Enclosure 7

International Meetings

International Center for Relativistic Astrophysics Network

ORGANIZATION   MEETINGS   RESEARCH   IRAP PH.D.   PUBLICATIONS   OUTREACH   CONTACT US

Visitors: 144484775
We have 3 guests online

Betelgeuse dimming: the state of the star International workshop

"Betelgeuse 2020 dimming" by Costantino Sigismondi

Betelgeuse, the alpha of Orion, has been classified as the brightest star of the constellation by Ptolemy around 150 AD. It is a semi-regular variable that in the top luminosity phases can be the brightest star of the northern hemisphere, with negative magnitude. Since October 2019, its luminosity is dimming and lost one whole magnitude, attaining the visual magnitude of 1.4, at the level of Regulus, the alpha of Leo. What is going on? This will be the subject of this workshop, organized in the occurrence of such epochal event, with some of the most prominent scientists in the field.
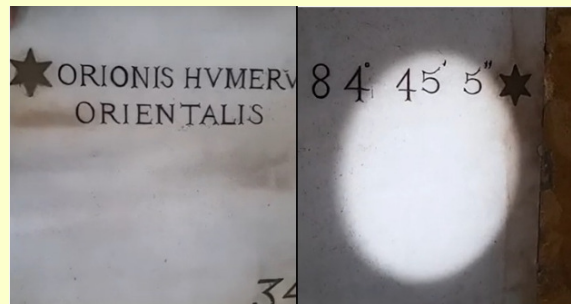
Betelgeuse as in 1702, Clementine Gnomon - Rome

Friday January 17, 2020, h 15:30 – 17:30
ICRANet, Piazza della Repubblica 10, Pescara

Ore 15:30 - Library

Welcoming addresses and Lectio Magistralis

Prof. Remo Ruffini, Direttore ICRANet: Supernovae and Gamma-Ray bursts

Ore 15:45 - Conference room Carlo Pace

Plenary speakers

- Costantino Sigismondi, ICRA/Sapienza: The case of eta Carinae in 1843
- Cesare Barbieri, University of Padova: Astronomy and media
- Margarita Karovska, Harvard CfA: Multiperiodicity in the Light Curve of Alpha Orionis
- Paolo Ochner, Asiago Astrophysical Observatory: Galactic SN classification
- Stella Kafka, AAVSO Director: AAVSO Mission and Database
- Massimo Turatto, INAF/Padova Observatory: Supernova and variability from spectra and lightcurves

Ore 17:00

Esercitazione pratica/training

Prof. Costantino Sigismondi, ICRA/Sapienza

Comitato Organizzatore: Costantino Sigismondi (ICRA/Sapienza e Pontificia Università Regina Apostolorum - chair), Prof. Remo Ruffini (ICRANet), ICRANet Pescara, Tiziana Pompa (Liceo Scientifico Galileo Galilei Pescara).

Video
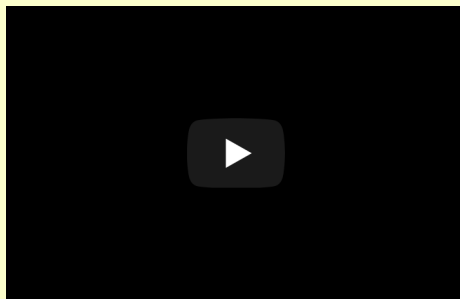
Nights of January 18,19,20
Observations at Liceo Scientifico G. Galilei of Pescara and ICRANet by Prof. Costantino Sigismondi

For suggestions&comments write to the Webmaster

The Fourth Zeldovich Virtual Meeting
An international conference in honor of
Ya. B. Zeldovich

ICRANet and National Academy of Sciences of Belarus
7 - 11 September 2020

Website: www.icranet.org/zeldovich4
Contacts: zeld4@icranet.org

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The series of Zeldovich meetings started with the celebration of the International Year of Astronomy 2009 in Belarus. These international meetings are organized in honor of Yakov Borisovich Zeldovich, A brilliant Soviet physicist and the father of the Russian scientific school on Relativistic Astrophysics, born in Minsk. the Zeldovich meetings are organized by ICRANet, by the National Academy of Sciences of Belarus and by the Belarusian State University. Exceptionally wide research interests of Zeldovich, ranging from chemical physics, elementary particle and nuclear physics to astrophysics and cosmology provide the topics covered by these conferences.

The Fourth Zeldovich Virtual Meeting

An international conference
in honor of Ya. B. Zeldovich

Conference booklet

September 7-11, 2020

International Center for Relativistic Astrophysics Network

National Academy of Sciences of Belarus

The Fourth Zeldovich Virtual Meeting

September 7–11, 2020

CONFERENCE BOOKLET

2020

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Time is indicated in Central European Summer Time (CEST).

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10:30-11:00
Stefan Gillessen. GRAVITY scientific results

11:00-11:30
Lorenzo Amati. The Transient High Energy Sky and Early Universe Surveyor (THESEUS)

11:30-12:00
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Alena Khokhriakova. Detectability of isolated neutron stars by eROSITA

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Andrej Manko. The two-photon production of quark-antiquark pairs at LHC

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16:30-17:00
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17:00-17:30
Jorge Rueda. An update of the binary-driven hypernova scenario

17:30-17:45
Valery Chechetkin. Large-Scale Instability in Supernovae and the Neutrino Spectrum

17:45-18:00
Maria Pruzhinskaya. New method to account for Type Ia Supernova environment in cosmological analysis

18:00-18:15
Elena Balakina. The influence of peculiar velocities of SNe Ia on distance measurements

18:15-18:30
Sergei Kilin, Remo Ruffini and Gregory Vereshchagin. Concluding remarks

Abstracts

1. Aljaf Muhsin. *Constraints on interacting dark energy models through cosmic chronometers and Gaussian process*

In my talk I will explain how it is possible to reconstruct the time evolution of the Hubble function by applying Gaussian process techniques to the cosmic chronometers data provided by the study of passively evolving galaxies. This procedure is model-independent because it does not require any information about the mysterious properties of the dark energy fluid filling the Universe. Then, I will instead specify to some interacting dark energy - dark matter cosmological models in which the latter fluid is modeled as a Modified Chaplygin Gas, and estimate the values of the cosmological parameters (present day values of the deceleration parameter, of the Hubble function, and of the abundance of dark energy with respect to dark matter) in light of the previously derived time evolution of the Hubble function. Finally, I will comment on the thermodynamical applicability of such models, I will compare and contrast our findings for the values of the cosmological parameters with the ones presented by recent literature which relies on some other observational datasets, and I will mention how we can deepen our understanding of the nature of dark matter and dark energy through the investigation of the energy flows taking place between the two. My talk will be based on the preprint arXiv:astro-ph.CO/2005.01891 I wrote under the supervision of Drs. Daniele Gregoris and Martiros Khurshudyan.

2. Amati Lorenzo. *The Transient High Energy Sky and Early Universe Surveyor (THESEUS)*

The Transient High-Energy Sky and Early Universe Surveyor (THESEUS) is a space mission concept currently under Phase A study by ESA as candidate M5 mission, aiming at exploiting Gamma-Ray Bursts for investigating the early Universe and at providing a substantial advancement of multi-messenger and time-domain astrophysics. Through an unprecedented combination of X-/gamma-rays monitors, an on-board IR telescope and automated fast slewing capabilities, THESEUS will be a wonderful machine for the detection, characterization and redshift measurement of any kind of GRBs and many classes of X-ray transients. In addition to the

full exploitaiton of high-redshift GRBs for cosmology (pop-III stars, cosmic re-ionization, SFR and metallicity evolution up to the "cosmic dawn"), THESEUS will allow the identification and study of the electromagnetic counterparts to sources of gravitational waves which will be routinely detected in the late '20s / early '30s by next generation facilities like aLIGO/aVirgo, LISA, KAGRA, and Einstein Tele-scope (ET), as well as of most classes of transient sources, thus providing an ideal synergy with the large e.m. facilities of the near future like LSST, ELT, TMT, SKA, CTA, ATHENA.

3. Arbuzova Elena. *Zeldovich equation and supersymmetric dark matter*

Cosmological number density of supersymmetric relics is calculated in R^2-modified gravity (Starobinsky inflation). Universe evolution in this theory strongly devi-ates from the conventional Friedmann cosmology. This opens window for heavy supersymmetric particles to be viable candidates for Dark Matter. The calcula-tions are based on the Zeldovich equation derived in 1965.

4. Arguelles Carlos. *Fermionic dark matter profiles*

We discuss the problem of dark matter halos, by assuming a quantum fermionic particle as the building block for the DM component, each of which self-gravitates in a quasi-virialized system of collisionless fermions. We show that fermionic DM accounting for the Pauli-principle and particle escape effects in the underlying phase-space distribution, leads to a more general density profile which develops a degenerate-core surrounded by a diluted-halo able to reproduce the rotation curves. In the case of our Galaxy, we show that the DM central core can produce analogous gravitational effects than the putative massive BH centered in SgrA*, for particle masses $m \sim 10 - 100$ keV/c^2. The formation, stability, and other cos-mological consequences of such novel fermionic DM profiles are also discussed.

