ICRANet-ISFAHAN Astronomy Meeting

Wednesday, 3 November 2021 - Friday, 5 November 2021

Programme

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Wednesday 03 November 2021

Opening ceremony: The Welcoming Speeches : The Minister of MSRT, Prof. ZulfiGul and The IUT President, Prof. S. M. Abtahi (10:00-10:30)

How the modern astronomy was introduced into Iranian universities (10:30-11:00)

- **Presenter: Prof. SOBOUTI, Yousef (IASBS-Iran)**

Celebrating the 50th anniversary of "Introducing the Black Hole" (11:00-11:30)

- **Presenter: Prof. RUFFINI, Remo**

Iranian National Observatory; status and vision (11:30-12:00)

- **Presenter: Prof. KHOSROSHAHI, Habib (IPM, Iran)**
  Iranian National Observatory (INO) is located on Mt Gargash at 3600m covering a gap in the longitude distribution of modern mid-size telescopes. The INO project is now in its final stage of completion and is approaching the first light. Major milestones including the civil construction, installation of the dome, manufacturing of the 3.4m optical telescope and installation of the telescope at the site have been completed. The telescope is going through engineering tests aimed at the commissioning of the pointing and tracking. A suite of instruments has been planned, taking advantage of a sub-arcsecond seeing and the longitude, including a high-resolution imaging camera and a spectrograph with the ability to switch between the instruments in response to transient events. INO offers a platform for regional and international collaborations in astronomy and cosmology.

The Huntsman Telescope - a Canon lens array designed for low surface brightness imaging (12:00-12:30)

- **Presenter: Prof. SPITLER, Lee (Macquarie University, Australia)**
  In this talk I give an update about the Huntsman Telescope, a new astronomy observing system that makes use of an array of 10 Canon lenses to take images of extremely faint astronomical sources. Inspired by the Dragonfly Telephoto Array, the system is designed to better understand galaxy evolution through the study of low surface brightness structures. I'll describe the science motivation, show preliminary data, and give an update on how the commissioning of the system at Siding Spring Observatory, Australia. I'll also review other initiatives with Huntsman, including an sub-second transient detection mode. https://huntsman.space/

Break (12:30-12:50)

Supenovae (SN) - Gamma Ray Burst (GRB) Connection (12:50-13:20)

- **Presenter: Prof. DELLA VALLE, Massimo ((apodimonte Astronomical Observatory - INAF, Naples, Italy))**

Gamma-ray bursts in the optical domain (13:20-13:50)

- **Presenter: Prof. IZZO, Luca (University of copenhagen, Demark)**

Origin of High-energy Galactic Cosmic Rays: Implication from Recent Ultrahigh-energy Gamma-ray Observations (15:30-16:00)

- **Presenter: Prof. LIU, Ruoyu (Nanjing University | NJU, China)**
  Observations of gamma-ray emission with energy above 100 TeV is a useful probe of the long-sought PeV cosmic-ray sources. In this talk, I will briefly review recent observations by the LHAASO, HAWC and ASgamma experiments on sources and diffusive emission with energy above 100 TeV, and then discuss their implications for the origin of high-energy Galactic cosmic rays.

Multiwavelength and Multimessenger view of blazars (16:00-16:30)

- **Presenter: Prof. SAHAKYAN, Narek (ICRANet-Armenia)**
  I will discuss the recent progress in multiwavelength and multimessenger observations of blazars and the current status of the theoretical models applied to model their emission. Blazars, the most extreme subclass of AGN having jets that move relativistically towards the observer, are characterized by highly variable non-thermal emission across the entire electromagnetic spectrum, from radio up to very high energy gamma-ray bands. The emission

properties of blazars in the spectral and time domains will be presented and discussed using the data collected from their observations in optical/UV, X-ray, and gamma-ray bands. In addition, the recent progress in the observations of very high-energy neutrinos from blazars will be discussed.

