Journées PNHE 2021

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PNHE

Programme national hautes énergies

Book of Abstracts

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The bright future of X-ray polarimetry

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50 years after the pioneering experiments, X-ray spectroscopy and timing techniques can be considered as well established. Nonetheless, one prominent feature of X-ray light has not been explored as scrupulously as others: its polarization. Between 1980 and 2000, the instruments were not sensitive enough to go beyond the first X-ray polarimetric results acquired in the 70s but the development of new detection techniques in the early 2000s revived the field. The first X-ray spatial mission to fly a new generation polarimeter will be launched by NASA in October 2021 and a couple of balloon-borne experiments are being considered. A much larger X-ray mission, the eXTP satellite, that will also be equipped with an X-ray polarimeter array, will be launched within the next ten-fifteen years. Several French institutions are actively involved in those missions, making X-ray polarimetry a fundamental research axis for the PNHE. Following the increasing interest of our community to the unexplored phase space of X-ray polarization, I will present the discoveries X-ray polarimetry is about to make.

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Ultraviolet polarization of quasars: forgotten treasures and future instruments

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Polarimetry has proven to be one of the most resourceful observational methods in astronomy, but it is probably in the field of quasars that polarimetry contributed the most. And what better waveband to observe quasars than in the ultraviolet? This is both where the quasar's central engine (a supermassive black hole and its accretion disk) emit the most, and where the polluting starlight contribution is the weakest. Unfortunately, there are no longer far- and mid-UV polarimeters available for quasar observations. A few telescopes mounted with spectropolarimetric instruments reaching the near-UV band still exist but one would have to observe high-redshift sources in order to probe the far-UV band, where photon count becomes problematic. Using the example of forgotten and unpublished UV polarimetric observations made by the HST/FOC instrument between 1990 and 2002, we intend to demonstrate that there are treasures to be discovered by looking at the UV polarization of quasars. In particular, we can probe the immediate vicinity of the central engine, detect jet/wind interactions in the form of bow shocks and even determine the 3D arrangement of matter in the first hundred of parsecs around quasars. But the lack of (imaging) polarimeters for the upcoming new generation of 30-m class telescopes is extremely worrying and will create an observational gap in our knowledge of the most powerful persistent sources in the Universe. Therefore, we must gather our effort to support future polarimetric missions, such as the CNES-lead ultra-high resolution UV spectropolarimeter POLLUX to be mounted aboard the LUVOIR mission.

Shocks & Cosmic rays: Theory & Simulations / 3

The non-resonant streaming instability: from theory to experiments

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The non-resonant streaming instability leads to the generation of large amplitude magnetic field fluctuations, and may play an essential role in the acceleration of cosmic rays. We present a study of the non-resonant streaming instability in non-ideal plasma environments with finite temperature and collisionality. We have extended the existing kinetic theory to the case of large plasma temperature, and shown that the instability may be strongly modified if the ions Larmor radius becomes comparable or larger than the unstable wavelengths. Using multi-dimensional hybrid-Particle-In-Cell simulations including a Monte Carlo module for Coulomb and neutral collisions, we study the non-linear evolution of the instability and show that Coulomb collisions can promote the growth of the instability. In contrast neutral collisions yield an important damping, in agreement with existing theoretical predictions. These results are then used to design future experiments aiming at observing the instability for the first time in laboratory conditions.

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The Origin of Galactic Cosmic Rays as Revealed by their Composition

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Galactic cosmic-rays (GCRs) are thought to be accelerated in strong shocks induced by massive star winds and supernova explosions sweeping across the interstellar medium. But the phase of the interstellar medium from which the CRs are extracted has remained elusive up to now. We have studied in detail the GCR source composition deduced from recent measurements by the AMS-02, Voyager 1 and SuperTIGER experiments to obtain information on the composition, ionisation state and dust content of the GCR source reservoirs. The results of this data analysis suggest that the GCRs are mainly accelerated in superbubbles energised by the activity of massive star winds and supernova explosions. The resulting model explains well the measured abundances of all primary and mostly primary CRs from H to Zr, including the overabundance of ^{22}Ne.