5. Arkhangelskaja Irene. *Long GRBs observations up to TeV energies: sources inhomogeneity*

Several thousands of gamma-ray bursts were observed by various experiments, but their sources of origin still remain unclear up to now. During several GRBs very high-energy photons were detected both in space and ground-based exper-iments (up to some tens of GeV and up to some TeV, respectively). For exam-ple, GRB 190114C was detected by Fermi and MAGIC in very wide band up to subTeV energies. 18 photons were observed by Milagrito in energy band 0.1–10 TeV within t_{90} interval during GRB 970417a. Typically considered short and long GRBs classes separated by $t_{90} = 2$ s and the subgroup of intermediate GRBs was separated in duration interval of 0.8 s $\leq t_{90} \leq 50$ s with 3 s taking into ac-count duration and duration-hardness distributions and such GRBs type reveal

in Fermi/GBM and Swift/BAT events analysis. Redshift measurements allow analyzing additional parameter and at least two long GRBs subgroup were separated with different characteristic distances $z \sim 1.1$ and $z \sim 2.2$. Here we introduce new value Rt is ratio of maximum energy photon arrival time to burst duration and it not required cosmological correction. At least 2 groups of long GRBs could be separated using this parameter: for 14 events highest energy gammas detected within t_{90} interval, but for other 41 bursts it registered more than 10 seconds later than one. Moreover, preliminary results of analysis allow concluding three types of GRBs with high energy emission registration without dependence of burst duration value. During first subtype events high energy emission duration interval smaller than t_{90}. Second subtype characterized longer period of high energy emission than t_{90}. But second subtype bursts divided to 2 subgroups. For one (a) gamma-quantum with maximum energy arrived within t_{90}, and for other such photon was registered later than t_{90}. Therefore, results of preliminary analyses allow conclude long GRBs population inhomogeneity.

6. Asgari Marika. *Weak lensing and the kilo Degree Survey*

The kilo degree survey (KiDS) is a purpose-built gravitational lensing survey with high quality images and a wide photometric coverage, resulting in very high fidelity data. This dataset, therefore, provides an excellent playground where we can test our methods in preparation for future weak lensing surveys. Cosmological constraints from weak lensing surveys are currently in mild tension with CMB analysis of the Planck data, a result which has sparked both skepticism and excitement within the community. In this talk I will show the latest results from the cosmic shear analysis of KiDS data and its combination with spectroscopic galaxy surveys. I will go through the systematics that can affect the results and methods to mitigate them.

7. Ashtekar Abhay. *Quantum Gravity in the Sky? Alleviating the tension in CMB using Planck scale physics*

I will discuss a bridge between a fundamental description of the very early universe and the most recent observations we have from the PLANCK satellite. Certain anomalies in the CMB bring out a tension between the standard six-parameter ΛCDM cosmological model and observations. The PLANCK team has commented: '...if any anomalies have primordial origin, then their large scale nature would suggest an explanation rooted in fundamental physics. Thus it is worth exploring any models that might explain an anomaly (even better, multiple anomalies) naturally, or with very few parameters.' I will show that this possibility is realized within Loop Quantum Cosmology where the primordial power spectrum is modified due to Planck scale physics.

8. Bahamonde Sebastian. *Solar System Tests in Modified Teleparallel Gravity*

In this talk, I will present different Solar System tests in a modified Teleparallel gravity theory based on an arbitrary function $f(T, B)$ which depends on the scalar torsion T and the boundary term B. I will first give an overview about Teleparallel theories which are based on choosing a manifold with a zero curvature but non-zero torsion. Then, I will show new perturbed spherically symmetric solutions around Schwarzschild in Teleparallel gravity. For each solution, I will show different Solar System tests such as the perihelion shift, deflection of light, Cassini experiment, Shapiro delay and the gravitational redshift. Finally, I confront these computations with different known experiments from these Solar System tests to put different bounds on the mentioned models.

9. Balakina Elena. *The influence of peculiar velocities of SNe 1a on distance measurements*

Type Ia supernovae (SNe) are used as a distance indicators since they have less luminosity dispersion at maximum light. Observations of distant SNe Ia led to the discovery of the accelerating expansion of the Universe and the most recent analysis of SNe Ia indicates that considering a flat ΛCDM cosmology, the contribution of dark energy in the total density of the Universe is about 70%. Cosmological parameters are estimated from the "luminosity distance-redshift" relation of SNe using the Hubble diagrams. Currently a lot of attention is paid to increase of the accuracy of luminosity distance determination of SNe. The uncertainty on the redshift is quite often considered negligible. The redshift used in "luminosity distance-redshift" relation is a cosmological redshift, i.e. the redshift due to the expansion of the Universe. In fact the redshift observed on the Earth also includes the contribution from the unknown peculiar velocities. To minimize the influence of poorly constrained peculiar velocities, in cosmo- logical analyses a standard value of 300-400 km/s peculiar velocity dispersion is added in quadrature to the redshift uncertainty. It has nonetheless been observed that velocity dispersion can exceed 1000 km/s in galaxy clusters and therefore, the dispersion inside the cluster can be greater than the one usually assumed in cos- mological analyses and can affect the distance measurements. To take this effect into account we study SNe Ia that are exploded in the galaxy clusters. As a supernova sample we use "Pantheon" the largest combined sample of SN Ia (HST, SNLS, SDSS, low-z samples and Pan-STARRS1) consisting of a total of 1048 objects ranging from 0.01 < z < 2.3. For those SNe Ia that belong to the galaxy clusters we are going to use the galaxy cluster redshift instead of the host galaxy redshift and examine the effect of this correction on the Hubble diagram.

10. Bambi Cosimo. *Testing general relativity with black holes using X-ray observations*

Einstein's theory of general relativity was proposed over 100 years ago and has successfully passed a large number of observational tests in weak gravitational

fields. However, the strong field regime is still largely unexplored, and there are many modified and alternative theories that have the same predictions as Einstein's gravity for weak fields and present deviations only when gravity becomes strong. Astrophysical black holes are ideal laboratories for testing gravity in the strong field regime. In this talk, I will present the XSPEC models RELXILL NK and NKBB, which are specifically designed for testing the metric around black holes by fitting, respectively, the reflection and the thermal components of the accretion disk. I will also show current constraints on possible new physics from the analysis of a few sources with these models.

11. Beckwith Andrew. *Using "Enhanced Quantization" to bound the Cosmological constant, (for a bound-on graviton mass), by comparing two action integrals(one being from general relativity) at the start of inflation*

We are looking at comparison of two action integrals and we identify the Lagrangian multiplier as setting up a constraint equation (on cosmological expansion). This is a direct result of the fourth equation of our manuscript which unconventionally compares the action integral of General relativity with the second derived action integral, which then permits equation 5, which is a bound on the Cosmological constant. What we have done is to replace the Hamber Quantum gravity reference-based action integral with a result from John Klauder's "Enhanced Quantization". In doing so, with Padamabhan's treatment of the inflaton, we then initiate an explicit bound upon the cosmological constant. The other approximation is to use the inflaton results and conflate them with John Klauder's Action principle for a way to have the idea of a potential well, generalized by Klauder, with a wall of space time in the Pre Planckian-regime to ask what bounds the Cosmological constant prior to inflation, and, get an upper bound on the mass of a graviton. We conclude with a redo of a multiverse version of the Penrose cyclic conformal cosmology to show how this mass of a heavy graviton is consistent from cycle to cycle. All this is possible due to equation 4. And we compare all this with results of reference [1] in the conclusion. The Graviton mass is proportional to the square root of the thereby bounded cosmological constant for reasons which are similar to what was discussed by M. Novello in 2005, and serve as a setting of gravity, itself at the nucleation of a new universe.

12. Beylin Vitaly. *Could the presence of dark matter affect the neutrino flux?*

We consider the possible influence of Dark Matter on the propagation and distribution of high-energy neutrino fluxes. Quasi-elastic and/or inelastic scattering of neutrinos off the DM or neutrino production in the processes of cosmic protons and photons interactions with the DM particles are discussed within the framework of the hypercolor extension of the Standard Model.

13. Bikbaev Timur. *Numerical simulation of dark atom interaction with nuclei*

The old and still not solved problem of dark atom solution for the puzzles of direct dark matter searches is related with rigorous prove of the existence of a low energy bound state in the dark atom interaction with nuclei. Such prove must involve a self-consistent account of the nuclear attraction and Coulomb repulsion in such interaction. In the lack of usual small parameters of atomic physics like smallness of electromagnetic coupling of the electronic shell or smallness of the size of nucleus as compared with the radius of the Bohr orbit the rigorous study of this problem inevitably implies numerical simulation of dark atom interaction with nuclei. The programme of such simulations of OHe- nucleus interaction involves multi-step approximation to the realistic picture by continuous addition to the initially classical picture of three point-like body problem realistic features of quantum mechanics.

14. Blixt Daniel. *Viability of teleparallel gravity*

General relativity is normally formulated in a Riemannian geometry, using curvature. However, there are equivalent formulations of general relativity with one being "teleparallel equivalent to general relativity", which only differ to the Einstein-Hilbert action by a boundary term. This formulation assumes vanishing curvature, but non-vanishing torsion. In recent years more research have been directed towards modified gravity, in order to describe for example dark energy, inflation and the Hubble tension. A lot of focus have been directed towards modified gravity with the Einstein-Hilbert action as the starting point. Less work has been directed towards modified gravity in the teleparallel framework. I will give an overview of what teleparallel gravity is, how one can construct modified gravity theories within this framework, the problems within this framework, and open questions.

