi: 10.1109/ICIP51287.2024.10648055.
Supervisor: Jose Maria Martinez Sanchez Email: josem.martinez@uam.es	Bees and algorithms: monitoring and classifying bees in the wild	This project focuses on advancing AI methods for automated monitoring of wild bee pollinators through computer vision. It will integrate annotated entomological collections with in-the-wild datasets to train deep learning models for segmentation/detection, classification, and multi-view tracking under diverse ecological conditions. Research will address key challenges such as class imbalance, domain adaptation between laboratory and field data, continual learning to prevent catastrophic forgetting, and multimodal approaches incorporating textual tokens (i.e., morphological traits). By optimizing recognition accuracy and model generalization, the project will enable scalable, non-invasive biodiversity monitoring and provide novel tools to study ecological dynamics. The project will be done in collaboration with the ecological department at UAM (https://teguam.es/en/). References: DOI 10.1007/s00371-025-03843-7 DOI 10.48550/arXiv.2302.13961 DOI 10.1109/CVPR52733.2024.00883 DOI 10.1109/TCSVT.2022.3207223
Supervisor: Juan Carlos San Miguel Avedillo Email: juancarlos.sanmiguel@uam.es	Bridging Urban Realities: Unsupervised Domain Adaptation for Graph-based	This project aims to develop novel unsupervised learning and domain adaptation techniques within structured graph neural networks to enhance semantic segmentation in complex urban environments. By leveraging unlabelled visual data from diverse geographic regions—particularly between Spain and China—the research seeks to build robust,

	Scalable Semantic Scene Understanding	scalable models capable of understanding urban scenes across varying conditions and domains. The project aligns with global efforts in smart city development, with potential applications in autonomous driving, urban planning, and intelligent surveillance. References: 1) https://doi.org/10.1016/j.patcog.2025.111633 2) https://doi.org/10.1109/CVPR52733.2024.00883 3) https://doi.org/10.48550/arXiv.2302.13961 4) https://doi.org/10.1109/TCSVT.2022.3207223
Supervisor: Javier Gomez Escribano Co-supervisor: Germán Montoro Manrique Email: jg.escribano@uam.es	Immersive Virtual Reality and Generative AI for Emotional Recognition and Social Skills Development in Children with Special Needs	This project aims to develop and evaluate an immersive Virtual Reality (VR) environment enhanced with Generative Artificial Intelligence (AI) to support children with Autism Spectrum Disorder (ASD) and other special needs in emotional recognition and social skills training. The system will enable natural interactions with AI-driven virtual characters in simulated scenarios, providing opportunities to practice emotional understanding and social behaviors. By integrating speech recognition, generative dialogue, and expressive voice synthesis, the platform will create an adaptive interactive environment designed to increase children's engagement and learning outcomes. The research will focus on assessing the usability, effectiveness, and potential therapeutic value of this approach in improving emotional comprehension and social communication among children with special needs. References: [1] https://doi.org/10.1016/j.entcom.2024.100861 [2] https://doi.org/10.1016/j.jss.2024.112164 [3] https://doi.org/10.1080/0144929X.2023.2268734 [4] https://doi.org/10.1145/3311927.3325307
Supervisor: Ivan Gonzalez Martinez Email: ivan.gonzalez@uam.es	Generative AI for Network Traffic Modeling	This project aims to develop a novel generative AI model that converts textual descriptions into realistic network traffic flows --similar in concept to text-to-image multimodal models. Instead of using few-shot prompting or fine-tuning existing architectures [1, 2] as in our previous publications, this research proposes a new Transformer-based framework specifically designed for packet-level and flow-level synthesis. The objective is to bridge natural language and network behavior, enabling applications such as simulation, anomaly detection, and synthetic dataset generation. Ideal candidates should have a strong passion for deep learning, natural language processing (NLP), and network systems. References: 1. https://doi.org/10.1016/j.comnet.2025.111308 2. http://arantxa.ii.uam.es/~jlopezv/publicaciones/iccida25igm.pdf