Cosmology with Gamma-Ray Burst (16:30-17:00)

- Presenter: Prof. AMATI , Lorenzo

Gamma-Ray Bursts constitute one of the most fascinating and relevant phenomena in modern science, with strong implications for several fields of astrophysics, cosmology and fundamental physics. In this review, I will focus on the perspective key-role of GRBs for cosmology. Indeed, the huge luminosity, the redshift distribution extending at least up to z~10 and the association with the explosive death of very massive stars make long GRBs (i.e., those lasting up to a few minutes) potentially extremely powerful probes for
shedding light on main open issues in our understanding of the early Universe: star formation rate evolution up to the first generation of stars (pop-III), cosmic reionization, luminosity function and metallicity evolution of primordial galaxies up to the "cosmic dawn". At the same time, interesting correlations between luminosity / radiated energy and spectral photon peak energy are subject of intensive investigations for "standardizing" GRBs and using them for measuring cosmological parameters, investigating the nature and evolution of "dark energy" and testing non-standard cosmological models. I will also report on the status, concepts and expected performances of space mission projects aiming at fully exploiting these unique potentialities of the GRB phenomenon, thus providing an ideal sinergy with the large e.m. facilities of the future like LSST, ELT, TMT, SKA, CTA, ATHENA

Break (17:00-17:20)

Black hole hyperaccretion disks and gamma-ray bursts (17:20-17:50)

- Presenter: Prof. ABBASSI, Shahram (Ferdowsi University of Mashhad)

Gamma-ray bursts (GRBs) are the most luminous explosions in the Universe, and their origin and mechanism are the focus of intense research and debate. Black hole hyperaccretion model is one of the plausible candidates for the central engine of gamma-ray bursts and their activity is supposed to result in the complicated explosion phenomena including gamma-ray bursts, gravitational waves, and their electromagnetic counterparts. In the inner regions of such disks, photons are totally trapped due to high density and temperature. Getting cool through neutrinos and antineutrinos efficiently, these accretion disks are also called Neutrino Dominated Accretion Flows (NDAFs). Moreover, the high magnetic field (10^15−16G) and large density (10^10g cm−3) can be considered as the two important physical features of these disks, and as a result, self-gravity and gravitational instability might be of a crucial role in these dense hyperaccretion flows. As well, the magnetic field is proposed to be of considerable importance via both large and small scale impacts. After providing an introduction to the GRB’s and the candidates of their central engines, we focus on these two factors (self-gravity and magnetic field) to probe their potential effects on the hyperaccretion disk’s structure, in addition to their subsequent impacts on the GRB’s spectral features. In other words, we apply these two features to provide an explanation for the prompt Gamma-ray emission with its highly variable structure in the early time, and the electromagnetic afterglow emission associated with the late time activity of the GRB’s central engine.

SPH simulations of the Induced Gravitational Collapse (17:50-18:20)

- Presenter: Prof. BECERRA, Laura (PUC, Chile)

The Induced Gravitational Collapse (IGC) paradigm points to a binary origin for the long-duration gamma-ray burst (GRBs) associated with supernovae (SN). In this one, a carbon-oxygen core (COcore) explodes in a Type Ib/c SN in presence of a close neutron star (NS) companion. The SN triggers a hypercritical accretion into the NS and depending on the initial binary parameters, two outcomes are possible given place to two families of long GRBs: binary-driven hypernova (BdHNe), where the NS reaches its critical mass, and collapses to a black hole (BH), emitting a GRB; and x-ray flashes (XRFs) where the hypercritical accretion onto the NS is not sufficient to induce its gravitational collapse. We perform three-dimensional (3D) numerical simulations of the IGC paradigm with the smoothed particle hydrodynamics (SPH) technique. We determine whether the star gravitational collapse is possible and assess if the binary holds gravitationally bound or it becomes unbound by the SN explosion.