15. Borsevici Victor. *Information and Gravity in the light of*

In this report the strong connection between information theory, General Relativity Theory and Quantum mechanics is proved on the basis of mathematical apparatus and experimental data. This approach leads to the unified concept of Black Holes, extended Standard Model, Dark energy and Genesis of the Universe. The numerous experimental and observation data including the LIGO collaboration has been used.

16. Campion Stefano. *On magnetic field screening*

In this talk I will present the results of the preliminary work about the screening of a BH strong magnetic field, operated by electron/positron pairs. It has been shown that a rotating BH immersed in a test background magnetic field, of initial strength B_0 and aligned parallel to the BH rotation axis, generates an induced electric field proportional to the magnetic field. We consider the condition of crossed fields ($B = B_z$, $E = E_y$). In this system the huge number of pairs,

created by the vacuum polarization process, start to be accelerated by the electric field and emit synchrotron photons. These photons interact with the magetic field mean the magnetic pair production process and create new pairs. All of these pairs created in this shower-like process circularize around the magnetic field lines generating an induced magnetic field which decreases the background one. The results show that the entity of the reduction depends principally by the following initial conditions: number of pairs, emission direction and BH spin.

17. Chandra Kapil. *Why Zeldovich failed to estimate the precise value of cosmological constant*

In this study we will show how quantum mechanics has failed to estimate the precise value of the cosmological constant by using the Planck mass/unit as the cut off. We report that the expression for the Planck mass is numerically incorrect, its only dimensionally balanced because it misses some dimensionless constant, however, when this unit is used to estimate the value of cosmological constant it gives its large value. This paper will show how a modification of the Planck unit gives a more accurate value and also fixes the long standing cosmological constant problem.

18. Chavez Paulino Javier Dominguez. *Vanishing super-Poynting observers of a pencil of light in the Melvin universe*

The exact solution to Einstein s field equations representing the gravitational field of a linear source infinitely extended in one direction and moving with the speed of light known as pencil of light was first obtained by Peres in 1959. Later, Bonnor in 1969 also considered the case of a spinning source with a first proper physical interpretation of the results. Mitskievich and Kumaradtya in 1989 obtained a solution interpreted as the superposition of a pencil of light and the Melvin universe. In this work we show that it can be found observers for which the aforementioned superposition of fields has a vanishing super-Poynting vector for its gravitational super-energy flux. We interpret this result as a physical effect associated with the superposition of light and a strong magnetic field in general relativity.

19. Chechetkin Valery. *Large-Scale Instability in Supernovae and the Neutrino Spectrum*

A large fraction of the energy released during the gravitational collapse of the core of a massive star is carried by neutrinos. Neutrinos play the main role in explaining core-collapse supernovae. A selfconsistent formulation of the gravitational collapse is solved using 2D gas dynamics, taking into account the spectral transport of neutrinos in the framework of neutrino diffusion with diffusion the the fluxes limiters. Large scale convection leads to an increase in the mean energy of the neutrinos from 10 to 15 MeV, which is important for explaining supernovae,

as well as for designing experiments on detecting high-energy neutrinos from supernovae.

20. Dolgov Alexander. *Massive primordial black holes*

Existence of primordial black holes (PBH), envisaged by Zeldovich and Novikov in 1967, seems to be well established now. A review is presented of the astronomical data of the recent years, which strongly indicate that the recently observed black holes are primordial. A mechanism of massive and supermassive PBH creation is described. Possible contribution of PBH to cosmological dark matter and their role in the observed gravitational waves are discussed

21. Dolgov Alexander. *Primordial black holes and modification of Zeldovich-Novikov mechanism*

A review of the recent astronomical observations is presented and it is argued that the data strongly indicate that practically all observed black holes are primordial. A modified mechanism of the primordial black hole formation is described.

22. Einasto Maret. *Connectivity and galaxy populations in supercluster cocoons: the case of A2142*

The largest galaxy systems in the cosmic web are superclusters, overdensity regions of galaxies, groups, clusters, and filaments. Low-density regions around superclusters are called basins of attraction or cocoons. In my talk I discuss the properties and galaxy content of galaxies, groups and filaments in the A2142 supercluster and its cocoon. Cocoon boundaries are determined by the lowest density regions around the supercluster. We analyse the structure, dynamical state, connectivity, and galaxy content of the supercluster, and its high density core with the cluster A2142. We found that the main body of the supercluster is collapsing, and long filaments which surround the supercluster are detached from it. Galaxies with very old stellar populations lie not only in the central parts of clusters and groups in the supercluster, but also in the poorest groups in the cocoon.

23. Freese Katherine. *Thoughts on what Dark Matter is (and what it isn't) and how to Find it*

I'll talk about several probes to learn about the nature of dark matter. I'll start with the latest on ordinary neutrinos: these make up only 1/2% of the content of the Universe, but we are close to nailing down neutrino mass and hierarchy using a combination of cosmology and oscillations measurements. The same is true for light (< keV) sterile neutrinos. I'll also review the status of WIMP searches: what is going on with DAMA? the future of paleodetectors. Will we see Dark Stars? Then on to new ways to test the nature of Dark Matter: the GAIA satellite and stellar streams as a test of Cold Dark Matter.

24. Gaina Alexei. *Recollections about Zeldovich*

I know Zeldovich since 1968, when I was a scholar in Telenesti, Republic of Moldova. I red the journal "Znanije-Sila" with interest. And my dream was to meet somewhere in a future Zeldovich. This happened only in 1973.

25. Good Michael. *Radiation from an inertial horizon*

Radiation is investigated from asymptotic zero acceleration motion where a horizon is formed and subsequently detected by an outside observer. A perfectly reflecting moving mirror (black hole analog) is used to model this system and compute the energy and spectrum. The trajectory is asymptotically inertial (zero proper acceleration)-ensuring negative energy flux (NEF), yet approaches lightspeed with a null ray horizon at a finite advanced time. We compute the spectrum and energy analytically. The results signal the potential existence of a geometry that, like a black hole, has an event horizon that radiates energetic particles to observers at infinity, however at late-times, the horizon of this system is shining with negative energy Hawking radiation.

26. Gregoris Daniele. *Curvature invariants, and black hole horizons*

Recent observations of gravitational waves by the LIGO Collaboration relied on numerical simulations of binary black hole systems. An issue that arises is to provide a convenient algorithm for locating the horizon of the two interacting black holes for two reasons: (i) if, at a certain time moment during the evolution, the two horizons overlap, then the mathematical modeling of this astrophysical system loses meaning; (ii) the black hole horizon is a casual boundary, and therefore what happens inside it cannot influence the physical phenomena occurring outside. The most widely adopted excision methods in numerical relativity exploit the focusing properties of a bundle of light rays accounted for by the differential Raichaudhuri equation. However, the integration of a differential equation is computationally expensive, and thus literature has been searching for procedures for locating the black hole horizon in terms of a more convenient algebraic equation. In my talk, I will exhibit two methods for finding the stationary horizon of a black hole using scalar polynomial and Cartan curvature invariants, respectively. In particular, I will show that certain curvature quantities: (i) vanish on the horizon; (ii) vanish only on the horizon (without providing false positives); (iii) switch their signs on the horizon. I will compare and contrast the different applicability of these two methods by discussing the specific examples of the Kerr-Newman-NUT-(Anti)-de Sitter and Banados-Teitelboim-Zanelli solutions because they allow for a transparent discrimination between the roles of the Weyl and Ricci curvature inside these procedures. The last part of the talk will be devoted to the study of the McVittie (which describes a black hole interacting with a surrounding expanding universe) horizon(s) comparing different modelings for the

cosmic fluid for accounting for dark energy absorption onto the black hole.

27. Hohmann Manuel. *Gauge-invariant approach to the parameterized post-Newtonian formalism*

The parameterized post-Newtonian (PPN) formalism is an invaluable tool to assess the viability of gravity theories using a number of constant parameters. These parameters form a bridge between theory and experiment, as they have been measured in various solar system experiments and can be calculated for any given theory of gravity. The practical calculation, however, can become rather cumbersome, if the field equations involve couplings to additional fields. In addition, the PPN formalism relies on the choice of a particular gauge (or coordinate system), which is determined only after solving the field equations. These difficulties can be overcome by applying a gauge invariant formalism, which is conventionally used in cosmological perturbation theory. The particular nature of the PPN formalism requires perturbations of at least quadratic order to be considered, as well as a different treatment of space and time directions. In my talk I show how to develop such kind of formalism for gravity theories in metric and tetrad formulation and give prospects on how to generalize this treatment to higher perturbation orders necessary for calculating high precision orbital motion.

28. Howard Eric. *On the dynamics of phase transitions in relativistic scalar field theory*

We study the Kibble-Zurek scaling dynamics and universal second order phase transitions in a relativistic scalar field theory in 1+1 dimensions. A current challenge in modern cosmology is whether the vacuum contains topological defects generated during the initial phase transitions in the Early Universe, such as domain walls, cosmic strings and textures. Using tensor networks techniques as a non-perturbative non-equilibrium numerical tool for quantum field theory, we perform an analysis of the formation of topological defects in a non-equilibrium quantum system, as a realistic toy model of the formation of cosmological defects in the large-scale structure of the Early Universe. We employ Matrix product states and the time dependent variational principle to predict the Kibble-Zurek scenario for a system undergoing a symmetry breaking phase transition in the context of a scalar field theory and study the non-equilibrium time evolution of a quantum field theory in 1+1 space-time dimensions.

