CURSO 2023/24	
Especialidad	
Física Teórica	**TEO**
Astrofísica	**ASTRO**
Física Nuclear y de Partículas	**FNyP**
Fotónica	**FOTO**

PROPUESTAS TRABAJO FIN DE MASTER EN FÍSICA AVANZADA (Curso 2023-2024)

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Núm	**Tema**	**Tutores**	**Email de contacto**	**Especialidad**	**Breve descripción (máximo 300 caracteres)**
1	Auroras beyond the Solar System: ciclotron maser emission in substellar objets.	Jose Carlos Guirado / Joan Climent	guirado@uv.es	ASTRO	Unexpected magnetic activity in brown dwarfs has recently emerged from observations at radio wavelengths. The highly polarized nature and high brightness temperature of the emission suggest the presence of coherent radiation mechanisms, which are observable through auroral phenomena. Using interferometric observations of a sample of brown dwarfs, we will study both the light curves and the morphology associated to these phenomena. The goal is to uncover if the auroras are generated in active magnetic structures or, alternatively, if they are the result of the magnetic interaction of the brown dwarf with possible exoplanets.
2	Spin evolution of proto-neutron stars: comparison of analytic to numerical models	Miguel Ángel Aloy/Martin Obergaulinger	miguel.a.aloy@uv.es, martin.obergaulinger@uv.es	ASTRO	Just-born neutron stars after the collapse of massive stellar cores are very hot, compact objects. Since the solid crust endowing the neutron-rich matter has not formed, these objects are termed proto-neutron stars (PNS). Since PNSs inherit part of the angular momentum of the collapsing core, and since vigorous convection is expected to happen in their outer layers, they are promising sources of gravitational waves. The spin of the PNS may evolve significantly after birth. Matter can be accreted/ejected on/from the PNS surface, neutrinos are copiously emitted and carry both energy and angular momentum of the PNS, and magnetic stresses may transfer angular momentum from/to the PNS. Understanding the spin evolution of PNSs is key to predict the gravitational wave signals, which may bring valuable information about the nature of matter at densities above the nuclear matter (saturation) density. In this project, we will develop an empiric model to better understand both, the spin evolution and the associated imprint in the gravitational wave signal. The models will be calibrated using existing numerical results for the early evolution of PNSs.
3	Spectra of highly magnetized neutron stars	Michael Gabler	michael.gabler@uv.es	ASTRO	Neutron stars are the compact remnants of supernova explosions. A particular subclass of these stars called magnetars posses the strongest magnetic fields observed in the universe. These magnetars are thought to be connected to many astrophysical phenomena of current interest like gamma-ray bursts or fast radio bursts. The proposed TFM project focuses on the calculation of the synthetic spectra of magnetars. Observations show that the magnetic field around magnetars is twisted. To maintain a twisted magnetospheric field in the exterior of a magnetar, strong currents are required. These currents are then targets for resonant cyclotron scattering of photons coming from the surface of the neutron star (see Fig. 1). During this process the photons can be upscattered from typically 1 keV up to 1 MeV. To calculate the final spectrum of the photons we have a numerical tool that follows the photons in the magnetosphere with a Monte-Carlo radiation transport tool.
4	Neutron star spins from supernova fallback	Michael Gabler	michael.gabler@uv.es	ASTRO	Neutron stars are the compact remnants of supernova explosions. Their birthproperties like mass, kick, and spin are determined by the explosion mechanism. Recently, a late time mechanism was suggested that significantly changes the neutron star spin at later times. Once the neutron star has attained sufficient kick by the interaction with the matter ejected during the supernova explosion, the continued accretion onto the neutron star can lead to significant increase in the rotation. In addition, the rotation should then be (anti-) aligned to the kick velocity. This was tested for supernova explosions of a set of mainly blue supergiants. During this TFM we aim at studying the spin-kick alignment for these red supergiant models.
5	Búsqueda de supertierras en estrellas K con ESPRESSO@VLT	Andrés Moya Bedón	andres.moya-bedon@uv.es	ASTRO	La búsqueda de planetas potencialmente habitables se ha centrado tradicionalmente alrededor de las estrellas M por motivos más técnicos que científicos. Pero los últimos estudios en los que se analiza la interacción entre los vientos estelares, muy intensos en las estrellas M, y los planetas en zona habitable, muy cercanos a la estrella en este caso, han revelado que estos planetas no son tan potencialmente habitables como se pensaba. Es por ello que, recientemente, se han empezado a mirar a las estrellas K como mejores opciones para buscar vida, en particular porque son menos activas, la zona de habitabilidad está algo más lejos de la estrella, y empezamos a tener capacidades técnicas como para estudiarlas. El grupo del Dr. Moya ha conseguido tiempo de observación con el espectrógrafo ESPRESSO@VLT para observar una serie de estrellas K en búsqueda de supertierras habitables, y los primeros espectros han sido ya observados. El proyecto se basa en el análisis en velocidad radial de espectros de una serie de estrellas K no cubiertas por las misiones espaciales de búsqueda de planetas en búsqueda de dichas supertierras potencialmente habitables.
6	Galaxy correlations at the smallest scales	Vicent J. Martínez/ Pablo Arnalte Mur	vicent.martinez@uv.es,pablo.arnalte@uv.es	ASTRO	Modern theories of galaxy formation assume that galaxies form within dark matter halos. Observational cosmology should be able to provide clues to understand the relationship between the spatial galaxy distribution and that of the dark matter within the halos. The two-point correlation function is an excellent tool to achieve this goal. Measuring the clustering of galaxies at small scales will provide information about the underlying dark matter distribution. This project aims to study the clustering of galaxies at the smallest possible scales usinga variety of photometric and spectroscopic redshift galaxy catalogs.
7	An introduction to numerical relativity in the characteristic formulation	Jose Antonio Font / Osvaldo Freitas	j.antonio.font@uv.es, ogf1996@gmail.com	ASTRO	Numerical Relativity, the numerical solution of Einstein's Field Equations, commonly adopts spacelike foliations of spacetime. This is the choice in standard formulations of widespread use nowadays, such as the BSSN approach. However, other approaches exist. One of them is the characteristic formulation in which spacetime is foliated with null hypersurfaces (light cones). This TFM proposal is an introduction to the characteristic formulation of numerical relativity. It will allow the student to understand the theoretical aspects of this formulation and to perform simple (but not trivial) numerical experiments. With this project the student will complement his/her training in numerical relativity by being exposed to other approaches that are not discussed in the subject "Advanced General Relativity" in the Master in Advanced Physics. The project will focus on the spherically-symmetric case, where the system of field equations is conveniently simple. This should allow the student to complete the TFM (i.e. learn the basics of the numerical approach to solve the equations and carry out the simulations) in the amount of time available in the Master. A working code written in Fortran will be made available to the student. This will be the baseline code for the numerical experiments, involving black holes and compact stars. Additional tasks the student could carry are: (1) rewriting of the code in python/julia, (2) using machine-learning-based integrators for the field equations, in particular physics-informed neural networks.