Az Zarreh Taa Aaftaab: The Role of General Relativity in the Structure of Elementary Particles of Matter

(18:20-18:50)

- Presenter: Prof. TAHVILDAR-ZADE, Shadi (Rutgers, USA)

It was a largely unfulfilled dream of Einstein to arrive at a quantum theory of atomistic matter that included electrodynamic phenomena, and one in which the principles of general relativity would reign supreme. Even though he is generally considered to have failed in this quest, his unifying vision remains a powerful one to this date. In this talk we explore some of the ways in which Einstein's dream may one day be realized, including (1) a

general-relativity-based formulation of the joint evolution of classical fields together with point-particles that are sources of those fields, (2) a well-motivated deformation of classical nonlinear theories to quantum theories in which the motion of particles is guided by linear waves on particle configuration space, and (3) ring-like particles inspired by general relativity and a possible resolution of the dark matter puzzle.

Thursday 04 November 2021

"Science is undermined every time we let ideology substitute for actual truth" - Ethan Siegel (10:00-10:30)

- Presenter: Prof. KERR, Roy Patrick (University of Canterbury, Christchurch, New Zealand and ICRANet, Italy)
I will discuss The following ideas that have reached dogma status,
1) The universe is approximately conformally flat and isotropic,
2) Black holes have singularities, and evaporate,
3) Entropy can be generalised to GR.

Angular Momentum to a Distant Observer (10:30-11:00)

- Presenter: Prof. YAU, Shing-Tung (Harvard-USA)
The notion of angular momentum in general relativity has been a subtle issue since the 1960's, due to the discovery of ``supertranslation ambiguity'': the angular momentums recorded by two distant observers of the same system may not be the same. In this talk, I shall show how mathematical theory identifies a correction term, and leads to a new definition of angular momentum that is free of any supertranslation ambiguity. This is based on joint work with Po-Ning Chen, Jordan Keller, Mu-Tao Wang, and Ye-Kai Wang

Gravitomagnetic interaction of a Kerr black hole with a magnetic field as the source of the high-energy radiation of gamma-ray bursts (11:00-11:30)

- Presenter: Prof. RUEDA, Jorge (ICRANet)
It is shown how the gravitomagnetic interaction of a Kerr black hole (BH) with a surrounding magnetic field induces an electric field able to accelerate surrounding charged particles to ultra-relativistic energies. Along the BH rotation axis, electrons/protons can reach even thousands of PeV leading to ultrahigh-energy cosmic rays (UHECRs) from stellar-mass BHs in long gamma-ray bursts (GRBs) and from supermassive BHs in active galactic nuclei (AGN). At off-axis latitudes around the BH vicinity, particles are accelerated to hundreds of GeV, and by synchrotron radiation emit high-energy GeV photons. Such a process occurs at all latitudes within 60 degrees of the polar axis. The theoretical framework describing these acceleration and radiation processes, how they extract the rotational energy of the Kerr BH, as well as the consequences for the astrophysics of GRBs are outlined.

Break (11:30-11:50)

New high precision tests of General Relativity (11:50-12:20)

- Presenter: Prof. LÄMMERZAHL, Claus (ZARM, University of Bremen)

Exploring gravitation in the inner Solar System: Giuseppe Colombo, Mercury and the BepiColombo mission (12:20-12:50)

- Presenter: Prof. PERON , Roberto (National Institute of Astrophysics (INA) - IAPS, Italy)
The Solar System is an arena where multiple scientific paths intersect and interact. Seen from the point of view of fundamental physics, it is a test bench where the machinery of gravitation can be more directly accessed, albeit in its "weak-field" appearance. It is particularly the case of planet Mercury, due to its relative proximity to the Sun. Fundamental contributions to its exploration came from an Italian scientist, Giuseppe "Bepi" Colombo, who in particular proposed an effective trajectory strategy for the Mariner 10 probe. After this pioneering mission and the more recent MESSENGER one, it is now the turn of an European mission, BepiColombo, to further enlarge our knowledge of Mercury and the near-Sun environment. The mission and its scientific objectives will be presented, with particular regard to the planned tests of general relativity theory and to Mercury geodesy and geophysics.