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Winds in compact objects in the X-ray High Spectral Resolution era to come

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X-ray satellites like XRISM (to be launched in early 2023) and, in a more distant future, Athena (2030+), will revolutionize our spectral view of compact objects. Thanks to their onboard calorimeters, they will provide an energy resolution of a few eV in the broad band (~1-10 keV) X-ray range, a factor several tens of times better than present satellites, especially above 6 keV.
I will discuss the improvement expected from these instruments in our understanding of the wind properties in compact objects (XrB and AGN).

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Perspectives for high-resolution spectroscopy with Athena X-IFU

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The Athena X-ray observatory is a L-class mission selected by ESA in its Cosmic Vision program to be launched in early 2030s. Successor of the XMM-Newton telescope, it will embark a revolutionary spectro-imager X-IFU using micro-calorimeter technologies allowing a breakthrough 2.5 eV spectral resolution compared to ~150 eV for XMM-Newton.

In this contribution I will review the science cases that X-IFU will address for the science of supernovae and their remnants. I will cover topics such as SN nucleosynthesis, what the remnant can tell us about the SN, and particle acceleration.
I will also discuss the challenges that we will face to analyse the high-resolution data from X-IFU, lay out some technical solutions that we are exploring and in a perspective approach explore the skills that are lacking in the french high-energy community to deal with those issues.

Gamma-rays / 7

Gamma-ray emission from supernova remnants interacting with interstellar clouds

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The bulk of the cosmic rays we see at Earth are at a few GeV. Most of them are expected to be accelerated in old supernova remnants (10 000 yrs and more). Indeed many old SNRs are readily observed in GeV gamma rays, and those interacting with interstellar clouds are particularly bright.
The GeV emission is essentially pio0-decay, but can be due to two acceleration mechanisms:
- reacceleration from the sea of ambient cosmic-rays followed by compression in slow radiative shocks
- acceleration from the thermal gas in faster shocks

I will discuss Fermi results on the Cygnus Loop SNR, which is large enough (3° diameter) to be resolved by the Fermi-LAT, and in which both mechanisms are at work. Multi-wavelength templates (UV from radiative shocks, and X-ray from hot gas) allow extracting the spectra of both components.

Dark matter + Multiwavelength studies of BH / 8

Multi-wavelength search for millisecond pulsars

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The Fermi GeV excess has kept physicists busy for the past decade. First attributed to dark matter annihilation, the favored explanation to date is an unresolved population of millisecond pulsars (MSPs), hiding in the Galactic Bulge. In order to prove this hypothesis, a multi-wavelength study is now needed. In a recent work [arXiv:2012.03580], we demonstrated that if the GeV excess is caused by an MSP population, about a hundred of them could be detectable by the Chandra X-ray observatory in a region of 6 degree × 6 degree about the Galactic Center. We found more than 3000 MSP candidates among Chandra X-ray catalogued sources, allowing us to conclude that the MSP hypothesis as explanation to the GeV excess is not excluded. Besides, we selected few hundreds of promising candidates, with good X-ray spectral knowledge and no optical counterpart for follow-up studies, which will be the focus of this talk. We looked for infrared and ultraviolet counterparts to our candidates, knowing that bulge MSPs should have none or very faint ones. With now a list of about 160 promising candidates, we aim at motivating radio searches and analysing radio data in order to detect the characteristic pulsation and/or identify them as polarized compact radio sources.

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Insights into AGN parsec-scale emission from radio to GeV gamma rays from VLBI, Gaia EDR3, and Fermi-LAT

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With the advent of the European Gaia astrometry mission and the constantly improving geodetic VLBI program who now provide both optical and radio reference frames with precisions better than 0.1 mas, challenging questions arise about the location of the optical centroid with respect to the radio one in extragalactic radio sources. We propose a study aiming at identifying which mechanisms are behind the optical emission: is it from a jet feature – also observable in radio – or a mix between the jet, the accretion disk, an extended halo or host galaxy? We use data from Gaia EDR3, the radio ICRF3, structure information from the MOJAVE program, and GeV fluxes from Fermi-LAT 3FGL catalog for a sample of about 350 common active galactic nuclei (AGN), dominated by blazars (BL Lac and FSRQs). We show that a majority (90%) of optical emissions can be associated with a radio feature downstream in the jet, either close the base (usually referred to as the "radio core") or, in contrast, in ejected radio knots at parsec-scale distances. We investigate the general trends of

such populations in terms of proper motion, polarization, and GeV emission. We discuss the case of a few sources for which no identification can be done between the optical centroid and a radio feature, as well as a population whose optical centroid is located upstream from the radio jet with a possibility that the optical position measured by Gaia results from both the radio core at the base of the radio jet and the accretion disk.