Supervisor: Juan Aguirre Bueno Email: juan.aguirre@uam.es	Advanced optoacoustic imaging	Optoacoustic imaging is an emerging technology that holds great promise for improving general clinical practice and preclinical research since it offers a unique combination of optical absorption contrast, high resolution, and high penetration depth. Optoacoustic technologies break the penetration limits of optical microscopy techniques. However, the technology is still on its infancy, and several important innovations are expected all the different imaging subfields (acquisition geometry, electronics, image formation algorithms etc) In this project, the student will develop advanced optoacoustic imaging systems with a focus on preclinical research and test them for several research applications. References: 1. https://doi.org/10.1038/s41551-019-0377-4 2. https://doi.org/10.1038/s41551-017-0068

		3. https://doi.org/10.1002/lpor.202300443 4. https://doi.org/10.1016/j.pacs.2023.100513
Supervisor: German Montoro Manrique Co-supervisor: Javier Gómez Escribano Email: german.montoro@uam.es	Accessibility of technologies for cognitive disabilities	Cognitive accessibility refers to the design and evaluation of digital technologies -web platforms, mobile applications, and online courses- to ensure usability for individuals with cognitive disabilities. These disabilities encompass a broad spectrum, including intellectual disabilities, autism, ADHD, and learning disorders, affecting memory, attention, comprehension, and executive function. Ensuring cognitive accessibility is critical for digital inclusion, as traditional standards (e.g., WCAG) often fall short in addressing the nuanced needs of this population. Specialized metrics, heuristics, and evaluation methods -integrating AI, manual, and user-centered approaches- are emerging to address cognitive load and comprehensibility. Standards and guidelines are evolving, with extensions (e.g., ICF, UDL) and participatory design improving coverage. Persistent gaps remain in empirical validation, user participation, and frameworks for autism and diverse cognitive profiles. Real-world implementation requires inclusive design, organizational commitment, and ongoing research to refine tools and methodologies. The field of cognitive accessibility in digital technologies is advancing, but continued research, development of tailored metrics and heuristics, improved standards, and inclusive evaluation methods are essential to achieve robust digital inclusion for individuals with cognitive disabilities. References: 1. https://doi.org/10.3390/s17061359 2. https://doi.org/10.1109/ACCESS.2020.3000095 3. https://doi.org/10.1080/0144929X.2023.2268734 4. https://doi.org/10.1016/j.jss.2024.112164
Supervisor: Jose Luis Jorro Aragoneses Email: jose.jorro@uam.es	Leveraging Language Models and Recommendation Models Signals to Generate Contextualized and Personalized Explanations	This thesis explores the design of personalized explanation models for recommender systems by leveraging signals extracted from underlying recommendation models—whether classical, contextual, or sequential. The research focuses on identifying and modeling informative internal signals that capture user-item relationships and decision factors. Large Language Models (LLMs) will then be applied to generate natural, contextualized, and user-centered explanations based on these signals. The study aims to bridge the gap between algorithmic reasoning and human interpretability, contributing to the development of transparent, adaptive, and explainable recommendation systems. References: Jorro-Aragoneses, J., Caro-Martinez, M., Recio-Garcia, J.A., Diaz-Agudo, B., Jimenez-Diaz, G. (2019). Personalized Case-Based Explanation of Matrix Factorization Recommendations. In: Bach, K., Marling, C. (eds) Case-Based Reasoning Research and Development. ICCBR 2019. Lecture Notes in Computer Science(), vol 11680. Springer, Cham. https://doi.org/10.1007/978-3-030-29249-2_10 Jorro-Aragoneses, J.L., Caro-Martínez, M., Díaz-Agudo, B., Recio-García, J.A. (2020). A User-Centric Evaluation to Generate Case-Based Explanations Using Formal Concept Analysis. In: Watson, I., Weber, R. (eds) Case-Based Reasoning Research and Development. ICCBR 2020. Lecture Notes in Computer Science(), vol 12311. Springer, Cham. https://doi.org/10.1007/978-3-030-58342-2_13 Caro-Martínez, M., Jorro-Aragoneses, J.L., Díaz-Agudo, B., Recio-García, J.A. (2024).