8	Vibrational modes of neutron stars that shatter their crust	Pablo Cerdá Durán / Arnau Rios	pablo.cerda@uv.es / arnau.rios@icc.ub.edu	ASTRO	Binary neutron star mergers are produced as their orbit shrinks due to gravitational wave emission. Neutron stars have a solid exterior crust that may shatter in these extreme encounters. In this work we explore the possibility of shattering the neutron star crust during the inspiral phase preceding the merger. During this phase the orbital frequency can couple resonantly with vibrational modes of the interior of the star and induce the shattering. The energy release could be an explanation for the electromagnetic precursors observed before short gamma ray bursts (events associated with the merger itself). They could also induce effects in the associated gravitational signal observable with current observatories (LIGO, Virgo, KAGRA). The resonant frequency is interesting because it depends on the properties of dense matter and, in particular, on the symmetry energy parameter that is predicted from nuclear physics. Therefore, it can be used to constrain the properties of the crust. The main aim of the project is to compute the oscillation modes of neutron stars with a solid crust. For this purpose the student will use the numerical code GREAT that solves the eigenvalue problem associated to linear oscillations in the star. To include the effects of the crust the student will have to modify the equations implemented in GREAT to account for the elasticity of the crust. This project is part of a larger project in collaboration with the Universitat de Barcelona, so the student would have the possibility to interact with researches both from the UV and the UB for its development.
9	Mapping the polarization of the gravitational-wave sky	Ruxandra Bondarescu (UB) / José Antonio	ruxandra@icc.ub.edu, j.antonio.font@uv.es	ASTRO	Just like electromagnetic waves, gravitational waves (GWs) are most generally characterized by their propagation direction and time-dependent waveform in each of two independent polarization states. Properties of incident plane GWs can be inferred from observations made in a properly oriented network of detectors. We can characterize the wave polarization via its (frequency dependent) Stokes parameters to infer general properties of the wave's source: e.g., point sources of circularly polarized radiation must be non-axisymmetric and radiating angular momentum, while point sources of linearly polarized waves must be either axisymmetric or oriented so that the direction of angular momentum loss is orthogonal to the observer line-of-sight. In terms of astrophysical sources, GW signals from face-on compact binaries are circularly polarized, while waveforms from core-collapse supernovae are more likely to be either linearly polarized or to show a low degree of circular polarization. The objective of this TFM project is to compute sky maps that will show where GW detector networks, like the current LIGO-Virgo-KAGRA (LVK) network, are sensitive to both polarizations, quantified through the Stokes parameters. By the end of the project the student will be able to determine the sensitivity of a GW antenna network to circular polarization using (a) only the two LIGO detectors, (b) a three-detector network composed of LIGO and Virgo, and (c) a future five-detector network composed by the LVK network and LIGO India.
10	Lattice Boltzmann Methods for relativistic fluid simulation	Raimon Luna	raimon.luna-perello@uv.es	ASTRO	Lattice Boltzmann Methods (LBM) are an alternative to traditional methods for computational fluid dynamics. Instead of solving the Navier-Stokes equations directly, LBM use a fictitious particle description on a lattice. LBM have generated an increasing interest, as they are particularly well suited to simulate flows in complex geometries, they are trivially parallelizable (for instance in GPUs) and can easily incorporate mutli-phase flows with microscopic interactions such as chemical reactions. In this TFM we will explore the applicability of such methods to relativistic fluid simulations, including shocks, for astrophisical purposes. We will start by solving simple Riemann problems, such as a shock tube, and progressively move towards more complex setups, such as relativistic fluid jets.
11	Gravitational-Waves parameter estimation with dictinary learning reconstruction	Alejandro Torres/ Miquel Llorens	alejandro.torres@uv.es	ASTRO	Dictionary learning techniques has proven to be a very usefull algorithm to extract astrophysical waveforms from GW detectors noise. However, is not clear how the reconstruction affects the parameter estimation procdure. In this TFM we propose to use dictionary learning methods in combination of the stardand parameter estimation in the LIGO/Virgo/KAGRA collaboration.
12	Amplification of quantum vacuum fluctuations by gravitational collapse.	A. del Rio, N. Sanchis-Gual	nicolas.sanchis@uv.es, adrian.rio@uv.es	ASTRO/TEO	When a star collapses to form a black hole it spontaneously excites quanta out of the vacuum state. Particles that are seen by observers at infinity (Hawking radiation) are quantum-correlated with those that fall into the black hole horizon. The goal of this project is to study the time evolution of quantum correlations of a scalar field as a spherically symmetric star collapses to form a Schwarzschild black hole. We will do this by computing the two-point function along two spacetime trajectories. The student will learn basic techniques from quantum field theory in curved spacetimes and from numerical relativity to solve this problem. The work will involve advanced numerical calculations with a computer.

13	Search for non- standard neutrino interactions with KM3NeT/ORCA	Juan Zúñiga Román	zuniga@ific.uv.es	FNyP	The KM3NeT/ORCA underwater neutrino detector located in the Mediterranean Sea has started to take data with almost 20 detection lines deployed. This project will consist on using this data to explore the existence of non-standard interactions (NSI) from the measurement of the oscillation of atmospheric neutrinos.
14	Top quark physics at the LHC and future colliders	Marcel Vos, Miguel Villaplana	marcel.vos@ific.uv.es, Miguel.Villaplana@uv.es	FNyP	El quark top es la partícula elemental conocida más pesada, es un candidato perfecto para el estudio de la interacción fuerte y juega un papel esencial en muchas extensiones del Modelo Estándar. Este TFM se centrará en el estudio de las propiedades del quark top mediante la aplicación de técnicas avanzadas de análisis a datos del experimento ATLAS del LHC.