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Probing supermassive compact objects properties with space millimeter interferometry

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The planet-size network of millimeter antennas Event Horizon Telescope (EHT) has recently delivered images of the surroundings of the supermassive compact object M87* at the center of the galaxy Messier 87. Such images are crucial to better understand the physics at play in a strong gravitational field environment. They might also allow to probe the extreme relativistic effects on the radiation emitted close to the compact object.

In this talk I will discuss how future extensions of the EHT with space-based antennas might allow us to probe with great precision the properties of the central compact object.

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The dark mass signature in the orbit of S2

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Context. The Schwarzschild precession of the star S2 which orbits the massive black hole at the centre of the milky way could recently be detected with ~ 12 arc-minutes per orbit by GRAVITY Collab. et al. (2020). The result also improved the 1σ upper bound on a possibly present dark continuous extended mass distribution (e.g. faint stars, stellar remnants, stellar mass black holes, dark matter) within S2's orbit to $\sim 4000\, M_{\odot}$. The secular (i.e. net) effect of an extended mass onto a star's orbit is known as mass precession. Its measurement is of interest in its own right, to learn about the matter content in the immediate vicinity of the black hole, but also since as a secular precession effect it acts as perturbation for the task of measuring relativistic precessions such as the Schwarzschild and Lense-Thirring (i.e. spin) precessions. To constrain the latter is one of the next major goals in the field.

Aims. We explore a strategy for how different precessions (and other effects) can be separated from each other despite their secular interference, by pinpointing their signatures within a single orbit. In this work we focus on the interference between the Schwarzschild and the mass precession. From these insights we then seek to assess the prospects for improving the above upper bounds on a dark mass within S2's orbit, or for detecting one in the years ahead.

Methods. We analyse the dependence of the osculating orbital elements (e.g. argument of pericentre and semi-major axis) and of the observables (i.e. astrometry and radial velocity) on true anomaly (i.e. on the location within the orbit) and we compare these functions for models with and without extended mass. We then translate the maximal astrometric impacts within one orbit to detection thresholds given hypothetical data of different accuracies. These theoretical investigations are then supported and complemented by an extensive mock data fitting analysis.

Results. We find that while an extended mass predominantly perturbs the orbit during its apocentre half and is mostly ineffective during the pericentre half, the opposite is true for the Schwarzschild precession. This allows for a clear separation of both effects, and for an identification of the orbital sections on which the data is particularly sensitive or insensitive to one or the other phenomenon. We determine the 1σ detection thresholds given data on one full orbit with different accuracies on different orbital sections. E.g. we find that with one full orbit of astrometric data with a precision of 50 micro-arcseconds (current performance of VLTI/GRAVITY) and spectroscopic data with a precision of $10\,\mathrm{km/s}$ (performance of VLT/SINFONI) the 1σ bound would improve to $\sim 1000\,M_\odot$. Furthermore we show that data limited to the pericentre half of the orbit is not sensitive to an extended mass component, while data limited to the apocentre half is, though only to a certain extend. We show that indeed a full orbit of data is required to substantially constrain an extended mass, and given such data it turns out that the pericentre half plays the stronger part in the sensitivity than the apocentre half.

Conclusions. Current data from VLTI/GRAVITY yet only covers one pericentre half of S2's orbit, such that the $\sim 4000\,M_\odot$ upper bound relies heavily on the far less accurate data from VLT/NACO. According to our findings a tracking of S2 with GRAVITY, VLT/ERIS and from 2026 on also ELT/MICADO up to a full orbit in ca. 2033 will substantially improve the dark mass sensitivity of the dataset. This will allow to tighten the upper bounds accordingly or even to detect a dark mass if present and not too small. In the context of the bigger picture our analysis demonstrates how precession effects which interfere on secular timescales can clearly be distinguished from each other based on their distinct astrometric signatures within a single orbit. The extension of our analysis to the Lense-Thirring effect should thus be of value in order to assess future spin detection prospects in the galactic centre.