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Supervisor: Marcos Escudero Viñolo Co-supervisor: Catarina Barata (IST) Email: marcos.escudero@uam.es	Unbiased Active Continual Learning	Current vision models are trained in vast amounts of data, usually adopting self-supervised pre-training (SSL), followed by a fine-tuning guided to a specific task. SSL leads to more generalizable features and improves the overall robustness of the models, but it still suffers from existing bias on the training data as well as lack of representative examples that cover the entire domain. This is particularly impactful in the multimodal medical domain, where data is hard to collect and missingness is prone to occur. This PhD will develop online learning strategies for multimodal settings, leveraging active learning and conformal prediction to avoid biased training. References: Sirotkin, K., Carballeira, P., & Escudero-Viñolo, M. (2022). A study on the distribution of social biases in self-supervised learning visual models. Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition, 10442-10451. https://doi.org/10.1109/CVPR52688.2022.01019 Barata, C., Rotemberg, V., Codella, N.C.F. et al. (2023). A reinforcement learning model for AI-based decision support in skin cancer. Nature Medicine 29, 1941–1946. https://doi.org/10.1038/s41591-023-02475-5 Mota, T., Verdelho, M. R., Araújo, D. J., Bissoto, A., Santiago, C., & Barata, C. (2024). Mmist-ccrcc: A real world medical dataset for the development of multi-modal systems. In Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition (pp. 2395-2403). http://dx.doi.org/10.1109/CVPRW63382.2024.00246 Alcover-Couso, R., Escudero-Vinolo, M., SanMiguel, J. C., & Bescos, J. (2025). Gradient-based class weighting for unsupervised domain adaptation in dense prediction visual tasks. Pattern Recognition, 166, 111633. Pergamon. https://doi.org/10.1016/j.patcog.2025.111633
Supervisor: Marcos Escudero Viñolo Co-supervisor: Carlos Santiago (IST) Email: marcos.escudero@uam.es	Language model guided disentangled representation learning	This PhD explores guiding disentangled representation learning under weak supervision using large language and vision-language models. By prompting these models to generate soft, low-cost annotations of sensitive attributes (e.g., gender, age), we aim to supervise the disentanglement of these factors from task-relevant representations without explicit labels. The goal is to align disentangled factors with human-understandable concepts, improving fairness and interpretability in downstream predictions. This approach bridges foundation model capabilities with fairness-aware learning to enable scalable, transparent ML systems. References: López-Cifuentes, A., Escudero-Vinolo, M., Bescós, J., & García-Martín, Á. (2020). Semantic-aware scene recognition. Pattern Recognition, 102, 107256. Pergamon. https://doi.org/10.1016/j.patcog.2020.107256 Santiago, C., Barata, C., Sasdelli, M., Carneiro, G., & Nascimento, J. C. (2021). LOW: Training deep neural networks by learning optimal sample weights. Pattern Recognition, 110, 107585. https://doi.org/10.1016/j.patcog.2020.107585 Santiago, C., Correia, M., Verdelho, M.R., Bissoto, A., Barata, C. (2023). Global and Local Explanations for Skin Cancer Diagnosis Using Prototypes. In: Celebi, M.E., et al. Medical Image Computing and Computer Assisted Intervention – MICCAI 2023 Workshops .

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Supervisor: Álvaro García Martín Email: alvaro.garcia@uam.es	Adaptive Generation of Synthetic Medical Images for Interactive and Personalized Medical Education	This PhD project proposes the development of an adaptive multimodal system focused on generating high-quality synthetic medical images to enhance interactive medical education. Building upon advances in vision–language alignment and diffusion-based generative modeling, the research aims to create a platform capable of producing realistic, diverse, and pedagogically meaningful medical images from textual or conceptual prompts. The system will adapt to user input and learning goals, generating tailored visual material that complements theoretical instruction and bridges data scarcity in specialized domains. By combining retrieval of real cases with controlled synthetic generation, the project seeks to support individualized, globally accessible, and ethically sound medical training through open, data-efficient AI tools. References: 1.Diana Albelda, Cecilia; García Martín, Álvaro; Bescós Cano, Jesús. "A Review on Deep Learning Methods for Glioma Segmentation, Limitations and Future Perspectives", Journal of Imaging. Volume 11, Issue 269, Aug 2025. https://doi.org/10.3390/jimaging11080269 2.-Diaz Benito, Miguel; Diana Albelda, Cecilia; García Martín, Álvaro; Bescós Cano, Jesús; Escudero-Viñolo, Marcos; SanMiguel, Juan C.. MIRAGE: Retrieval and Generation of Multimodal Images and Texts for Medical Education. The Fourth Workshop on Applications of Medical AI (AMAI), 28th International conference on medical image computing and computer assisted intervention, MICCAI 2025 (Best Student Paper, Honorable Mention). 3.-Roberto Alcover-Couso, Juan C. SanMiguel, Marcos Escudero-Viñolo and Alvaro Garcia-Martin: “On exploring weakly supervised domain adaptation strategies for semantic segmentation using synthetic data”. Multimedia Tools and Applications. Volume 82, pp. 35879-35911, March 2023, https://doi.org/10.1007/s11042-023-14662-0. 4.-Javier Montalvo, Álvaro García-Martín, Pablo Carballeira, Juan C. SanMiguel. "Unsupervised Class Generation to Expand Semantic Segmentation Datasets", Journal of Imaging. Volume 11, Issue 6, May 2025. https://doi.org/10.3390/jimaging11060172