15	From Z to H	Salvador Martí	salvador.marti@ific.uv.es	FNyP	The Higgs coupling to the Z boson is being studied with the data collected by the ATLAS experiment at the CERN LHC accelerator. The 4lepton (with electrons or muons) final state channel produces a very clean signal and allows to study the Higgs coupling to muons.
16	Dimuons signatures in KM3NeT	Alfonso Garcia	Alfonso.Garcia@ific.uv.es	FNyP	This project aims to detect rare "dimuon" events in the KM3NeT ARCA neutrino telescope. These events are associated with heavy quark production in neutrino interactions and have not been observed in such telescopes before. The project involves simulating dimuon production and using Graph Neural Networks to classify dimuon events, with the objective of quantifying their observability with ARCA.
17	Estimation of Systematic Errors in Deep Learning Methods applied to the extraction of ttbar resonances in ATLAS experiment	José Salt, Santiago González	jose.salt@ific.uv.es,sgonzale@ific.uv.es	FNyP	Machine/ Deep Learning methods have been applied to the problem of the classification of ttbar events at the final state: the signal is the potential ttbar resonances predicted in several Beyond the Standard Model approaches and the background is the SM processes. The results are competitive when compared with those obtained by more 'traditional' analysis methods. Due to the nature of ML/DL methods, these results must be carefully verified and can be affected by systematic errors arising from the application of the methods themselves. We will study methods of Decision Trees, Random Forest, Neural Networks, Logistic Regression, etc. and compare these systematics
18	Ultra-fast scintillators for high-energy gamma-rays during proton therapy treatments	Fernando Hueso González	fernando.hueso@ific.uv.es	FNyP	El/la estudiante desarrollará su trabajo en el grupo IRIS (http://ific.uv.es/iris). Este grupo trabaja en la monitorización de tratamientos de protonterapia. En este proyecto, se caracterizarán experimentalmente diferentes centelleadores de respuesta muy rápida (1 ns) para su utilización como detectors de prompt gamma-rays, los cuales se producen en reacciones nucleares entre los protones acelerados y los núcleos del tejido del tumor. Asimismo, se estudiará la respuesta del fotodetector la electrónica cuando la tasa de cuentas es muy alta, y se complementará la investigación con simulaciones de Monte Carlo paralelizadas en GPUs.
19	Vertex detector upgrade of the Belle II experiment	Carlos Mariñas	cmarinas@ific.uv.es	FNyP	To handle the high collision rates at the luminosity level aimed by the SuperKEKB accelerator (KEK, Japan), an upgrade of the vertex detector system is necessary. The work is to study the impact on the precision and resolution of the vertex measurements using selected benchmark physics channels, along with the potential integration with the trigger systems of the new CMOS-based vertex detector system.
20	Exploring new physics through B decays at Belle II	Carlos Mariñas	cmarinas@ific.uv.es	FNyP	The high luminosity of SuperKEKB, clean environment of e+e- collisions and improved detectors of the Belle II experiment provide ideal conditions to search for rare flavour-changing B decays that are sensitive to effects beyond the Standard Model. The work developed during the internship will contribute to improving the analysis tools used in such searches.
21	Constructing new subtractions methods for the LHC	Leandro Cieri	lcieri@uv.es	FNyP	The Standard Model has proved to be one of the most successful theories in physics. It has been and continues to be tested to very high precision at CERN's LHC. As the data obtained at the LHC reach an unprecedented accuracy, the precision of the extraction of relevant parameters from the experiment is beginning to be limited by the theory. We propose to construct a new subtraction method at N4LO (the highest in the literature) in QCD perturbation theory. We will calculate some of the necessary ingredients at this order and test the factorisation theorem at this accuracy. These constituents are relevant for Higgs and Drell-Yan physics.
22	High Performance Algorithms for LHC Experiments	Luca Fiorini	fiorini@ific.uv.es	FNyP	La próxima actualización de los experimentos del LHC aumentará la cantidad de datos a procesar, requiriendo ejecutar algoritmos más eficientes basados en Inteligencia Artificial (IA) en aceleradores hardware (GPU, FPGA, etc). Esta propuesta permitirá formar parte de la Colaboración ATLAS del CERN, diseñar algoritmos de IA para la reconstrucción de datos y para comparar su rendimiento.
23	Técnicas de Machine Learning aplicadas a la selección de neutrinos de alta energía en KM3NeT para la detección de fuentes cósmicas	Agustín Sánchez Losa	Agustin.Sanchez@ific.uv.es	FNyP	Durante la presente década los telescopios de neutrinos están próximos a contribuir a esclarecer los mecanismos de producción de rayos cósmicos en fuentes astrofísicas. El objetivo principal del proyecto que se propone consiste en aplicar técnicas de Machine Learning (BDTs, etc) a los datos acumulados por el telescopio de neutrinos KM3NET para mejorar la selección de datos para la detección de fuentes de neutrinos cósmicos de alta energía, así como aprender y conocer las investigaciones en física de astropartículas y técnicas de instrumentación.
24	Search for the neutrinoless double beta decay in NEXT	Pau Novella	pau.novella@ific.uv.es	FNyP	NEXT aims at the competitive search of the neutrinoless double beta decay in Xe-136, using electroluminiscent Time Projection Chambers (TPCs). The NEXT-100 detector has been installed in the Laboratorio Subterráneo de Canfranc (LSC) and will start operation in early 2024. The proposed project involves the commissioning and calibration of the detector, as well as the first measurement of the backgrounds towards the search of the neutrinoless double beta decay.
25	Machine Learning in the NEXT experiment to search for neutrinoless double beta decay	Neus Lopez March	Neus Lopez March	FNyP	Experimental discovery of neutrinoless double beta decay would provide insights into the matter/antimatter asymmetry of the Universe. The NEXT experiment is searching for this decay in Xe-136 using a high pressure xenon gas time projection chamber with electroluminescent amplification. Applications of Graph Neural Networks (GNNs) in particle physics are evolving rapidly since it has been shown indifferent research areas that GNNs present supreme performance compared to standard machine learning approaches.The goal of the proposed research is to develop a GNN based-approach to improve signal discovery sensitivity of the neutrinoless double beta decay (0νββ) search in the NEXT-100 detector.