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Acceleration and dissipation in Pulsar Wind Nebulae

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Pulsar Wind Nebulae (PWNe) are complex astrophysical environments where an highly magnetized wind made of electron-positron pairs interacts with the surrounding SN remnant through a relativistic shock wave. While MHD modelling can reproduce the large-scale morphology of PWNe, a refined description of the underpinning kinetic-scale processes is still missing. One open question in this regard is how the electromagnetic field energy of the wind can be efficiently dissipated into kinetic energy. A possible scenario is that the wind becomes turbulent before crossing the shock. By means of Particle-In-Cell kinetic simulations, we have studied the heating of a relativistic plasma flow immersed in a forced/decaying magnetic turbulence, and then how such a turbulent flow modifies the properties of a relativistic shock wave, including its propagation dynamics and particle acceleration efficiency.

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Follow-up of ZTF-FINK alerts with GRANDMA and its citizen science program

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The combination of electromagnetic and gravitational-wave data provides a unique opportunity to study the evolution of compact binary systems. Although the kilonova detection AT2017gfo in association with gravitational waves led to groundbreaking results in our understanding of the binary neutron star scenario, many open questions remain.
Answering these questions requires early observations, well-sampled light curves and spectra of kilonovae. While the GW-detectors are off, we have developed a program within the Global Rapid Advanced Network Devoted to the Multi-messenger Addicts (GRANDMA), to follow-up and characterize kilonovae candidates produced by public optical surveys such as the Zwicky Transient Facility. This program is jointly operated with the Fink broker, specifically designed for the Rubin Observatory.
In this talk, we will presen tthe GRANDMA kilonovae program with FINK, and its application within the citizen science program with observations performed during this summer.
GRANDMA is supported by PNHE.

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The transient X-ray sky

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The large European Space Agency (ESA) X-ray observatory, XMM-Newton, has been observing the X-ray, ultra-violet and optical sky for over 21 years, resulting in almost a million X-ray detections and nearly 9 million detections in the UV and optical. Many highly variable sources have been discovered in the data once it is made available in the catalogues put together by the XMM-Newton Survey Science Centre. During this talk I will present some of the interesting objects found in the catalogues, such as partial and full tidal disruption events, ultra luminous X-ray sources (ULXs), changing look AGN and interacting binaries before describing plans for transitioning XMM-Newton into the time domain astronomy era.

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The Athena X-ray Observatory

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Athena is the second large mission of the Cosmic Vision science program of the European Space Agency. Dedicated to the study of the Hot and Energetic Universe, Athena will carry a large aperture X-ray telescope, and two complementary focal plane instruments: the Wide Field Imager (WFI) and the X-ray Integral Field Unit (X-IFU). In this talk, I will briefly recall the prime scientific objectives of Athena, aiming at understanding the formation and evolution of large scale structures and on the role of black holes in shaping the Universe. I will then describe the mission profile and the science payload, emphasising on its X-IFU, whose breakthrough capabilities will contribute to make Athena the most powerful X-ray observatory ever launched. I will report on the latest status of the mission, including the anticipated performance of its payload. Athena is to be launched at the start of the 2030s.

UHECR / 17

Le projet GRAND dans le contexte français et international de la recherche de particules comsique de ultra-haute énérgies

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Nosu présentons ici le status du projet "Giant Radio Array for Neutrino detection" qui vise à déployer à travers le monde un réseau de détecteurs radio constitués chacun de 10'000 antennes environ, afin de rechercher des neutrinos cosmisques d'ultra haute énergie.
Nous présenterons en particulier le status du prototype GRANDProto300, qui vise à démontrer le principe de détection de GRAND au court des toutes prochaines années.
Nous placerons cette présentation en regards des efforts effectués au niveau national et international sur cette thématique.

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L'initiative TS2020+ (Transient Sky 2020+)