The role of campfires in the heating of solar coronal plasma observed by Solar Orbiter and Solar Dynamics Observatory (12:50-13:20)

- Presenter: Prof. SAFARI, Hossein

Uncovering the Energetic of the Interstellar and the Intergalactic Medium with the SKA (13:20-13:50)

- Presenter: Prof. TABATABAEI, Fatemeh (IPM)
Investigating the physics and energetic of the medium where galactic structures, on various scales, are formed is the most fundamental step to understand the formation and evolution of galaxies. Modern galaxy evolution models

suggest gas accretion from the intergalactic medium or from cosmic filaments as a mechanism to maintain star formation and AGNs. Through gas heating and/or gas removal, these models also propose supernova feedback and AGN feedback as mechanisms to quench massive star formation. Observational studies however have not reached to a conclusive result, showing that feedback can, in some cases, trigger star formation, leaving the issue as an open challenge. It seems that we have missed some basic concepts about the formation of structures in the ISM and the IGM: What are physical parameters/agents governing the structure formation on various scales? and what is their relative importance? How does the ISM/IGM energy balance change over the cosmic time? Addressing these, it is vital to obtain a more complete picture of the ISM & IGM than what is known currently. The advent of the SKA and its new instrumental capabilities tracing the most energetic ISM components combined with the ground-breaking results from the ALMA, HST, VLT/MUSE, etc has opened a new window shedding light on the issue. The SKA's sensitive radio continuum observations will trace high-energy particles and magnetic fields not only in star forming regions and AGNs, but also in more quiescent regions in molecular clouds and diffuse ISM, enabling us to study the role of magnetic fields/cosmic rays in structure and star formation. On larger scales, these observations will allow us to address what determines the accretion rate from the IGM. Sensitive radio continuum observations on large scales may also bring constrains on the entity of the dark matter mapped by the HST and DECam.

Universality of Peaking Time of Supernovae in Association with Gamma-Ray Bursts (15:00-15:30)

- Presenter: Prof. AIMURATOV, Yerlan (Fesenkov Inst., Kazakhstan)

We discuss on the recent progress in Gamma-Ray Bursts - Supernova connection and make inferences coming from the universality of peaking time of Supernovae in this association.

Self-Similarities and Power-laws in the Time-resolved Spectra of GRB 190114C, 130427A, 160509A, and 160625B (15:30-16:00)

- Presenter: Prof. LI, Liang (ICRANet)

Context. A new time-resolved spectral analysis performed on GRB 190114C has allowed to identify in its prompt emission observed by Fermi-GBM three specific Episodes predicted to occur in BdHNe I. Episode 1, which includes the "SN-rise" with a characteristic cutoff power-law and blackbody spectra; the Episode 2, initiated by the moment of formation of the BH, temporally coincident with the onset of the GeV emission and the onset of the ultra-relativistic prompt emission (UPE) phase a characterized by cutoff power- law and blackbody spectra; Episode 3, the "cavity", with its characteristic featureless spectrum recently described in a companion paper (Ruffini et al. 2019b). An extreme time-resolved analysis performed on an iterative process in a sequence of ever decreasing time interval, has allowed to find self-similar structures and power-laws in the UPE of GRB 190114C; see e.g., the companion paper (Ruffini et al. 2019a). This has led to the first evidence for the identification of a discrete quantized emission in the GeV and MeV emission presented in the companion papers (Ruffini et al. 2018b; Rueda & Ruffini 2019).
Aims. To identify and verify the BdHNe I properties in the additional sources GRB 160509A, GRB 160625B and GRB 1340427A, and compare and contrast the results with the ones of a BdHN II source GRB 180728A (Wang et al. 2019b). We have also identified in all four sources, following the analysis GRB 130427A in the companion paper (Ruffini et al. 2018b), the GeV radiation during and following the UPE phase. Also in all the four sources, we describe the spectral properties of their afterglow emission, including the mass estimate of the νNS, following the results presented in the companion paper (Rueda et al. 2019).

Methods. In GRB 160509A and GRB 160625B, we have first identified the aforementioned three BdHN I Episodes. In the UPE phase, we have performed the time-resolved spectral analysis following the iterative process in a sequence of ever decreasing time intervals. We have also examined both the GeV radiation and the afterglow phases. The same procedure has been repeated in the case of GRB 130427A with the exception of the UPE phase, in view of a pile-up problem. The case of GRB 180728A, a BdHN II, has been used as a counterexample.