26	Low-diffusion techniques to improve the topological signature in the NEXT detectors to search for neutrinoless double beta decay	Neus López, Justo Martín-Albo, Pau Novell	neus.lopez@ific.uv.es	FNyP	Experimental discovery of neutrinoless double beta decay would provide insights into the matter/antimatter asymmetry of the Universe. The NEXT experiment is searching for this decay in Xe-136 using a high pressure xenon gas time projection chamber with electroluminescent amplification. The student will characterize the xenon-helium mixture using a prototype of the NEXT experiment at IFIC. This will involve conducting a pressure scan while varying the helium concentration in the mixture from 5% to 20%. Additionally, the measurement of transverse and longitudinal diffusion will be carried out using a Kr source and a Th-228 source.
27	Towards a tonne scale detector to search for neutrinoless double beta decay in NEXT	Neus López, Justo Martín-Albo	neus.lopez@ific.uv.es	FNyP	Experimental discovery of neutrinoless double beta decay would provide insights into the matter/antimatter asymmetry of the Universe. The NEXT experiment is searching for this decay in Xe-136 using a high pressure xenon gas time projection chamber with electroluminescent amplification. The student will engage in simulations and laboratory measurements of large-area photon collectors, such as X-ARAPUCA and double-clad wavelength shifting fibers, in order to comprehend the essential parameters influencing light detection efficiency. This research aims to enhance the future experiments conducted by the NEXT collaboration.
28	Construction and operation of a muon tagger for NEXT	José Alfonso Soto	josealfonso.soto@ific.uv.es	FNyP	NEXT is a neutrinoless double beta decay experiment using xenon Time Projection Chambers. NEXT-100 is a detector installed at the Laboratorio Subterráneo de Canfranc (LSC) that will start taking data in early 2024. A 7m2 muon tagger based on scintillator bars readout by SiPMs will be installed in NEXT-100 to mitigate the cosmic muon background, one of the most significant. A first 1m2 prototype muon tagger will be installed and operated at IFIC. The student will participate in the construction and operation of the prototype muon tagger installed at IFIC, and the construction of the muon tagger for NEXT-100.
29	Meaurement of the electroweak diphoton production with ATLAS at the LHC	Josu Cantero	Josu.Cantero@ific.uv.es	FNyP	The way in which the gauge bosons (W,Z and gamma) couple is a unique prediction of the SM. In particular, by measuring the electroweak diphoton production, the couplings between W bosons and photons can be tested. This TFM will be dedicated to develop new strategies for the measurement of the EW di-photon production using Run 2 data of the LHC.
30	Higgs and top physics at the LHC / Top quark couplings: challenging the Standard Model	María Moreno Llácer y Marcel Vos	marcel.vos@ific.uv.es, Maria.Moreno@ific.uv.es	FNyP	The Higgs boson was discovered in 2012. Since then, its properties and couplings to many SM particles have been characterized in detail. In this TFM we will study the experimental results of the LHC experiments that characterize the Higgs boson and its interactions with the top quark.
31	Detection of High-energy Neutrinos of Galactic Origin with the ANTARES Neutrino Telescope	Francisco Salesa Greus	sagreus@ific.uv.es	FNyP	The sources of the most energetic cosmic rays in our Galaxy are unknown. Even if the most likely candidates have been determined, thanks to gamma-ray observations with experiments like HAWC, we need high-energy neutrino observations to unambiguously identify them. In this TFM we propose to study the capabilities of ANTARES for the detection of extended Galactic sources based on HAWC observations.
32	Hunting New Physics with NA64 experiment at CERN	Laura Molina Bueno	laura.molina@ific.uv.es	FNyP	Several fundamental questions remain open in particle physics: the origin of Dark Matter, neutrino masses and the matter-antimatter asymmetry of the universe. The existence of feebly or weakly interacting particles arising in New Physics scenarios can provide solutions to these questions. NA64 is a world-reference fixed target experiment at CERN searching for such particles in electron, positron and muon interactions with a target. The student will participate in the analysis of the newly collected data in 2023, getting familiar with all the experiment elements. The project will be carried out in close collaboration with researchers based at CERN and inside the NA64 collaboration.
33	Feasibility studies for Beyond Standard Model searches with ProtoDUNEs at CERN	J. Martin-Albo Simon, L. Molina Bueno	justo.martin-albo@ific.uv.es, laura.molina@ific.uv.es	FNyP	The Deep Underground Neutrino Experiment (DUNE) is part of the next generation of neutrino experiments. The primary physics goal of DUNE is to unequivocally study the neutrino oscillation paradigm, but these experiments are also excellent platforms to probe many Beyond Standard Model (BSM) scenarios. To accomplish such milestones, DUNE will build the largest Liquid Argon Time Projection Chamber (LArTPC), detectors with 10 ktonnes of LAr. The ProtoDUNE project at CERN, two LArTPCs with 700 tonnes, was developed to engineer and validate the technology towards the ktonne-scale. At IFIC, we have proposed to use such detectors to carry out, besides R&D activities, dedicated BSM searches. The student will participate in the feasibility studies ongoing to demonstrate such a possibility.
34	I+D en un prototipo de célula recolectora de fotones para el experimento DUNE	Justo Martin-Albo, Anselmo Cervera	justo.martin-albo@ific.uv.es, acervera@ific.uv.es	FNyP	El haz de neutrinos más potente del mundo atravesará 1300 Km de la corteza terrestre hasta llegar a un detector de enormes dimensiones, situado a 1500 m de profundidad en una antigua mina de oro abandonada. El estudiante participaría en el I+D para el sistema de detección de fotones de este detector, que se llevaría a cabo en el IFIC con un sofisticado equipamiento para medidas ópticas y electrónicas. En este contexto, se esta construyendo un prototipo de célula recolectora de fotones, que combina plástico centelleador, filtros dicroicos y fotomultiplicadores de silicio, así como la electronica de lectura asociada. Las tareas a realizar incluyen la puesta en marcha del sistema, su caracterización completa y su posterior optimización, apoyada por simulaciones de Geant4 en las que el estudiante también participaría. Los resultados de estas investigaciones se plasmarán en un artículo científico.

35	Mejora de la escala energética del experimento DUNE por medio de un mapa tridimensional de temperaturas	Anselmo Cervera	acervera@ific.uv.es	FNyP	El haz de neutrinos más potente del mundo atravesará 1300 Km de la corteza terrestre hasta llegar a un detector con 17000 toneladas de argon liquido, situado a 1500 m de profundidad en una antigua mina de oro abandonada, en Dakota del Sur. El IFIC es responsable de la instalación de 800 sensores de temperatura con resolución cercana a la milésima de grado. El estudiante colaborará de forma directa con la Universidad de Dakota del Sur (SDSU), que está desarrollando una simulación de dinámica de fluidos (CFD) que permite predecir el comportamiento del argón dentro del detector. Utilizando técnicas avanzadas de analysis de datos, la combinación de estas simulaciones y del mapa de temperaturas observado permitirá mejorar las prestaciones del detector. Siendo este estudio pionero en física de partículas, los resultados obtenidos se plasmarían en un artículo científico de especial relevancia para la colaboración DUNE.