29. Ishka Sobhan Kazempour. *Imposing Gravitational Wave Constrains on the Einstein-Gauss-Bonnet Cosmology*

Several observations have been indicating that there are some unsolved problems in cosmology. One of the solutions is the Scalar-tensor theory which is extended by coupling to gauss-bonnet term. Also, this theory could be solved with use of

Noether symmetries due to the benefits of this approach. Initially, I illustrate the equations fields of that theory and some cosmological properties. Moreover, in this talk, I want to show some features in gravitational waves for testing that theory. In other words, I try to show some characteristics in gravitational waves in order to indicate some constraints on that theory which could be imposed.

30. Ivanov Michael A. *The system of equations describing 4 generations with the symmetry group $SU(3)_C \times SU(2)_L \times U(1)$*

The system of 16-component equations including two equations of the Bethe-Salpeter kind (without an interaction) and two additional conditions are considered. It is shown that the group of the initial symmetry is $SU(3)_C \times SU(2)_L \times U(1)$. The symmetry group is established as the consequence of the field equations; $SU(2)$ should be chiral, the color space has the signature $(+ + -)$. The structure of permissible multiplets of the group coincides with the one postulated in the $SU(3)_C \times SU(2)_L$-model of strong and electroweak interactions excluding the possible existence of the additional $SU(2)_R$-singlet in a generation. This paper (in Russian) was deposited in VINITY 19.12.1988 as VINITI No 8842-B88; it was an important stage in the development of my model of the composite fundamental fermions (see hep-th/0207210). Now I have translated it in English to do more available.

31. Khlopov Maxim. *Multi-messenger cosmological probes for new physics in the light of Ya.B.Zeldovich's Legacy*

The modern Standard cosmological scenario, reflecting to large extent the development of Zeldovich's legacy in cosmoparticle physics, involves inflation, baryosynthesis and dark matter/energy. Physics of all these elements of the cosmological paradigm lays Beyond the Standard model (BSM) of elementary particles and involves in its turn cosmological probes for its study. To specify this physics the idea of multi-messenger probes of new physics is proposed, involving the set of additional model dependent consequences of physical models for inflation, baryosynthesis and dark matter. After brief review of Cosmophenomenology of new physics, we concentrate on Primordial black holes (PBHs), first proposed by Zeldovich and Novikov, which are of special interest in this context. They are formed in the early Universe and reflect its possible strong nonhomogeneity. In homogeneous and isotropic Universe such nonhomgeneities can be generated by cosmological first order phase transitions, topological defects, created in the second order phase transitions at inflationary and post-inflationary stages, or early matter dominated stages. All these mechanisms are related to the fundamental structure of particle symmetry and mechanisms of its breaking at super high energy. They are beyond the standard model of elementary particles and provide tests for the physics, underlying the modern cosmology. Constraints on PBH spectrum provide probes for the corresponding phenomena. Positive evidence for

PBH existence leads beyond the standard paradigm of the cosmological scenario.

32. Khokhriakova Alena. *Detectability of isolated neutron stars by eROSITA*

A four-year survey using the eROSITA telescope onboard the Spektrum-RG observatory with focusing optics will provide the best survey of the sky in the soft (0.5-2 keV) and standard (2-10 keV) X-ray bands, both in terms of sensitivity and of angular resolution. We have conducted research on the possibility of detecting various types of isolated neutron stars using eROSITA. Among the already known objects, eROSITA will be able to register ~87 pulsars, 18 magnetars, 6 central compact objects, the Magnificent Seven and 2 other X-ray isolated neutron stars during the four-year mission. In addition, eROSITA is expected to be able to detect accreting isolated neutron stars, as well as discover new cooling neutron stars and magnetars.

33. Kirichenko Anastasia. *Antihelium flux from antimatter globular cluster*

Theoretical estimations for the secondary antihelium component of cosmic rays put the expected signal below the sensitivity of AMS02. Therefore the experimental discovery of cosmic antihelium in this experiment would inevitably prove the existence of primordial macroscopic regions of antibaryon matter in the baryon asymmetrical Universe. Evolution of antimatter domain can lead to formation of antimatter globular cluster. We use the analogy of matter and antimatter globular cluster to study antimatter globular cluster as the source of cosmic antihelium, taking into account possible mechanisms of generation of fluxes of antinuclei in antimatter stars and propagation of antihelum from this source in magnetic field of Galaxy.

34. Kirillov Alexander. *Relic magnetic wormholes as possible source of toroidal magnetic fields in galaxies*

Magnetic fields observed in galaxies have the toroidal component. We present the hypothesis that such fields maybe remnants of relic magnetic torus - shaped wormholes. Such magnetic wormholes produce the two important effects. The first effect is that in the primordial plasma before the recombination magnetic fields of wormholes trap baryons whose energy is smaller than a threshold energy. They collect baryons from the nearest (horizon size) region and form clumps of baryonic matter. Such clumps may serve as seeds for the formation of ring galaxies and smaller objects having the ring form. Upon the recombination torus-like clumps may decay and merge. The second effect is that upon the recombination epoch such wormholes cease to strongly interact with baryon clumps and may expand or collapse. However the large - scale toroidal magnetic field retains and may leave a trace in galaxies.

35. Kiryluk Joanna. *High energy neutrinos - latest results from IceCube*

High energy neutrinos of astrophysical origin are fundamental new probes of the Universe. Since the IceCube s discovery of PeV neutrinos originating outside of our galaxy, the first evidence was found for the TXS 0506+056 as a cosmic rays accelerator and a common source of high energy neutrinos and gamma rays, a breakthrough in multi-messenger astronomy. In this talk we will review IceCube results on neutrino astrophysics and fundamental physics, as well as plans for the future.

36. Klimovicova Kateřina. *Oscillations of non-slender tori in the Hartle-Thorne geometry*

We examine the influence of the quadrupole moment of slowly rotating neutron stars on the oscillations of non-slender accretion tori. We assume a perfect fluid, polytropic, constant specific angular momentum, non-selfgravitating torus and analytically calculate formulas for the oscillation frequencies. So far, these have only been studied in the Kerr geometry. We apply known methods for examining the properties of radial and vertical axisymmetric and non-axisymmetric (m = -1) epicyclic modes of oscillating accretion tori in the Hartle-Thorne geometry. Our results are valid within the accuracy of up to second order in the angular momentum of the neutron star and the first order in its quadrupole moment. These can be used to study the properties of relativistic compact objects through the low-mass X-ray binaries phenomenon commonly known as the twin-peak quasi-periodic oscillations.

37. Komarov Stanislav. *On the reconstruction of relative motion of components of a binary star in gravitational field of supermassive black hole from its redshift*

Motion of a compact binary star in the vicinity of a rotating supermassive black hole is considered. Calculation of the redshift of electromagnetic spectrum of a star in binary as function of the time of observation is performed. We present an approach to solution of inverse problem: reconstruction of relative motion of components of the binary from observational data of redshift. The approach is tested on the numerical model.

38. Larranaga Eduard. *A Toy Model to calculate the Gravitational Radiation produced by a Particle plunging into a Static Spherically Symmetric Black Hole in Massive Gravity*

In this work, we study the gravitational radiation waveform produced by a point particle that orbits or that plunges into a static and spherically symmetric black hole from a massive gravity theory. In order to simplify the treatment, we consider a toy model in which the particle is assumed to be linearly coupled to a massive scalar field.

39. Lattanzi Massimiliano. *Probing neutrino physics with cosmological observations*

Cosmological observations represent a powerful tool to constrain neutrino physics, complementary to laboratory experiments. In particular, observations of the cosmic microwave background (CMB) and of the distribution of large scale structures (LSS) have the potential to constrain the properties of relic neutrinos, as well as of additional light relic particles in the Universe. I will present current constraints on neutrino properties, including their mass and effective number, from the most recent cosmological data. I will also discuss prospects from future experiments, both from the ground and from space.

40. Lecian Orchidea Maria. *New studies within Morris-Thorne whormholes*

Speaker: O.M. Lecian Authors: A.A. Kirillov, E.P. Savelova, O.M. Lecian. Abstract: Morris-Thorne wormholes grvitational configurations have been studied as far as the scattering of gravitational waves is concerned; the comparison with the scattering of normal objects is considered. The scattered gravitational-wave signal is demonstrated to be in the same energy-spectrum band as the incident signal, for which process the tails which the tails hich are convoyed withtin the basic signal are cacluclated to have a universal form. The scattering process produced by normal objects exhibit retared features; whormholes are proved to manifest also advanced tails. In the case the total energy contained in the tails exceeds the energy of the ingoing wave by a higher-order factor (10^3), whormholes are determined ot produce a stronger result. For both studied phenomena, the retarding features of the tails a long-lasting features in the case the mean aplitudhas The scattering on normal matter objects forms tails which have always the retarding character, while wormholes lead to advanced tails as well. In both cases, the retarding tails have a long-time-lasting peculair behavior when the mean amplitude is shaped as particiular newly-studied functions of time. In the case of a single gravitational-wave event, the tail (which is featured as echo) is proved to contribute only within a small change wrt the mean amplitude. Detectable occurrences are predicted to be obsrved as far as the modifications induced by the events accumulated in the tails events; this is experienced in the noise created within the stochastic gravitational-wave background. Spectral analysis of the noise, and, in paritcular, of that in the trasport equation along geodesics is perfomed.