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Les rencontres TS2020+ (financées par le PNHE) rassemblent de manière régulière les chercheurs et les chercheuses de la communauté française d'étude multi-longueurs d'onde et multi-messagers du ciel variable et transitoire. Les objectifs sont de faire le lien entre les grandes collaborations instrumentales concernées (CTA, GRANDMA, Ligo/Virgo, Rubin/LSST , SKA, SVOM, …) , de présenter les questions scientifiques en jeu, d'échanger sur les moyens de suivi sur alerte, d'analyse, d'interprétation, etc., et de favoriser lorsque c'est possible la mutualisation de certains efforts. Les trois premiers ateliers (Orsay 2017, Montpellier 2018, Paris 2019) ont permis de dresser le panorama des moyens instrumentaux de la décennie qui commence et des questions scientifiques qui pourront être abordées, de discuter plus précisément la problématique des alertes, et d'avoir un aperçu de l'organisation des différentes collaborations impliquées dans l'astronomie multi-messagers. La quatrième rencontre prévue à Strasbourg en 2020 aurait dû être consacrée aux outils pour le suivi du ciel transitoire, avec des ateliers pratiques. Elle n'a pu avoir lieu en raison de la pandémie, et a été remplacée par une série de webinaires quasi-mensuels depuis octobre 2020, présentant les activités en cours sur les projets et thématiques en lien avec TS2020+, ainsi que des résultats scientifiques récents.
L'initiative TS2020+ est fructueuse, jouant un rôle positif pour former une communauté nationale autour de la science sur alertes, favorisant des partenariats durables comme par exemple entre le projet de broker Rubin FINK et le réseau de télescopes GRANDMA, et permettant de synthétiser les attentes de la communauté vis à vis de certains enjeux à l'échelle nationale, comme par exemple les services nationaux d'observation (SNO) liés à la science sur alertes (enquête réalisée au printemps 2021, dont je présenterai les réponses).
Dans cet exposé, je reviendrai sur les différentes activités évoquées ci-dessus et lancerai la discussion

sur l'avenir
de cette initiative TS2020+.

Radio observations of HE phenomena / 19

Radio astronomie et activités PNHE

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La radio-astronomie vit actuellement une révolution majeure avec la mise en place de SKA au niveau mondial et le développement de précurseurs et éclaireurs à travers le monde. Depuis 2021, la France est officiellement rentrée dans SKA. Les précurseurs (e.g. MeerKAT) tournent à plein régime, et à très basses fréquences, un nouvel observatoire très sensible (NenuFAR) se met en place à la Station de Nançay.

Il existe une synergie très forte entre les observatoires hautes énergies et radio sur de nombreuses thématiques du PNHE. Cela concerne aussi bien les objets galactiques (systèmes binaires, pulsars, SNR, SGR …) que l'Univers lointain (GRB, AGN, FRB, TDE, amas de galaxie, transients, OG, …).

Avec cette revue, je présenterai un état des lieux de la radioastronomie actuelle avec une mise en perspective des attentes scientifiques très fortes associées aux thématiques du PNHE.

Multi-messenger astrophysics / 20

The multimessenger astrophysics of massive black holes

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The joint detection of gravitational waves and an electromagnetic counterpart from a neutron star merger in 2017 has been a major breakthrough in astrophysics. Massive black holes, 1e4-1e10 Msun, which power quasar and inhabit the center of most galaxies, are also expected to merge and be very strong gravitational wave emitters, with various electromagnetic signatures accompanying the inspiral and merger of the two black holes. I will discuss theoretical models of merging massive black holes and their properties

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Modeling compact objects in the multi-messenger era

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The first detection of gravitational waves (GWs) from a binary neutron
star merger (GW170817) by the LIGO-Virgo collaboration together with
an electromagnetic counterpart has brilliantly given birth to

multi-messenger astronomy. In the coming years, the GW detector network sensitivity will be further increased making this rapidly evolving new astronomy challenge our understanding of hot and dense nuclear matter in neutron stars and the structure of these compact stars themselves. In addition to binary mergers, future multi-messenger observations include the possibility of a galactic core-collapse supernova, where the GW and neutrino signal carry among others the imprint of dense matter properties. A complete understanding of these exciting observations will be achieved only once they can be modeled successfully. Many questions still remain open, among others on microphysics properties (equation of state, transport coefficients, neutrino reaction rates), or the influence of the magnetic field. In this talk I will concentrate on microphysics and present some examples of recent advances in the modeling and the resulting consequences for compact star physics.

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LSST

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LSST survey of the Vera Rubin Telescope

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In this talk, I will present the Vera Rubin Observatory Legacy Survey of Space and Time (VRO LSST). During the next decade, VRO will obtain high-resolution optical images of the Southern Sky at unprecedented depths. LSST is designed to address four science areas: probing dark energy and dark matter, taking an inventory of the solar system, exploring the transient optical sky and mapping the Milky Way.
VRO public alert stream will communicate the detection of millions of potential transient objects every night. The key to use this stream is to be able to select promising transients and to automatically connect with multi wavelength facilities. I will introduce Fink, a broker developed on high-end technology and designed for fast and efficient analysis of big data streams. Fink enables the selection of promising transients by providing preliminary classifications and combining information from multiple channels (both surveys and catalogues). Within minutes, Fink is able to communicate these candidates to teams and follow-up facilities. Fink opens a new way of combining data from LSST and other time-domain surveys and will be key for analyses ranging from transient astrophysics to cosmology.