36	I+D con luz en el ultravioleta profundo para el experimento de neutrinos DUNE	Laura Molina, Jose Soto, Anselmo Cervera	laura.molina@ific.uv.es, jose.soto@ific.uv.es, acervera@ific.uv.es	FNyP	DUNE está construyendo el detector de argon liquido más grande hasta la fecha. En este medio, las partículas cargadas producen luz de centelleo con una longitud de onda de 128 nm. La I+D en esta region del espectro resulta extremadamente compleja, ya que la luz es absorbida por el aire, siendo necesaria una atmósfera de argón gaseoso o vacío. En el IFIC hemos desarrollado ArGOO (Argon Gas Optical Observatory), un novedoso sistema que presenta varias ventajas frente a sus análogos en vacío. Las tareas a realizar por el estudiante incluyen la optimización y puesta en marcha de ArGOO, la toma de datos con diversas muestras y detectores de luz, el análisis exhaustivo de los mismos, y la participación en la elaboración de un articulo científico.
37	Desarrollo en el CERN de una técnica novedosa para la calibración de las cámaras de proyección temporal (TPC) del experimento DUNE	Nadia Yahlali, Anselmo Cervera	nadia.yahlali@ific.uv.es, acervera@ific.uv.es	FNyP	En el experimento DUNE, el haz de neutrinos más potente del mundo atravesará 1300 Km de la corteza terrestre hasta llegar a un detector (TPC) de enormes dimensiones, situado a 1500 m de profundidad en una antigua mina de oro abandonada. La TPC se encuentra inmersa en argón líquido, cuya pureza es clave para garantizar las prestaciones del detector. El estudiante participaría en el desarrollo del software de reconstrucción y en el análisis de los datos recogidos por un pequeño prototipo en el CERN, expuesto a una fuente radioactiva de Bi207, cuya desintegración beta permite entre otros, monitorizar la pureza del argón de forma continua. Siendo este estudio pionero en este campo, los resultados obtenidos se plasmarán en un artículo científico de especial relevancia para la colaboración DUNE.
38	I+D para el sistema de monitorización de temperaturas de DUNE usando redes de Bragg en fibras ópticas	Nadia Yahlali, Anselmo Cervera	nadia.yahlali@ific.uv.es, acervera@ific.uv.es	FNyP	El haz de neutrinos más potente del mundo atravesará 1300 Km de la corteza terrestre hasta llegar a un detector con 17000 toneladas de argon liquido, situado a 1500 m de profundidad en una antigua mina de oro abandonada. El IFIC es responsable del sistema de monitorización de temperaturas en el argón, para el que se requiere una resolución cercana a la milésima de grado. El elevado potencial eléctrico (300000 voltios) al que está sometido el detector imposibilita el uso de sensores de temperatura convencionales. El IFIC ha propuesto el uso de una tecnología novedosa que sustituye los elementos metálicos por fibras ópticas. El estudiante participaría en el I+D que se llevará a cabo en el IFIC, combinando trabajos en el laboratorio con fibras ópticas sumergidas en argón liquido, y análisis de datos. Dada la originalidad del proyecto, se prevé la publicación de un articulo científico.
39	Exploring the Higgs boson and top quark Yukawa coupling with the ATLAS experiment at the LHC.	Susana Cabrera Urbán y Carlos Escobar Ibá	susana.cabrera@ific.uv.es, carlos.escobar@ific.uv.es	FNyP	Hasta la fecha, el quark top es la partícula elemental más pesada conocida. Su elevada masa sugiere que dicho quark pudiera desempeñar una función especial en muchas teorías que predicen nueva física. Además, su gran masa implica un gran acoplamiento con el bosón de Higgs, lo que ha llevado a pensar que puede desempeñar un papel especial en el mecanismo de ruptura de simetría electrodébil. En esta propuesta de TFM, el estudiante participará en los estudios de la producción asociada de un bosón de Higgs y un quark top utilizando la muestra de datos de colisiones protón-protón producidas por el LHC y recogidas por el detector ATLAS. Estos estudios se llevarán a cabo con sofisticadas técnicas de análisis que incorporan la utilización de métodos avanzados en inteligencia artificial. Dicha producción asociada de un bosón de Higgs y un quark top es sensible tanto a la magnitud como al signo del acoplamiento de Yukawa entre dichas partículas, lo cual nos permitirá explorar efectos de nueva Física más allá del Modelo Estándar, por ejemplo la violación de CP.
40	Diseño de los monitores de pérdidas (BLMs) para la primera etapa del acelerador médico de hadronterapia LincDOS6+	Marçà Boronat Arevalo	boronat.arevalo@ific.uv.es	FNyP	La optimización de los haces de partículas es parte fundamental del trabajo en física de aceleradores, sobre todo en aceleradores para tratamiento médico, como la hadronterapia, por lo que es necesario disponer de una instrumentación adecuada al tipo de acelerador que tenemos. El trabajo propuesto consistirá en diseñar y dimensionar los detectores de radiación del sistema de detección de pérdidas (BLMs), usando Geant4, para el futuro acelerador de hadrones que se va a construir y operar en el IFIC.
41	Measuring the quantum dead-cone effect in jets originated from b quarks using the Lund jet plane	Miguel Villaplana, Josu Cantero	Miguel.Villaplana@uv.es, Josu.Cantero@ific.uv.es	FNyP	The quantum dead-cone effect is a phenomenon which predicts a suppression of the gluon radiation emited by a heavy quark in a region collinear around the emitter. This region depends on the mass of the quark. This TFM consists on developing strategies for measuring the quantum dead cone effect using data from the ATLAS experiment of the LHC.
42	Exotic signatures from Axion-like particles (ALPs) and top quarks with the ATLAS experiment	Emma Torró Pastor, Carlos Escobar Ibáñez	emma.torro@ific.uv.es, carlos.escobar@ific.uv.es	FNyP	Axion-like particles (ALPs) are proposed in many extensions of the Standard Model as candidates to explain the nature of dark matter. In this project we will explore cases where a light long-lived ALP couples to top quarks leading to exotic (unconventional) signatures that can only be observed through dedicated searches. We will identify the region of the parameter space where these exotic signatures could lead to New Physics discovery in the ATLAS experiment at the LHC.