41. Lecian Orchidea Maria. *Specific aspects of the evolution of antimatter globular clusters domains*

Authors: M.Yu.Khlopov, O.M. Lecian Title: Specific aspects of the evolution of antimatter globular clusters domains Abstract: In the Affleck-Dine-Linde scenario

of baryosynthesis, there exists a possibility of creation of sufficiently large regions with antibaryon excess . Such regions can evolve in antimatter globular clusters. They appear only in the result of domain evolution and only at the stage of galaxy formation. Their number is demonstrated to increase as a function of time, being determined by the mechanism of antibaryon excess generation and on the properties of the inflaton filed and related ones; the number of clusters depends also on the Hubble parameter at the inflationary stage, as well as on the field initial conditions in the Einstein field Equations. Possible evolution of the domains of the antimatter globular clusters provides observational constraints on the mechanisms of inflation, baryosynthesis and evolution of antibaryon domains in baryon-asymmetrical Universe.

42. **Majumdar Partha Sarathi.** *Holographic Bound on Area of Compact-binary-merger-remnant*

Using concomitantly the Generalized Second Law of black hole thermodynamics and the holo- graphic Bekenstein entropy bound embellished by Loop Quantum Gravity corrections to quantum black hole entropy, we show that the boundary area of the remnant from a compact binary merger in recent direct observation of gravitational waves (as in GW150914) is bounded from be- low. This lower bound is more general than the bound obtained from the application of Hawking's classical area theorem for black holes, since it depends neither on whether the coalescing binary consists of black holes, nor on whether the merger-remnant is a black hole or a different compact star.

43. **Maltsev Kiril.** *On the foundations of black hole thermodynamics*

Among the seminal contributions of Y. Zel'dovich was his initiation of black hole thermodynamics as an emergent field of research. In his original 1970 paper, Zel'dovich advocates that horizons of Kerr black holes are sources of superradiant modes of quantum emission, whence validity of the Heisenberg uncertainty principle is imposed onto the horizon mechanics. Along with Bekenstein's conjectured association of horizon surface area with entropy in 1972, it is the impact of Hawking's visit to Moscow and exchange with Zel'dovich and his students in 1973, that guided Hawking to investigate the behavior of quantum fields in the vicinity of Schwarzschild black holes to derive a black body spectrum of Hawking-Zel'dovich radiation in 1974. In this talk, we will re-assess the problem of establishment of thermodynamic significance in the foundation of black hole thermodynamics. The question we aim to address is: under which conditions is it viable to endow the four laws of relativistic black hole mechanics, which have been found as theorems of differential geometry, with a bona fide thermodynamic meaning? This consideration will lead us to review the conceptual definitions of temperature and entropy in phenomenological thermodynamics vs. in statistical mechanics, and to clearly distinguish what follows for purely classical vs. for

semi-classical black holes. We will argue that, for Schwarzschild black holes, the notions of both the classical and statistical temperature are well-grounded; however that, grounding entropy turns out more complicated. Its strict phenomenological definition in the sense of Clausius requires a preliminary construction of a Carnot cycle involving a Black Hole. The quests for statistical mechanical Black Hole entropy motivate a variety of approaches to a quantum theory of gravity. We will end with their overarching discussion, while contrasting the Boltzmann, Gibbs-von Neumann and Shannon notions of statistical entropy.

44. **Manko Andrej.** *The two-photon production quark–antiquark pairs at LHC*

The results of the processes of two—photon production quark–anitquark pairs at hadron colliders are given in this report. These processes are researched at the leading and the next—to—leading order at the elastic case. The total and differential cross sections are obtained. These processes can be used to research the hadronization quakrs to hadrons and find the effect "new physics".

45. **Mayorov Andrey.** *Antiparticles in cosmic rays*

In this report, the current state of research in the field of studying the mechanisms of generation and propagation of anti-nuclei in the Galaxy is discussed. The experimental results obtained to date indicate that the models of the secondary origin of galactic antiprotons (production during the interaction of cosmic rays with interstellar gas) are most realistic, as a result, their registration allows one to study the processes of acceleration and propagation of cosmic rays in the Galaxy. However, the errors of measurements do not completely exclude the possibility for antiprotons to be born in an additional source at both low (less than ~100-200 MeV) and high (more than ~100 GeV) energies. Possible interpretations are usually associated with exotic sources, such as primordial black holes or hypothetical massive weakly interacting dark matter particles. The existence of the latter goes beyond the framework of the standard model of elementary particle physics, but one of the properties of WIMPs is of fundamental importance - their mutual annihilation with the formation of pairs of particles and antiparticles, for example, electrons / positrons or protons / antiprotons (or decay of dark matter particles with the formation of antileptons or antibaryons). This kind of the source can explain the so-called "anomalous PAMELA effect", which consists in a significant excess of the fraction of positrons in cosmic rays, rather than in the model of their secondary formation. Measurements of the positron fraction in the AMS-02 experiment have the highest statistical accuracy and expand the results obtained in the PAMELA experiment, allowing progress in the development of the theory of the formation of positrons and antiprotons in the Galaxy. Searching for heavier anti-nuclei (antideuterons and antihelium) in cosmic rays are also very interesting and discussed in the report together with measurements of the fluxes of other antiparticles.

46. Merloni Andrea. *Mapping the hot Universe: the first year of operations of eROSITA on SRG*

The emergence of the three-dimensional structure of the cosmic web over the history of the Universe displays very distinctive features when observed in X-rays, where both the most massive collapsed structure (clusters of galaxies) and the most energetic events in the life of galaxies (AGN and Quasars) reveal themselves unambiguously. The next generation of wide-area, sensitive X-ray surveys designed to map the hot and energetic Universe will be heralded by eROSITA (extended ROentgen Survey with an Imaging Telescope Array), the core instrument on the Russian-German Spektrum-Roentgen-Gamma (SRG) mission, successfully launched in July 2019. On December 13, after completion of its Calibration and Performance Verification phase, SRG/eROSITA has begun its four-years program dedicated to surveying the entire sky eight times in the energy range 0.2-8 keV. The high sensitivity, large field of view, high spatial resolution and high survey efficiency of eROSITA is bound to revolutionize X-ray astronomy: within just the first year of operation it has discovered more new celestial X-ray objects as have been catalogued from 1962 until today. I will present an overview of the instrument capabilities, the current status of the mission, the early science results and the outlook for the X-ray all-sky survey program.

47. Mikhailov Evgeny. *No-z approximation and RZ-model for studying magnetic fields in astrophysical objects*

No-z approximation and RZ-model for studying magnetic fields in astrophysical objects Evgeny Mikhailov, Vasily Pushkarev, Dmitry Sokoloff M.V.Lomonosov Moscow State University, Russia The evolution of the magnetic fields in different astrophysical objects is usually described by the dynamo mechanism which is based on joint action of the differential rotation and alpha-effect. The evolution of the large-scale field is described by the Steenbeck Krause Rudler equation, which is quite difficult to be solved both from analytical and numerical point of view. So there are different models for the field which take into account the shape of the objects and their typical physical properties. As for the galaxies, the magnetic fields are described using no-z approximation and the rz-model. This experience can also be taken for the accretion discs, which have the same shape. No-z approximation is used for thin discs, where the field nearly lies in the equatorial plane. So we can solve the equations only for two main components of the field, and the z-dependence is described by the cosine law. Some of the partial derivatives can be changed by simple ratios, and the equations are quite simple to be analyzed. The rz-model can be taken for thick discs. It considers the field as a combination of two parts. The poloidal field is described by its vector potential. The equations include the same parameters as the previous approximation, but they should be solved taking into account arbitrary z-dependence of the field components. The thickness of the disc can change the critical values of the dynamo number and

the field structure. The results for the magnetic field for different parameters of the disc using these two approaches are shown. We discuss the opportunities to model the magnetic field of accretion discs and another objects, and the advantages of these approximations for specific cases. This research was supported by RFBR (project 18-02-00085 A). References 1. Moss, D. 1995, MNRAS, 275, 191. 2. Mikhailov, E. 2018, Astrophysics, 61, 147.

48. Mirabel Felix. *Black holes in the universe*

In the last decades, have been found solid observational evidences on the existence of black holes in the universe, from stellar masses up to masses equivalent to millions, even billion solar masses. These astrophysical black holes are sources of phenomena of very high energies, and constitute unique laboratories to confront with observations theories at the frontier of physics. Besides being objects of interest for physics, there are increasing evidences that black holes play an important role in cosmic evolution, and in the formation and evolution of galaxies, since the "Dark Ages" until present.