Results. The results of the spectral analysis have validated the common properties in all BdHNe I: the three Episodes as well as the self-similar structures and the associated power-laws in the UPE phase. The profound similarities of the results have made a significant step forward in the taxonomy of GRBs and in evidencing a standard composition of the BdHN I. This opens the opportunity of a vaster inquire of the astrophysical nature of their components in the population synthesis approach: e.g., the BH formation in all BdHN I occurs due to accretion of the SN ejecta in a tight binary system with a neutron star companion which reaches its critical mass, leading to the formation of the BH. The SN-rise in all five BdHNe are compare and contrasted.

Conclusions. The most far reaching discovery of self-similarities and power-laws here extensively confirmed, thanks also to the conclusions presented in the companion papers (Ruffini et al. 2018b, 2019a), leads to the existence of a discrete quantized repetitive polarized emission, both in the GeV and MeV observed by Fermi-GBM and Fermi-LAT, on a timescale as short as 10−14 s. These results open new paths in the discovery of fundamental physical laws.

Break (16:00-16:10)

Data Science in Relativistic Astrophysics - 1: Classification the stars using photometric optical data of SDSS (16:10-16:55)

- Presenter: Prof. ZHOLLIDEH HAGHIGHI, M. H. (IPM and KNTU, Iran)
Classification the stars using photometric optical data of SDSS

RR Lyrae variables are periodic variable stars, commonly found in globular clusters. They are used as standard candles to measure (extra) galactic distances, assisting with the cosmic distance ladder. They are pulsating horizontal branch stars of spectral class A or F, with a mass of around half the Sun's. They are thought to have shed mass during the red-giant branch phase and were once stars of similar or slightly less mass than the Sun, around 0.8 solar masses. In contemporary astronomy, a period-luminosity relation makes them good standard candles for relatively nearby targets, especially within the Milky Way and Local Group. They are also frequent subjects in the studies of globular clusters. We use the set of photometric observations of RR Lyrae stars in the SDSS as our data. The data set comes from SDSS Stripe 82, and combines the Stripe 82 standard stars, which represent observations of non-variable stars; and the RR Lyrae variables pulled from the same observations as the standard stars, and selected based on their variability using supplemental data. The sample is further constrained to a smaller region of the overall color–color space following ($0.7<u-g<1.35$, $-0.15 < g - r < 0.4$, $-0.15 < r - i < 0.22$, and $-0.21 < i - z < 0.25$). These selection criteria lead to a sample of 92,658 non-variable stars, and 483 RR Lyraes. Two features of this combined data set make it a good candidate for testing classification algorithms:

1- The RR Lyrae stars and main sequence stars occupy a very similar region in u, g, r, i, z color space.

2- The extreme imbalance between the number of sources and the number of background objects is typical of real-world astronomical studies, where it is often desirable to select rare events out of a large background. Such unbalanced data aptly illustrates the strengths and weaknesses of various classification methods.

Our goal is to characterize the relation between the features in the data and their classes and apply these classifications to a larger set of unlabeled data. In this hands-on session, participants will learn how to use machine learning algorithms in practice and classify observed stars from optical data. This session has two parts in the first part we try to classify objects by some well known conventional machine learning algorithms such as logistic regression and etc. In the second part we use Neural Network for our classification purposes.

Data Science in Relativistic Astrophysics, 2-Classification of astronomical objects and determining their redshift using spectroscopic optical data of SDSS (16:55-17:40)

- Presenter: Prof. MORADI, Rahim (ICRANet-Italy)
Classification of astronomical objects and determining their redshift using spectroscopic optical data of SDSS

Quasi-stellar radio source (Quasars) or quasi stellar objects (QSO) are high-luminosity active galactic nuclei (AGN) which are believed to be powered by accretion disks around supermassive black holes (SMBHs) with masses in the range of 1 million to 1 billion solar mass. Thanks to their high luminosity, quasars have been found to spread from redshift z~0 all the way back to z~7 when the universe was forming its first structures, namely the epoch of reionization. Therefore, study the high-redshift quasars can be taken into account as a powerful tool to study the cosmic history and structure formation in the early universe. Owing to their existence at redshifts ranging from z=0 to z~ 7, quasars provide a new possible standard candle, like type Ia supernovae, which can infer new cosmological constraints to study the evolution of the universe.