43	Searching for New Physics with Ultra-long-lived particles with MATHUSLA	Emma Torró Pastor	emma.torro@ific.uv.es	FNyP	Many beyond the Standard Model theories predict the existence of new particles with long lifetimes, which could only be discovered with dedicated experiments like MATHUSLA. In this TFM we will study the contribution of cosmic rays as a very important source of background in this experiment, which is expected to start taking data in the HL-LHC phase.
44	TAS beta-decay studies of odd Hg isotopes	Alejandro Algora, Sonja Orrigo	algora@ific.uv.es, orrigo@ific.uv.es	FNyP	The student will analyze data from the IS707 experiment done at ISOLDE-CERN with the Total Absorption Spectrometer (TAS) Lucrecia. The goal is to extract the beta-strength distribution for odd Hg isotopes/isomers which, compared to QRPA calculations, allows to determine the shape of the parent states. The Hg isotopes are a very special isotopic chain in the nuclide chart. They show a dramatic staggering in the mean square radii, that for many years was unique in the whole nuclide chart. This staggering was associated to a change in deformation from spherical shape to more deformed shape (oblate shape) starting at around 186Hg, and interpreted as one of the first manifestations of the shape coexistence phenomena in nuclei. The special features of these nuclei have attracted considerable attention in the past [see for example the recent article by B. A. Mash et al., published in Nature (https://doi.org/10.1038/s41567-018-0292-8) and references therein that shows that the staggering finishes at mass 181]. The dramatic staggering in the odd isotopes is interpreted as the existence of two shape isomers, with very different nuclear structure. Our experiment aims to confirm this assumption from the perspective of beta decay, employing a new analysis technique [see A. Algora et al, Phys. Lett. B 819 (2021) 136438] and recently updated theoretical calculations performed by Pedro Sarriguren (IEM, CSIC, Madrid). It will constitute the first experiment in which two shape isomers are studied from the perspective of beta decay in the same nuclei.
45	Contributing to the upgrade of the cutting-edge ATLAS tracker detector for the HL-LHC	Carlos Lacasta, Urmila Soldevilla y Carlos E	Carlos.Lacasta@ific.uv.es, U.Soldevila@ific.uv.es, Carlos.Escobar@ific.uv.es	FNyP	At the CERN laboratory, the LHC is the world's largest, most complex, and most powerful particle accelerator ever built. It has already transformed our understanding of the universe. In the coming years, it will undergo a major transformation, becoming the High-Luminosity LHC (HL-LHC). This new beast will deliver five times more collisions than the current LHC, allowing scientists to probe the Standard Model and search for new physics with unprecedented precision and sensitivity. To capture the intricate details of these high-energy events, the tracker of the ATLAS detector must undergo a major transformation. The current tracker, a masterpiece of engineering, will be replaced by a new silicon-based tracker, a technical marvel. This new detector will be able to withstand the harsh radiation environment of the HL-LHC, with an unprecedented spatial resolution, tracking the paths of charged particles with unmatched precision. In this TFM, we propose to contribute to constructing, electrically and thermally characterizing, and testing the new ATLAS tracker detector at the IFIC's clean room.
46	Fabricación y estudios en criogenia de redes de Bragg en fibras ópticas (FBG) para el experimento DUNE	Nadia Yahlali, José Luis Cruz	nadia.yahlali@ific.uv.es, jose.l.cruz@uv.es	FNyP y FOTO	El haz de neutrinos más potente del mundo atravesará 1300 Km de la corteza terrestre hasta llegar a un detector con 17000 toneladas de argon liquido, situado a 1500 m de profundidad en una antigua mina de oro abandonada. El IFIC es responsable del sistema de monitorización de temperaturas en el argón, para el que se requiere una resolución cercana a la milésima de grado. El elevado potencial eléctrico (300000 voltios) al que está sometido el detector imposibilita el uso de sensores de temperatura convencionales. El IFIC ha propuesto el uso de una tecnología novedosa que sustituye los elementos metálicos por fibras ópticas. El estudiante participaría en la fabricación de FBGs en el laboratorio de fibras de la UV, así como su caracterización en criogénica y su comparación con FBGs comerciales. Dada la originalidad del proyecto, se prevé la publicación de un articulo científico.
47	The top quark as portals to new physics / Opportunities	María Moreno Llácer y Verónica Sanz	maria.moreno@ific.uv.es, veronica.sanz@uv.es	FNyP y TEO	The top quark is the heaviest elementary particle (even heavier than the Higgs boson itself) and, thus, it has a special role in the search for new physics beyond the Standard Model. The aim of this project is to explore the coupling of a light axion-like particle (ALP) to top quarks using the latest LHC data. Axions are hypothetical light particles which can interact with light and other known particles, but we have not observed them yet. In this project we will study whether the top quark could be a key to find axions.
48	Topological Photonic Crystals	Alejandro Molina Sánchez/Albert Ferrando	alejandro.molina@uv.es, albert.ferrando@uv.es	FOTO	In this TFM we will simulate the confined modes of light in one-dimensional photonic crystals. We will find the solutions that are compatible with the existence of topological edge states. In addition, we will complement the simulations with the SSH model applied to condesed matter systems.
49	Metals under extreme conditions of pressure and temperature	Daniel Errandonea / Simone Anzellini	daniel.errandonea@uv.es, simone2.anzellini@uv.es	FOTO	In this TFM the high-temperature and high-pressure phase diagram of transition metals will be studied experimentally using synchrotron powder XRD and diamond-anvil cells. The existence of phase transitions will be studied at different pressure and temperature conditions and the melting temperature will be studied as a function of pressure. The project is related to the study of the physcs of the interior of planets.
50	Tunning electronic properties using high pressure	Daniel Errandonea	daniel.errandonea@uv.es	FOTO	In this TFM we will experimentally study the influence of pressure in the electronic properties of a semiconductor. In particular we will perform optical absorption measurements under high-pressure conditions using a diamond-anvil cell. From the experiments the pressure dependence of the band-gap energy will be obtained. Changes in electronic properties will be correlated to changes in the crystal structure. The idea of the project is to develope novel materials with tunned properties for different technological applications.