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Future plans for the LIGO-Virgo-KAGRA network and for Einstein Telescope

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After a brief summary of results of LIGO-Virgo O3 observational run, I will present the future plans for the LIGO-Virgo-KAGRA network. I will then discuss the status and plans for the third generation detectors, Einstein Telescope and Cosmic Explorer. Finally, I will review the scientific potential of the upcoming detectors and the connections with the PNHE community.

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GDR Ondes Gravitationnelles

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Ce séminaire présentera le GdR Ondes Gravitationnelles, son rôle, sa structure, ses groupes de travails et ses actions récentes

Multi-messenger astrophysics / 26

Stochastic gravitational-wave backgrounds from astrophysical sources

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The gravitational-wave observatories LIGO and Virgo have so far detected several tens of stellar-mass compact binary mergers, but many more sources, too faint to be detected, lurk below the noise, creating a stochastic background. On the other end of the mass scale, super-massive binary black hole mergers are expected to create a stochastic background observable with pulsar timing arrays. I will discuss some recent work in modelling these backgrounds, their astrophysical implications and future detections prospects.

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Sursauts gamma & contreparties électromagnétiques des ondes gravitationnelles

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Dans cet exposé, je présenterai les enjeux scientifiques de l'étude des sursauts gamma et des sources astrophysiques d'ondes gravitationnelles qui produisent également de la lumière. L'accent sera mis dans ce second cas sur les coalescences de système binaires d'objets compacts. J'essaierai de résumer quelles sont les principales questions qui se posent sur la compréhension physique de ces phénomènes et de décrire les progrès attendus sur le plan observationnel pour la décennie 2020 et au-delà, en mettant cette fois l'accent sur les projets dans lesquels la communauté française est particulièrement investie.

Multi-messenger astrophysics / 28

SVOM et Einstein Probe à l'affût du ciel transitoire

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A partir de 2023 la mission spatiale franco-chinoise SVOM sera opérationnelle. Elle sera suivie par la mission spatiale chinoise Einstein Probe à laquelle nous contribuons plus modestement. Dans cet exposé je vous présenterai rapidement ces deux missions dédiées au ciel transitoire, leurs caractéristiques principales et leurs complémentarités. Enfin dans le contexte du "time domain astronomy"

nous regarderons comment la communauté française pourra bénéficier de ces deux satellites agiles et de leur réseau sol associé pour observer et étudier les différentes classes de source transitoire.

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Follow-up of ZTF-FINK alerts with GRANDMA and its citizen science program

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Astronomie neutrino avec KM3NeT

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IceCube et ANTARES ont détectés le flux diffus de neutrinos de haute énergie et commencent à voir les premieres évidences des sources de ces neutrinos. Aprés avoir fait un petit panorama des principaux résultats actuels, je vous montrerais ce qu'on peut faire avec KM3NeT, la prochaine génération de télescope à neutrino dans la Méditerranée. A l'heure actuelle, 6 lignes de détection sont en operation sur les deux sites de KM3NeT. Dans cette configuration réduite, on atteint une sensibilité instantanée similaire voir meilleure qu'ANTARES sur toute la gamme en énergie. Dans quelques jours, des opérations en mer sont prévues sur les 2 sites pour doubler la taille des 2 détecteurs. La construction va continuer régulièrement dans les prochaines années. A très basse énergie (MeV), le nouveau module optique segmenté permet à KM3NeT d'être un excellent détecteur de supernova (à effondrement de coeur), ce monitoring du ciel est déjà en operation depuis quelques années prêt pour la prochaine supernova galactique.