In this part, after introducing the methods to process and prepare the spectroscopic optical data of SDSS, we represent the architecture of a 1-dimensional convolutional neural network (CNN) to estimate the redshift of quasars in Sloan Digital Sky Survey IV (SDSS-IV) catalog from DR16 quasar-only (DR16Q) of eBOSS. We show how this CNN can be easily extended in order to classify stars, galaxies and quasars as well as prediction of their redshift. The CNN takes the flux of the quasars as an 1--dimensional array and their redshift as labels. Therefore, This CNN extract the spectroscopic features of SDSS data and predicts the redshift of quasars. We finally represent a similar CNN, but less efficient, which is already used by SDSS website to classify the quasars, stars and galaxies, as well as predict the redshift.

In this session, participants will learn how to process the SDSS spectral data in order to implement them in 1-dimensional CNN and observe the preliminary results.

Data Science in Relativistic Astrophysics, 3-More networks and more areas (17:40-18:25)

- Presenter: Prof. YU, Wang (ICRANet, Italy)
More networks and more areas

Based on the first two tutorials, we introduce more types of neural networks applied to more kinds of astronomical data.

In the above example of inferring redshift from SDSS data, we build simple but efficient 1D CNN networks and obtain accurate results. We further complicate the CNN network by introducing advanced structures such as Residual, Attention, etc., and applied the latest networks from the industry field to the same data to infer redshift, and to test whether the accuracy has improved.

Secondly, we make a brief introduction to gravitational wave and gamma-ray burst data, and transfer the above networks to the machine learning subjects of gravitational wave and gamma-ray burst. Astronomical data are nothing but temporal and spatial data, we hope this short tutorial can broaden the horizon and be able to build the network flexibly.

Friday 05 November 2021

The Light of the Moon: Ibn al-Haytham and Galileo (10:00-10:30)

- Presenter: Prof. MASOUMI HAMEDANI , Hossein (Iranian Institute of Philosophy, Iran)
In a treatise entitled On the Light of the Moon, the physicist and mathematician of the 10th-11th centuries Ibn al-Haytham proves that the Moon is not a polished body and that it does not reflect the light it receives from the Sun in the way a convex mirror does. Almost six centuries later, Galileo takes up the same problem in his famous Dialogues Concerning the Two Great World System. By a method which is somewhat different from that of Ibn al-Haytham, he arrives at a similar conclusion.
The aim of this article is to discuss the similarities and the differences of the two methods and the conclusions their authors draw from them.

Astronomy in Islamic World - a European perspective (10:30-11:00)

- Presenter: Prof. KERNER, Richard (Sorbonne Université, France)
Arab and Islamic Civilization emerged at the crossroads in a double sense, as a bridge between the Greco-Roman Antiquity and European Modernity in time, and as the junction between the declining Roman Empire and the still vigorous Indian and Persian civilizations in space. In this talk, we shall highlight the most important contributions of Islamic Polymaths to Mathematics and Astronomy, paving the way to the next stage of the development of science which occurred in the late Middle Ages in Europe.