51	Estudio de nanocomposites basados en perovskitas de haluros metálicos mediante técnicas SPM	Ana Cros Stötter/ PabloPérez Boix	Ana.Cros@uv.es	FOTO	Las excelentes propiedades físico-químicas de las perovskitas de haluros metálicos han revolucionado el panorama de los materiales fotovoltaicos de los últimos 10 años al certificar eficiencias en conversión fotovoltaica por encima del 25% a escala de laboratorio. Las propiedades de estos materiales cambian de forma significativa cuando se pasa a estructuras de escala nanométrica. Como proyecto de TFM se propone el uso de técnicas basadas en microscopía de sonda de barrido (SPM) para: a) analizar el efecto de la cristalinidad y el tamaño de dominio cristalino en la formación de capas finas del nanocomposite; b) analizar las propiedades electrónicas de nanocomposites de diferentes composiciones a escala nanométrica; c) Estudiar su variación bajo iluminación; c) comparar los resultados con las propiedades del material policristalino.

52	Estudio de nanocomposites basados en perovskitas de haluros metálicos mediante técnicas SPM	Ana Cros Stötter/ PabloPérez Boix	Ana.Cros@uv.es	FOTO	Las excelentes propiedades físico-químicas de las perovskitas de haluros metálicos han revolucionado el panorama de los materiales fotovoltaicos de los últimos 10 años al certificar eficiencias en conversión fotovoltaica por encima del 25% a escala de laboratorio. Las propiedades de estos materiales cambian de forma significativa cuando se pasa a estructuras de escala nanométrica. Como proyecto de TFM se propone el uso de técnicas basadas en microscopía de sonda de barrido (SPM) para: a) analizar el efecto de la cristalinidad y el tamaño de dominio cristalino en la formación de capas finas del nanocomposite; b) analizar las propiedades electrónicas de nanocomposites de diferentes composiciones a escala nanométrica; c) Estudiar su variación bajo iluminación; c) comparar los resultados con las propiedades del material policristalino.
53	Propagació de polsos òptics en guies d'ona amb no linealitats dispersives	David Castelló Lurbe / Enrique Silvestre	david.castello-lurbe@uv.es	FOTO	Es proposa avaluar analíticament l'impacte de la dependència freqüencial del coeficient no lineal sobre l'evolució de polsos òptics en guies d'ona. Per aconseguir-ho, es deduirà l'equació de propagació de les escales de longitud no lineal i dispersiva sota diferents models dinàmics.
54	Mesura de banda ampla de les corbes de dispersió de guies d'ona	David Castelló Lurbe / Enrique Silvestre	david.castello-lurbe@uv.es	FOTO	Es proposa simular numèricament la mesura de les corbes de dispersió, tant lineal com no lineal, de guies d'ona mitjançant la generació de supercontinu i fent ús d'una llei de conservació de l'equació que governa aquest fenomen.
55	Co-localized scanning probe microscopy-Raman scattering studies of the reduction of graphene oxide	Núria Garro	nuria.garro@uv.es	FOTO	Graphene oxide (GO) and its reduced counterpart (rGO) are 2D materials used in a wide range of applications partly thanks to their easy and cost-effective chemical synthesis. GO consists of a defective carbon basal plane randomly decorated with oxygen-containing functional groups which, when removed, turns into rGO and presents radically different properties. While GO is highly reactive and electrically insulating, rGO is a rather good electrical conductor. This TFM project will investigate the properties of individual GO and rGO flakes combining Raman scattering and scanning probe microscopies performed over the same regions in a co-localized manner. These techniques allow to tackle the electronic properties, chemical composition, and structural defects at micro- and nano-scales.
56	Acousto-optical modulation of quantum light	Mauricio Morais de Lima/Josep Canet	mauricio.morais@uv.es, Jose.Canet-Ferrer@uv.es	FOTO	The bright single photon emission exhibited by perovskite nanocubes makes this kind of quantum emitters an outstanding qbit candidate for quantum communication applications. Nevertheless, the utter accomplishment of their capabilities requires the overcoming of some technological issues, such as the lack of a reliable qbit initialization strategy. Our current project QDimension (COMCUANTICA/011) is devoted to develop a QKD (quantum key distribution) based on perovskite nanocubes. In this context, the TFM candidate will embed nanocubes into acousto-optical transducers in order to modulate their quantum emission. To do so, the candidate will be trained in optical spectroscopy, acousto-optics and cryogenics techniques. These studies are expected to contribute to set the bases for the initialization of photonic qbits based in perovskites.
57	Time-to-space conversion of quantum information	Josep Canet/ Mauricio Morais de Lima	jose.canet-ferrer@uv.es, mauricio.morais@uv.es	FOTO	Photonic qbits are outstanding candidates for quantum communication applications. On one hand, contrary to other quantum systems, photonic qbits can keep quantum coherence for tenths of kilometers due to its negligible interaction with the environment. On the other hand, this advantage becomes a drawback since limits the operation of single photon trains or the processing of quantum information. Our project QDimension (COMCUANTICA/011) is devoted to develop a QKD (quantum key distribution) protocol based in a novel method for managing quantum information. In this context, the TFM candidate will study the time-to-space conversion of intensity fluctuations of thermal and Poissonian light sources. To do so, the candidate will be trained in fundamental quantum optics methods (single photon spectroscopy and HBT interferometry). In further experiments, the studies of the candidate will be extended to sub-Poissonian light for making quantum statistics.
58	Laser-based synthesis of perovskite quantum dots	Jose Marques Hueso y Juan Martínez Past	Jose.marques@uv.es , Juan.Mtnez.Pastor@uv.es	FOTO	It has been recently demonstrated that laser synthesis can be used to selectively synthesize halide perovskite quantum dots as small pixels. Using this novel technique, we propose to undertake the synthesis of different perovskite nanocrystals (composition and size), paying attention to the pixel size and spatial resolution of the technique. The laser synthesis of perovskite microstructures formed by quantum dots will be characterized by micro-photoluminescence, pixel by pixel, under continuous wave and pulsed excitation at room temperature.
59	Fabrication of perovskite photodetector small arrays by direct-laser writing patterning	Juan Martínez Pastor y Jose Marques Hues	Juan.Mtnez.Pastor@uv.es , Jose.marques@uv.es	FOTO	In this project we will develop the metal interconnection array of a photodetector by using a novel technique of laser synthesis. This direct-laser writing technique allows to create circuitry tracks on top of flexible substrates of large dimensions with a resolution of tens of micrometers. The next step will be the deposition of a metal halide perovskite as a thin film on top of the patterned substrate and the device characterization pixel by pixel.