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The bright future of X-ray polarimetry

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Perspectives for high-resolution spectroscopy with Athena X-IFU

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Winds in compact objects in the X-ray High Spectral Resolution era to come

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Probing supermassive compact objects properties with space millimeter interferometry

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The dark mass signature in the orbit of S2

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Multi-wavelength search for millisecond pulsars

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Simulations numériques PIC en France : état des lieux et perspectives

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Les simulations PIC ont révolutionné notre compréhension des phénomènes dissipatifs et d'accélération de particules dans les plasmas spatiaux et astrophysiques. Au cours de la dernière décennie, ces véritables observatoires et microscopes numériques ont rencontré de nombreux succès dans la communauté française, comme l'étude des chocs non-collisionnels, la reconnexion magnétique, ou encore l'étude des magnétosphères planétaires et des objets compacts. Pour rester compétitif à l'échelle internationale, les défis à venir dont nous devrons faire face sont multiples. On peut citer par exemple le besoin d'adapter les codes existants aux futures machines de calcul exaflopiques, cela pour un nombre croissant d'utilisateurs, le développement de modèles plus complexes pour intégrer davantage de physique (rayonnement, relativité générale, processus QED), ou encore le développement de méthodes hybrides. Dans cette présentation, je dresserai un état des lieux des forces et des besoins de la communauté française pour la décennie à venir.

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Acceleration and dissipation in Pulsar Wind Nebulae

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The Origin of Galactic Cosmic Rays as Revealed by their Composition

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The non-resonant streaming instability: from theory to experiments

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Science with the Cherenkov Telescope Array

The Cherenkov Telescope Array (CTA) will soon observe the sky in the energy range from a few tens of GeV to 300 TeV with unprecedented sensitivity and improved angular and energy resolution with respect to current-generation instruments. The science case for CTA covers a broad range of topics: the origin and role of cosmic rays, extreme astrophysical objects, and exploring the frontiers of physics. In this contribution we will provide an overview of prospects for science with CTA, with special focus on topics of particular interest for the French high-energy astrophysics community such as Galactic gamma-ray sources, active galactic nuclei and jets, multimessenger and transient phenomena, and dark-matter searches.

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Perspectives de l'astronomie au MeV

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L'astronomie gamma de basse énergie explore de nombreux domaines de recherche en astrophysique (pulsars, trous noirs, noyaux actifs de galaxie, nucléosynthèse, …). Elle garde un grand potentiel de découvertes, tout particulièrement en lien avec l'astronomie des phénomènes rapides et l'astronomie multi-messagers. Pendant cette présentation , je ferai un état des lieux rapide des thèmes les plus fréquemment abordés ainsi que des télescopes actuellement disponible en X dur et au MeV. J'aborderai aussi les perspectives observationnelles et instrumentales pour la décennie 2020.

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Gamma-ray emission from supernova remnants interacting with interstellar clouds

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Dark matter + Multiwavelength studies of BH / 51

Insights into AGN parsec-scale emission from radio to GeV gamma rays from VLBI, Gaia EDR3, and Fermi-LAT

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Ultraviolet polarization of quasars: forgotten treasures and future instruments

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Supernovae gravitationnelles et naissance des étoiles à neutrons : instabilités et champ magnétique

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L'effondrement du coeur de fer des étoiles massives donne naissance aux objets compacts et à une diversité d'explosions. Je décrirai des travaux théoriques et numériques développés pour comprendre les propriétés de l'objet compact et de l'explosion associée. Des instabilités hydrodynamiques telles que SASI ou la convection due aux neutrinos jouent un rôle important pour déclencher l'explosion et laissent une trace dans le signal attendu en ondes gravitationnelles et neutrinos. Le champ magnétique particulièrement intense des magnétars, lorsqu'il est associé à une rotation rapide, pourrait quand à lui déclencher des explosions extrêmes, telles que les supernovae superlumineuses et les sursauts gamma. Je décrirais des travaux récents portant sur l'origine de ce champ magnétique extrême et ses conséquences pour la dynamique de l'explosion.

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The LISA mission: status and perspectives for PNHE

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The Laser Interferometer Space Antenna (LISA) is the large mission of ESA for observing gravitational waves (GW) from space. It has a huge science case and will observe a large number of GW sources making an important contribution to the multi-messenger astronomy. LISA is finishing its phase A and will be launched mid-2030s. In this talk, we will briefly describe the mission, give its current status (technology, planning, data analysis preparation, etc) and focused on GW sources of interest for PNHE and multi-messenger astronomy with LISA.

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Les activités du GdR RESANET en lien avec le PNHE

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This talk will give a brief summary of the activities of the GdR RESANET at the interface between nuclear physics and astrophysics. It will present activities in measurements of nuclear cross sections for astrophysical processes and in the modelling of neutron stars and associated phenomena, such as for instance gravitational wave physics.