49. Mirzoyan Razmik. *On the Recent Detections of GRBs at TeraelectronVolt Energies*

A quarter of century ago the MAGIC telescope project defined it's goal to extend the observational energy range of very high energy gamma rays by using the ground-based imaging air Cherenkov technique from few hundred down to few tens of GeV. Closing the order of magnitude energy gap between the satellite and ground-based observational techniques and providing real-time high-detection rates of gamma-rays from diverse celestial sources as, for example, from pulsars, from distant AGN and GRBs, was of key importance. Also, the telescopes were designed to receive satellite alerts and automatically re-position within 20-25 seconds and observe any chosen type of source at any position in the sky. Most of these design features were implemented in the hope to measure TeV gamma-rays from elusive GRBs, hopefully still in the prompt emission phase. With time we learnt to further enhance the sensitivity of the telescopes and measure sources as in the few tens of GeV as well as at a few hundred TeVs. Finally, after 15 years of operation we succeeded measuring the first GRB at energy ≥ 200 GeV. Further measurements and indications followed, which helped us to address unexpected and exciting results about the GRBs and the space-time at TeV energies.

50. Mukhanov Viacheslav. *The final state of nonsigular evaporating black hole*

The final state of nonsigular evaporating black hole will be discussed.

51. Mukherjee Suvodip. *Discovering Axion-like particles using Cosmic Microwave Background*

Cosmic Microwave Background (CMB) is a powerful probe to the Universe which carries signatures of cosmic secrets from a vast range of redshifts. Along with spatial fluctuations in CMB, spectral distortions of CMB blackbody are also a rich source of cosmological information. In my talk, I will introduce a new probe to Axion-Like Particles (ALPs) which will be accessible from the upcoming CMB missions. ALPs can produce a new kind of spectral distortion in CMB due to the resonant and non-resonant conversion of CMB photons into ALPs in the presence of an external magnetic field. This effect leads to both polarized and unpolarized spatially varying spectral distortion signal with a unique spectral shape and spatial structure. The discovery space from future CMB experiments are complementary to other cosmological probes and will explore new parameter spaces which are outside the reach of current particle physics experiments.

52. Obukhov Ilya. *Possible Scenario of Electrons-Positrons Symmetry Destroy*

A model, in which a mechanism of spinor particles-antiparticles symmetry destroy exist, is presented in this report. A scenario when small thermodynamic fluctuations in the early stage of the Universe evolution can lead to almost complete absence of antiparticles at present time is considered.

53. Ohrymenko Ivan. *Gravitational wave detector with moving reflectors*

Operating gravitational wave detectors represent modernized Michelson interferometer – LIGO-detector. Reduction of vibrations in the system and high stabilization of the reflective mirrors is one of the technical problem of the LIGO. It is proposed to study the features of the LIGO-detector with movable mirrors. The software simulating the operation of the LIGO with movable mirrors and providing an opportunity to study its characteristics and capacity is developed and named «LIGO-RM». The primary goal of the modelling is to study the signal of the gravitational waves detector with oscillating mirrors. The «LIGO-RM» contains graphic user interface (GUI) that provides interactive control of the mirrors movement nature and monitoring of the detector signal change. The software simulates the presence of gravitational wave of a requested type and makes it able to monitor its effect on the operation results of the LIGO interferometer in interactive mode or as a numerical outcome. A range of numerical experiments is conducted and the signals on the detector with and without mirrors oscillations are shown. LIGO-RM supports animation allowing you to visualize the principles of the LIGO detector with movable mirrors. The results of calculations and a possibility of the registration of the gravitational waves using the LIGO-detector with movable mirrors are discussed. A space gravitational wave detector based on a system of 8 geostationary satellites is proposed. The results of the calculations of the geostationary orbits parameters and of the space detector parameters for 8 planets of the Solar System are discussed.

54. Panko Elena. *Substructures in the galaxy clusters in rich regions*

We present the results of the detail study of the inner 2D structure of the galaxy clusters. Our observation data set contains 2 subsets: 460 rich galaxy clusters and 103 galaxy clusters belonging to superclusters. We found significant number of clusters with regular substructures such as X-, Y-type forms (cross and semi-cross), as well as curved bands and short dense chains. The alignment of galaxies in the substructures corresponds both alignment in the filaments and alignment in the sheets.

55. Pashentseva Maria. *Applying no-z approximation for modeling dynamo action in accretion discs*

Maria Pashensteva, Evgeny Mikhailov, Dmitry Sokoloff Moscow State University, Russia Magnetic fields can play an important role in evolution of accretion discs, surrounding such objects as black holes, neutron stars, white dwarfs and other celestial bodies [1]. They can be connected with motions of conducting medium in the discs. As for different astrophysical objects (stars, galaxies etc.) the magnetic fields are usually described with dynamo theory, which is based on differential rotation, that jointly enlarge the regular component of the field. We can suppose that such processes can act in the accretion discs too. To model these magnetic fields, we can take direct numerical simulation for the equations of magnetohydrodynamics. However, it is necessary to have large computational resources. As for the field which has been obtained in such calculations [2], it has the structure, which is very similar with one in the galaxy discs. So, we can take the models, which have been developed for the galaxies. One of the most useful approaches is connected with no-z approximation for the magnetic field in thin disc [3]. We have studied the magnetic field of the accretion discs, using no-z approximation and taking into account different length scales. We also described the radial flows, which can be important while studying the processes in such objects. The typical dependencies of the field on time and spatial coordinates are presented. It is necessary to emphasize that for accretion discs the boundary conditions and the type of nonlinearity in the dynamo equations strongly change the structure of magnetic field. This research was supported by RFBR (project 18-02-00085 A). References: 1. Shakura, N.I., Sunyaev, R.A. 1973, AA, 24, 337 2. Stone, J.M., Norman, M.L. 1994, ApJ, 433, 746. 3. Moss, D., Sokoloff, D., Suleimanov, V. 2016, AA, 588, A18.

56. Pookkillath Masroor C. *Minimally Modified Gravity fitting Planck data better than ΛCDM*

We study the phenomenology of a class of minimally modified gravity theories called $f(\mathcal{H})$ theories, in which the usual general relativistic Hamiltonian constraint is replaced by a free function of it. After reviewing the construction of

the theory and a consistent matter coupling, we analyze the dynamics of cosmology at the levels of both background and perturbations, and present a concrete example of the theory with a 3-parameter family of the function f. Finally, we compare this example model to Planck data as well as some later-time probes, showing that such a realization of $f(\mathcal{H})$ theories fits the data significantly better than the standard ΛCDM model, in particular by modifying gravity at intermediate redshifts, $z \simeq 743$.

57. Prakapenia Mikalai. *Three-particle interactions in relativistic plasma*

Triple interactions, namely relativistic bremsstrahlung, double Compton scattering, radiative pair production, triple pair production/annihilation and their inverse processes, are usually considered as emission processes in astrophysical problems, as well as in laboratory plasmas. Their role in plasma kinetics is fundamental. We present a couple of results of numerical computations in the framework of our conservative scheme for computation of Uehling-Uhlenbeck collision integral for all triple interactions in relativistic plasma based on direct integration of exact QED matrix elements. The computational scheme is relevant for quantitative description of relativistic plasmas out of equilibrium. Reaction rates for thermal distributions are compared, where possible, with the corresponding analytic expressions, showing good agreement.

58. Pruzhinskaya Maria. *New method to account for Type Ia Supernova environment in cosmological analysis*

Among the other types of supernovae, Type Ia Supernovae (SNe Ia) have less luminosity dispersion at maximum light and show higher optical luminosities. These properties allow to use SNe Ia as cosmological distance indicators that led to the discovery of the accelerating expansion of the Universe. However, even after the so-called "standardization" procedure (luminosity correction for stretch and colour parameters) there is a remaining dispersion on the Hubble diagram of about 0.11 mag. This dispersion can be due to environmental effects (age, chemical composition, dust around a SN) which are not yet fully taken into account in the modern cosmological analyses. In this work we study the impact of SN host-galaxy morphology on the distance measurements and cosmology. The analysis is based on two most recent cosmological samples of supernovae: JLA (Joint Light-curve Analysis) and Pantheon. We confirm that the stretch-parameter depends on the host morphology, but there is no any correlation for the colour. We also show that the improvement of the Hubble diagram fit can be carried on by including additional nuisance parameter accounting for host morphology. In the epoch of large transient surveys (such as LSST), development of observational techniques and further processing of the data, a study of environment and other possible sources of systematical uncertainties in the cosmological analysis is of high priority.

59. Rubio Marcelo. *The heat equation in General Relativity*

We comment on the difficulties that appear when trying to understand the propagation of heat in a relativistic fluid theory. After giving a general picture about this problem, we focus on a particular heat conduction law coming from Relativistic Kinetic Theory. Although this formalism turns out to be the most appropriate to understand heat propagation at the microscopic level, we show that it constitutes an ill-posed initial-value formulation. Finally, we compare these results with a previous proposal for heat propagation provided by Eckart.

60. Rueda Jorge. *An update of the binary-driven hypernova scenario*

I report on the most recent achievements, improvements, and developments of the binary-driven hypernova (BdHN) model of long gamma-ray bursts (GRBs) from the point of view of physical ingredients and their numerical simulation: from the supernova explosion, to the hypercritical accretion onto the neutron star companion of the exploding star, to the black hole formation from gravitational collapse of the neutron star, to the associated (high-energy) radiation mechanisms of each phase including the neutrino emission.