60	Relativitat General en el formalisme d'Einstein-Cartan	María Antonia Lledó	maria.lledo@ific.uv.es	TEO	L' objectiu del treball és estudiar la formulació d'Einstein-Cartan de la Relativitat General, que és totalment equivalent a la formulació usual de Einstein, però usa formes diferencials. La idea és estudiar primer què són les formes diferencials en una varietat diferenciable, entendre la tètrada o vielbein com a forma de soldadura en l'espai tangent a l'espai-temps, formular una acció funcional amb aquestes eines i demostrar la equivalència de les equacions de camp amb les equacions d'Einstein en el buit.
61	Dark Matter in the minimal non-minimal Universal Extra-Dimension model	Andrea Donini/Roberto Ruiz de Austri	donini@ific.uv.es	TEO	Once the Standard Model particle content is embedded in a 5-dimensional space-time, a natural Dark Matter candidate is represented by the lightest Kaluza-Klein particle (LKK). The simplest possibility to do so is the so-called "minimal Universal Extra Dimension" model (mUED). Unfortunately, the LHC data mostly exclude this possibility, as no resonance has been found in the range of masses that would reproduce the observed Dark Matter abundance in the Universe. In a previous Master Thesis, a minimal extension of this model, the "minimal non-minimal Universal Extra-Dimension" (mnmUED), has been advanced, using an effective theory approach. The phenomenology of this model should still be studied in detail, in order to understand if the extended parameter space is able to reconcile the obtained relic abundance with the LHC data.
62	Neutrinos in cosmology: fluid approximation schemes and their validity.	Olga Mena / Rasmi Hajjar Muñoz	omena@ific.uv.es, rasmi.hajjar@ific.uv.es	TEO	Neutrinos play a major role in shaping the universe. It is therefore crucial understanding how this particle affects the universe's evolution and also exploit cosmology to place constraints on the relevant properties of neutrinos. The cosmological evolution is usually computed by solving the Boltzmann equation, and currently there are some Boltzmann solvers such as CLASS and CAMB, which allow solve numerically this equation in an easy way. However, since the neutrino evolution is computationally expensive, these codes usually switch at some point from the full hierarchy of Boltzmann equations into an effective fluid approximation for the neutrino species. Since this approximation is not trivial and it can induce huge discrepancies on the neutrino parameters controlling the evolution, it is a very important task to understand how well can these approximate schemes describe the underlying neutrino physics and how can we introduce these descriptions in our state of the art codes without biasing the different cosmological observables.
63	Baryon and (individual) lepton number and their variants	Claudia Hagedorn	claudia.hagedorn@ific.uv.es	TEO	Baryon and (individual) lepton number are accidental symmetries in the Standard Model without neutrino masses (SM). Effects of violating such symmetries are studied, e.g. proton decay and mu -> e gamma. Theories beyond the SM and alternatives to the well-known baryon and lepton number are considered.
64	Quantum entanglement in top quark pair production with a quantum algorithm	Germán Rodrigo	german.rodrigo@csic.es	TEO	We propose to study the quantum entanglement between the spins of top quarks and top antiquarks at the LHC, and to construct a quantum analog by means of a quantum computing simulation.
65	Characterization of multipartite entanglement from quantum fluctuations	Manuel Gessner	manuel.gessner@uv.es	TEO	We will develop methods that allow us to certify and quantify the presence of entanglement - a key resource for the development of quantum technologies. To do this, we will explore the quantum fluctuations of collective spins in multiqubit systems and compare them to the limit imposed by local quantum uncertainty relations.
66	Tetraquarks exóticos con encanto y belleza	Raquel Molina	Raquel.Molina@ific.uv.es	TEO	Motivados por el reciente descubrimiento de los tetraquarks con doble encanto, la colaboración LHCb se propone ir a la búsqueda y captura de partículas exóticas que posean un quark b y uno c. Sin embargo, tanto sus masas como canales de desintegración son todavía desconocidos. En este TFM proponemos estudiar la dispersión de mesones D^(*) con B^(*) en una ecuación de canales acoplados que respeta unitariedad para ver si es posible la existencia de tales partículas.
67	Electric and magnetic dipole moments of the muon	Oscar Vives y Marco Ardu	oscar.vives@uv.es, marco2.ardu@uv.es	TEO	Electric and magnetic dipole moments (EDMs and MDMs) are fundamental properties of subatomic particles that can be used to detect new physics with great precision. Recent experiments have shown hints of Beyond Standard Model interactions in the magnetic moment of the muon, which is known as the g-2 anomaly. In this context, we will explore the interplay between the anomalous magnetic moment of the muon and its electric dipole moment. We will investigate a simple toy model that addresses the g-2 anomaly and could be probed by the next generation of searches for the muon EDM
68	Neutrino-nucleon quasi-elastic scattering in presence of beyond Standard Model interactions	Luis Alvarez Ruso	Luis.Alvarez@ific.uv.es	TEO	Neutrinos are elusive particles that interact weakly with matter. Nevertheless, (small) deviations in these interactions from the expectations based on the Standard Model of Particle Physics are bound to have profound consequences. Future precise measurements of neutrino-nucleon cross sections combined with progress in the Lattice QCD description of nucleon form factors may open a window to seek for such deviations from the Standard Model. As a step in this direction, we propose to extend the theoretical description of the neutrino-nucleon quasielastic scattering cross section to account for generalized (beyond Standard Model) effective interactions. We shall explore the precision in both experimental measurements and QCD input that would allow to set new physics constrains.
69	Factores de forma escalares de mesones y su consecuencia en la búsqueda de nuevos escalares ligeros.	Emilie Passemar	Emilie.Passemar@ific.uv.es	TEO	Muchas extensiones notables del modelo estándar presentan ?, un singlete escalar de gauge, con una masa por debajo o en la escala débil. Escenarios con nuevos escalares de masa O(GeV) están motivados por los modelos de relajación, de materia oscura e de inflación. La desintegración de un escalar con una masa del orden de GeV es, sin embargo, difícil de abordar ya que, tenemos que describir la interacción fuerte. En este trabajo, mejoraremos el tratamiento de la interacción fuerte usando factores de forma, necesario para restringir estos nuevos estados escalares ligeros. Actualizaremos los límites existentes sobre los escalares ligeros y las futuras sensibilidades experimentales, que pueden estar fuertemente afectadas por la descripción de la interacción fuerte que vamos a mejorar.