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The origin of galactic cosmic rays: progresses, impacts and perspectives

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Cosmic Rays with energies below a fraction of EeV are coming from our galaxy but the way they are produced and they propagate to the Earth is still widely unknown. I will address recent progresses made in our understanding of Cosmic Ray acceleration and propagation on the point of view of microphysics and phenomenological studies. Then, I will shortly discuss why Cosmic Rays feed back are important to consider in different fields of modern Astrophysics from young stellar objects to the largest galactic scales.

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Bilan et perspectives dans le domaine des ultra-hautes énergies

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L'étude des rayons cosmiques d'ultra-haute énergie (UHECRs) s'inscrit dans un effort global d'élucidation des phénomènes cosmiques de très haute énergie. La dernière décennie d'observation des UHECRs a permis d'affiner considérablement les mesures et d'accroître le volume de données disponibles. Si ces progrès n'ont pas encore conduit à l'identification des sources, ni éclairé autant qu'il était espéré les mécanismes d'accélération des particules aux énergies extrêmes, c'est en raison des caractéristiques propres des UHECRs (apparemment très enrichis en éléments lourds) et de leurs sources (apparemment plus nombreuses qu'anticipé parfois). Ces informations sont très précieuses en elles-mêmes, et invitent la communauté à prendre du recul pour examiner les voies de progrès à court et moyen termes qui permettront le mieux de tirer parti de ce domaine d'étude et de ses interactions multiples avec le reste de l'astrophysique et de la physique des hautes énergies. Diverses réflexions et divers développements instrumentaux sont en cours, au sol comme dans l'espace. Nous les présenterons brièvement, et tracerons quelques perspectives pour la décennie à venir.

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Dark matter and signatures in multimessenger astronomy

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Unsuccessful searches for new physics in the TeV domain at the LHC so far cast some doubt about the predictivity level of some theoretical frameworks beyond the standard model of particle physics that lead to dark matter candidates. Hierarchies among scenarios have been reshuffled and are now more and more ruled according to the plausibility of dark matter production in the early universe. Besides, the cold dark matter scenario suffers difficulties in matching with observations of dark matter structuring on small (subgalactic) scales, which could be interpreted in terms of new specific properties for dark matter itself. In this talk, I will briefly sketch the current landscape of (the main) dark matter candidates and discuss their potential signatures in multimessenger astronomy.

Radio observations of HE phenomena / 63

An overview of pulsar observations with French radio telescopes

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The study of pulsars started at the Nançay Observatory in the mid-1980s, after the discovery of the first millisecond pulsar. Since then, several generations of instruments have been developed as well as a wide spectrum of projects ranging from the characterisation of emission processes or the production of precise ephemerides for high energy observatories to the use of pulsars as natural clocks to test alternative theories of gravity or to detect low frequency gravitational waves. I will present a summary of current scientific activities around radio pulsars in France, mainly from the point of view of the Nançay-Orléans group and through the prism of observations with the NRT, NenuFAR, LOFAR and MeerKAT radio telescopes.

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Microturbulence in unmagnetized relativistic collisionless shock waves

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Microturbulence produced by plasma instabilities plays an important role in the dynamics and dissipation mechanisms of relativistic astrophysical collisionless shocks, such as those associated with gamma-ray bursts and blazar environments. We present the tenets of an analytical model that

describes the dynamics of the precursor of relativistic unmagnetized collisionless shock waves in electron-positron and electron-ion plasmas. The model is compared with results from particle-in-cell simulations and shown to accurately capture the deceleration and heating of the background plasma species. We further address the dynamics of relativistic radiation mediated shock waves that dictate the early emission in numerous transient sources such as supernovae and binary neutron star mergers. In the relativistic regime, a high pair multiplicity inside the shock transition leads to a lepton-baryon velocity separation, prone to plasma instabilities. We present a theoretical and numerical analysis of the hierarchy of plasma instabilities growing in an electron-ion plasma loaded with pairs and subject to a radiation force. Based on this analysis, we extend the analytical model introduced in the first part to demonstrate nonadiabatic compression in a Joule-like heating process by the joined contributions of the decelerating turbulence, radiation force, and electrostatic field. These results show that this analytical framework can be useful in describing how the microturbulence impact the dynamics and energy partition of a large class of relativistic shock waves.