61. Sazhina Olga. *Optical analysis of a CMB cosmic string candidate*

The complexity of the cosmological scenario regarding cosmic strings stands still in the way of a complete understanding. I describe a promising strategy for the possible detection of these elusive physical entities. It is based on the search of strong gravitational lensing events in the location area of the CS candidate (CSc-1), which was declared in my previous work by CMB analysis. Using photometric and geometric criteria, I identified pairs of candidates of lensed galaxies (LGCs) in the ''string field'', which were then compared with the average density of background galaxy pairs in a set of ''control fields''. It was found an excess of 22 per cent (per sq. deg) of the LGCs in ''string field'', which exceeds the estimated cosmic dispersion. However, the confirmation of the gravitational lensing origin of our LGCs requires spectroscopic observations that seem to be justified by the present results. We plan to acquire their spectra and to continue the study of the spectral and morphological features of the LGCs in the CSc-1 field and to analyse the other CS candidates using the same strategy (MNRAS 485, 1876–1885 2019).

62. Sery Alexey. *Baryshevsky-Luboshitz Effect in Spin-Polarized Electron Gas at High Temperatures in Quantizing Magnetic Field*

In the framework of quantum electrodynamics in the first order perturbation theory on electromagnetic coupling constant a formula describing Baryshevsky-Luboshitz effect is obtained for the calculation of the rotation angle of the plane of linear polarization of photons per unit path in an electron gas at high temperatures in quantizing magnetic field. The finite width of resonance on intermediate

virtual Landau level is taken into account, the contribution of anomalous magnetic moment of electron is neglected.

63. Shaplov Alexey. *Stability of a static spherically symmetric wormhole in the framework of 5-dimensional Projective Unified Field Theory (PUFT)*

We have obtained static spherically symmetric solution within the framework of PUFT which corresponds to wormholes at a certain ratio of parameters. We investigate the obtained solution for stability. It was found that there is an exponentially in time growing mode for all parameter values, which leads to the instability of the wormhole.

64. Sharif Muhammad. *Compact Strange Objects in Modified Gravity*

This talk investigates the characteristics of a spherically symmetric relativistic star in the framework of the massive Brans-Dicke theory. The field equations are derived for specific forms of coupling and potential functions by employing the MIT bag model. The unknown metric tensors are evaluated through a well-behaved function along with Karmarkar condition for class-one embedding. The value of the bag constant is computed with the help of junction conditions for the strange star candidate Her X-1. We examine trends of energy density and anisotropic pressure of the constructed model for specific values of the coupling parameter and corresponding predicted values of the bag constant. Finally, we discuss the physical viability and stability of the model through various tests. It is concluded that the obtained celestial structure is in agreement with the energy constraints as well as stability criteria in the presence of a massive scalar field.

65. Joseph Silk. *The Future of Cosmology*

66. Snellen Ignas. *Exoplanets and the search for extraterretrial life*

Placing the solar system in the context of other planetary systems is one of the central objectives driving the study of extrasolar planets. One of the most fascinating questions in modern science is whether other life-bearing planets exist. In this talk I will review the current state of the art of exoplanet research and discuss future ways to probe biomarker gases in Earth-like exoplanets that could point to biological activity.

67. Sokoloff Dmitry. *Dynamo in accretion discs*

Accretion discs seems to be quite similar to the discs of spiral galaxies. Large-scale magnetic fields of spiral galaxies are well-investigated observationaly. Origin of such magnetic field is connected with dynamo action based on joint action

of differential rotation and mirror-asymmetric interstellar turbulence. Modification of galactic dynamo theory in context of accretion discs looks as a rather straightforward undertaking. Nevertheless, this modification faces some problems discussed in the talk.

68. Soloviev Vladimir. *The canonical structure of bigravity*

This work is motivated by an intention to make the theory of bigravity more comprehensible. Bigravity is a modification of the General Relativity (GR), maybe even the most natural one. Lagrangian of this theory is a sum of two GR Lagrangians formed of two spacetime metrics and a potential of their interaction discovered by de Rham, Gabadadze, and Tolley. The canonical structure of bigravity simplifies when the action is expressed through tetrads, not metrics. Then both two sets of lapse-and-shift variables appear linearly in the Hamiltonian and can be treated as Lagrange multipliers standing at primary constraints. As the theory is explicitly invariant only under diagonal diffeomorphisms of the spacetime manifold and under diagonal rotations of the spatial triads, the number of arbitrary Lagrange multipliers is 7 (1+3+3) and the same is number of the first class constraints. The rest of Lagrange multipliers generate 10 second class constraints. The examination of compatibility of the primary second class constraints with the dynamical equations gives us 10 new equations, 6 of them are the so-called tetrad symmetry conditions, and the other 4 are analogous to the second class constraints of the metric approach. One of these 4 constraints accompanied by one primary constraint serves to remove the ghost degree of freedom, the other 3 in cooperation with their already fixed Lagrange multipliers serve to supplement the two Hamiltonian-like constraints. This reorganization of constraints reproduces the results of celebrated Hassan-Rosen transform. From the geometrical viewpoint it is interesting to notice the appearance of three bilinear combinations of triads corresponding to the pair of spatial metrics in the dRGT potential. One of these combinations is symmetric and therefore can be treated as a new (hybrid) spatial metric. Its role in the coupling to matter fields requires a detailed investigation. It is interesting to mention the correspondence of this combination to the spatial components of the geometric mean of the two spacetime metrics introduced by Kocic.

69. Starobinsky Alexei. *Evolution of the mixed R2-Higgs inflationary model*

The $R + R^2$ (Starobinsky), where R is the Ricci scalar, and the Higgs inflationary models represent the simplest phenomenological inflationary models which are internally consistent, have only one free dimensionless parameter to be taken from observations, produce a smooth exit from inflation to the subsequent hot radiation-dominated stage through an intermediate matter-dominated one, and which formally identical predictions for primordial scalar (matter) and tensor perturbations are in the excellent agreement with all present observational data.

Consideration of the mixed R^2-Higgs inflationary model driven both by the modified $R + R^2$ gravity and a strongly non-minimally coupled scalar (possibly, the Higgs) field helps to shift problems with strong coupling at high energies up to the Planck energy scale. It is shown that the inflationary behavior of this two-field model is effectively one-field-like. Generic pre-inflationary behavior and heating and creation of matter after the end of inflation in this model are discussed, too. For some narrow range of the model parameters, fast heating after the end of inflation is possible due to the appearance of the tachyonic instability, while outside this range, a large number of field oscillations during an intermediate matter-dominated stage is needed for complete transition to the hot radiation-dominated stage, similar to the case of the pure $R + R^2$ model.

70. Stefanov Vladislav. *Gravitational Dephasing for Timed Dicke State*

In the presentation we talk about an effect of dephasing induced by weak gravitational field on the collective radiation dynamics of atomic system in timed single-photon Dicke states. We show that a photon absorbed by the stationary system of randomly placed stationary atoms is no more spontaneously emitted in the direction of the impinging photon. The influence of gravity leads to broadening of the angular distribution of emission.

71. Vereshchagin Gregory. *On Bose-condensation of photons in relativistic plasma*

The phenomenon of Bose-Einstein condensation is traditionally associated with low temperatures. In 1969 Zeldovich and Levich in a seminal paper proposed that photons interacting with a plasma at high temperatures may undergo such a condensation. While their idea is well grounded, their proposal to obtain such a condensation with hot photons and cold electrons is not suitable. The necessary conditions for the onset of condensation in relativistic plasma will be discussed, along with possible observational consequences.

72. Yuan Ye-Fei. *Probes of strong gravity: SgrA* and M87**

General relativity (GR) has passed every test in our solar system, to date. But there is still a lack of strict tests of GR in the strong gravitational field near the event horizon of black holes. Owing to their proximity, the event horizon of SgrA* and M87* (two massive black holes residing in the center of our Galaxy and the giant elliptical galaxy M87, respectively) have the largest angular sizes in the sky, they are the natural laboratories for studying physics of strong gravitational fields. At 21:00 on April 10, 2019 (SGT), the first Event Horizon Telescope (EHT) image of M87* was released, which clearly shows the black hole shadow for the first time, and directly demonstrates the existence of black hole in our Universe. In addition, in May 2018, VLTI-Gravity of the European Southern Observatory detected the

orbital motions of hot spots near the last stable circular orbit of the SgrA*. In this talk, after a very brief introduction to the physics of strong gravitational fields, I will convince you how to use the gas dynamics and radiation around the horizon of SgrA* and M87* to test general relativity in the strong field regime.

73. Yunis Rafael Ignacio. *Self Interactions in WDM: A View From Cosmological Perturbation Theory (CPT)*

In this talk, we aim to provide a general view into Self Interacting WDM (SI-WDM) models from the context of Cosmological Perturbation Theory (CPT), by deriving the theoretical background that underlies this approach, providing solutions to the exact collision terms in the Boltzmann Hierarchies and providing numerical results in the Relaxation Time Approximation (RTA). We consider here elastic self interactions between massive DM particles that decouple from the hot plasma while relativistic, and provide both the exact collision terms for DM-DM interactions as well as approximate Boltzmann Hierarchies in the RTA for general massive-field mediator models. We aim to provide a general framework, from both the theoretical as well as numerical side on the effects of SI-WDM on linear structure formation and its effect on the linear power spectrum, with its consequent imprints on non-linear structure formation. We pay special attention to the mechanisms of decoupling of self interactions, and analyze scenarios where the particle undergoes self decoupling while relativistic as well as when non relativistic.