Break (11:00-11:20)

Dark matter fermions: from linear to non-linear structure formation (11:20-11:50)

- Presenter: Prof. ARGUELLES, Carlos (ICRANet, Italy)
Relaxation mechanisms of collisionless self-gravitating systems of fermions in cosmology, can lead to equilibrium states which are stable, long-lived, and able to explain the dark matter (DM) halos in galaxies. The most general fermionic DM profile out of such a mechanism, develops a degenerate compact core which is surrounded by an extended halo. When applied to the Milky Way, it is demonstrated that the outer halo can explain the rotation curve of our Galaxy, while the central DM-core explains the dynamics of all the best resolved S-cluster stars orbiting SgrA *, without assuming a central black hole (BH). When such novel core-halo DM profiles are applied to larger galaxies, the dense DM core can reach the critical mass for gravitational collapse into a BH of □ 10^8 Mo. This result provides a new mechanism for supermassive BH formation in active galaxies directly from DM, leading to a paradigm shift in the understanding of galactic cores.

The dynamics of ultra-diffuse dwarf galaxies in MOND (11:50-12:20)

- Presenter: Prof. HAGHI , Hosein (ISABS-Iran)
In this talk, I will review the current state of research on the apparently dark matter-free ultra-diffuse dwarf galaxies, emphasizing what our research team has investigated in recent years. In particular, I will focus on galaxies NGC 1052-DF2 and NGC 1052-DF4 in the framework of MOND. Due to the non-linear Poisson equation in MOND, a dwarf galaxy has weaker self-gravity when in close proximity to a massive host. Using our analytic formulation and fully self-consistent live N-body models in MOND, I will show you how the dynamics of these galaxies are in good agreement with MOND prediction.

Probing the first instants of the universe with large scale structure (12:20-12:50)

- Presenter: Prof. STAHL, Clement (Strasbourg U., France)
In this talk, I will discuss the state of the art in the field of large scale structure for cosmology. I will in particular discuss the novel approach of effective field theory which allows to integrate out complicated small scales physics. I will entertain the possibility that it is now possible to propagate a primordial signal throughout cosmic history and detect it in future galaxy surveys, In this sense, large scale structures could be used to constrain primordial physics and thus push forward our fundamental understanding of our universe.

Shadows around at Sgr A* and M87* as a tool to test gravity theories (12:50-13:20)

- Presenter: Prof. ZAKHAROV, Alexander (BLTP, JINR, Dubna, Russia)
The shadow around the supermassive black hole in M87 was reconstructed in 2019 based on its observations with the Event Horizon Telescope in 2017. Recently polarization map for the M87* shadow was presented. We discuss opportunities to evaluate parameters of alternative theories of gravity with shadow observations, in particular, a tidal charge could be estimated from these observations.

Luminosity of accretion disks in compact objects with a quadrupole (15:00-15:30)

- Presenter: Prof. BOSHKAEV, Kuantay (Al-Farabi Kazakh National University, Almaty, Kazakhstan Nazarbayev University, Nur-Sultan, Kazakhstan)

We consider the circular motion of test particles in the gravitational field of a static and axially symmetric compact object described by the q metric. To this end, we calculate orbital parameters of test particles on accretion disks such as angular velocity, total energy, angular momentum, and radius of the innermost stable circular orbit as functions of the mass and quadrupole parameters of the source. The radiative flux, differential and spectral luminosity of the accretion disk, which are quantities that can be experimentally measured, are then explored in detail. The obtained results are compared with the corresponding ones for the Schwarzschild and Kerr black holes in order to establish whether black holes may be distinguished from the q metric via observations of the accretion disk's spectrum

Axion in Astrophysics (15:30-16:00)

- Presenter: Prof. CARENZA, Pierluca (Stockholm U., OKC, Sweden)

This is a review of the latest developments on axion astrophysics, with particular attention to the axion production in stellar environments and to the phenomenology of the axion-photon mixing on astrophysical scales.

Production of Thermal QCD Axions in the Early Universe (16:00-16:30)

- Presenter: Prof. HAJKARIM, Fazlollah (UNIPD-Italy)

We study the thermal production of axions over different scales especially around the QCD and electroweak phase transitions in the early universe. We focus on the most motivated axion models (KSVZ and DFSZ) and investigate how the thermal history can influence on the production rate of hot axion as dark radiation. This can lead to predictions for the future measurements of the cosmic microwave background by experiments like CMB-S4.

Concluding remarks (16:30-17:00)

- Presenter: Prof. SHAKERI, Soroush