74. Zaslavskii Oleg. *Super-Penrose process: classification of scenarios*

If two particles collide near a rotating black hole, their energy in the centre of mass frame $E_{c.m.}$ can become unbounded under certain conditions. In doing so, the Killing energy E of debris at infinity is, in general, remain restricted. If E is also unbounded, this is called the super-Penrose process. We elucidate when such a process is possible and give full classification of corresponding relativistic objects for rotating space-times. In particular, we show that it is possible for rotating wormholes. We also discuss briefly the case of a pure electric super-Penrose process that is valid even in the flat space-time. The key role in consideration is played by the Wald inequalities.

75. Zhang Huang-Nan. *The Insight-HXMT mission, China's first X-ray astronomy mission*

76. Zloshchastiev Konstantin. *Dark matter, dark energy and multi-scale gravity as manifestations of superfluid vacuum*

Quantum liquids described by wave equations with logarithmic nonlinearity, usually referred as "logarithmic fluids", are very instrumental in describing generic

condensate-like matter [1], including strongly-interacting quantum liquids, one example being a superfluid component of He-4 [2,3]. Applications of the logarithmic fluids can also be found in a theory of physical vacuum, which is a popular framework for explaining a phenomenon of gravity. Using the logarithmic superfluid model, one can formulate quantum post-relativistic theory of superfluid vacuum, which contains special and general relativity in the "phononic" (low-momenta) limit, but differs at higher momenta [4-9]. Here we derive an effective gravitational potential induced by the quantum wavefunction of physical vacuum in a stationary state, while the vacuum itself is viewed as the superfluid described by the logarithmic quantum wave equation. We determine that gravity has a multiple-scale pattern, to the extent that one can distinguish sub-Newtonian, Newtonian, galactic, metagalactic and cosmological terms. The last of these dominates at the largest length scale of the model, where superfluid vacuum induces an asymptotically Friedmann–Lemâitre–Robertson–Walker-type spacetime, which provides an explanation for the accelerating expansion of the Universe. Under certain conditions, the model predicts an occurrence of two expansion mechanisms, which could explain the discrepancy between measurements of the Hubble constant using different methods. On a galactic scale, our model explains the non-Keplerian behaviour of galactic rotation curves, as well as why their profiles can vary depending on the galaxy. It also makes a number of predictions about the behaviour of gravity at larger galactic and extragalactic scales, which are expected to be seen in the outer regions of large spiral galaxies [10].

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About Yakov Borisovich Zeldovich

Yakov Borisovich Zeldovich was born on 8 of March 1914 in Minsk. He spent his childhood there, and at the age of 10 he moved to Leningrad where he received school education. He got his Ph.D. degree in chemistry at the age of 22 without formally receiving higher education. He was awarded D.Sc. degree at the age of 25.

Starting from 1943, Zeldovich played a crucial role in the development of the Soviet Union's nuclear and thermonuclear bombs. He was elected corresponding member of the Academy of Sciences in 1946 and full member in 1958.

Starting from 1963 he turned to particle physics, cosmology and astrophysics, with pioneering contributions to these fields. He is known as a founder of the Russian school of Relativistic Astrophysics.

He made fundamental contributions in theories of ignition, combustion and detonation, nitrogen oxidation, kinetics of nuclear reactions, microwave background radiation, the large-scale structure of the Universe, accretion, particle creation near black holes and many others.

About Zeldovich Meetings

In 2008 ICRANet initiated a series of international meetings in Minsk, Belarus, celebrating Yakov Borisovich Zeldovich, the famous Soviet chemical physicist, physicist and astrophysicist.

Exceptionally wide research interests of Ya. B. Zeldovich ranging from chemical physics, elementary particle and nuclear physics to astrophysics and cosmology provide the topics covered at these conferences:

- Early Universe, large scale structure, cosmic microwave background;

- Neutron stars, black holes, gamma-ray bursts, supernovae, hypernovae;

- Ultra-high energy particles;

- Gravitational waves;

- Astrobiology.

Three international meetings in honor of Ya. B. Zeldovich have been organized in Belarus in 2009, 2014 and 2018 by ICRANet and co-sponsored by ICRANet, the National Academy of Sciences of Belarus, Belarusian State University and the Central European Initiative.

Many participants at these conferences were close collaborators of Ya. B. Zeldovich, among them: Vladimir Belinski, Gennady Bisnovatyi-Kogan, Valery Chechetkin, Arthur Chernin, Andrey Doroshkevich, Jaan Einasto, Maxim Khlopov, Vladimir Kurt, Vladimir Popov, Mikhail Sazhin, Nikolai Shakura, Alexei Starobinsky.

Figure 1: Picture taken in front of Zeldovich monument in front of the National Academy of Sciences in Minsk, 2014. From left to right: Andrey Doroshkevich, Marek Demianski, Remo Ruffini, Alexey Starobinski, Lev Titarchuk, Gennady Bisnavatyi-Kogan, Vladimir Belinski.

The First Zeldovich meeting, 2009

Within the celebration of the International Year of Astronomy in 2009, ICRANet and Belarusian State University organized the international conference, the First "Zeldovich meeting" in Minsk on April 20-23, 2009. The conference has created a stimulating environment for scientific exchange and contacts between scientists in the West, those coming from the great Russian school of Zeldovich, and local scientist from Belarus. Such internationally renowned scientists as Roy Kerr, Hagen Kleinert, Nikolay Shakura attended the conference and presented recent results of their work. In addition, public lectures were given by Remo Ruffini, Gregory Vereshchagin and Vladimir Kurt, as well as a round table with participation of Zeldovich collaborators such as Vladimir Belinski, Valeri Chechetkin, Jaan Einasto, Vladimir Kurt, Vladimir Popov, and Nikolai Shakura, was organized. The proceeding of the meeting were published by the American Institute of Physics, in volume 1205 of AIP conference proceedings, and are available for free.

The Second Zeldovich meeting, 2014

In 2014, the 100th anniversary of Zeldovich was celebrated with many international conferences organized worldwide. The first international meeting in this series was the Second Zeldovich meeting in Minsk. Again, many of the speakers at the conference were the closest former collaborators of Zeldovich. Many young researchers took part in the meeting. In particular, the students from International Relativistic Astrophysics PhD program, including both CAPES-ICRANet and Erasmus Mundus program, participated in the conference and presented results of their scientific work. The conference was jointly organized by ICRANet and the National Academy of Sciences of Belarus. The opening address was given by Nobel Laureate prof.

Zhores Ivanovich Alferov and by Prof. Remo Ruffini. There were more than 80 participants, nationals of Argentina, Armenia, Belarus, Brazil, China, Germany, India, Italy, Kazakhstan, Poland, Russia, and other countries. The conference covered many topics including cosmology, relativistic astrophysics, general relativity, elementary particle and nuclear physics, detonations and explosions.

Starting from this meeting the proceedings of the Zeldovich meeting are published by the leading Russian journal on astronomy and astrophysics, Astronomy Reports. In addition, many contributions at this meeting were published in a special open access issue of Nonlinear Phenomena in Complex Systems journal.

The Third Zeldovich meeting, 2018

The Third Zeldovich meeting was held in April 23-27, 2018 in Minsk, Belarus. The conference was jointly organized by ICRANet and the National Academy of Sciences of Belarus. The meeting was sponsored by these two organizations and by the Central European Initiative (CEI).

About 80 participants, researchers from Argentina, Armenia, Belarus, Bosnia and Herzegovina, China, Colombia, Germany, Hungary, Italy, Kazakhstan, Poland, Russia, Slovenia, Taiwan, Ukraine and other countries took part in the meeting.

The conference covered many topics including cosmology, relativistic astrophysics, general relativity, elementary particle and nuclear physics, detonations and explosions.

For the first time international collaborations present their recent scientific results at the 3rd Zeldovich meeting in Minsk, Belarus, among them: MASTER-Net

project, Pierre Auger collaboration, RadioAstron space mission, H.E.S.S. collaboration and Gamma-400 project.

The Forth Zeldovich virtual meeting, 2020

The Fourth Zeldovich meeting was initially planned for April 20-24, 2020 in Minsk, Belarus. The COVID-19 pandemic lead to lockdown in Europe and many other countries, making impossible the standard format of the meeting.

The meeting will be held in online format. New scientific results from X-ray missions such as SRG and HSTC, as well as black hole observations from GRAVITY collaboration, new results from IceCube, MAGIC and other instruments and observatories will be presented, along with advances in theoretical understanding of astrophysical systems such as black holes, neutron stars, clusters of galaxies and dark matter.

About ICRANet

In 1985, the International Center for Relativistic Astrophysics (ICRA) was founded by Remo Ruffini together with Riccardo Giacconi (Nobel Prize for Physics 2002), Abdus Salam (Nobel Prize for Physics 1979), Paul Boynton (University of Washington), George Coyne (then director of the Vatican observatory), Francis Everitt (Stanford University) and Fang Li-Zhi (University of Science and Technology of China).

In 2003 the International Center for Relativistic Astrophysics Network (ICRANet) was created as an international organization, which promotes research activities in relativistic astrophysics and related areas. Its members are four countries and three Universities and Research Centers: Republic of Armenia, the Federative Republic of Brazil, Italian Republic, the Vatican City State, the University of Arizona (USA), Stanford University (USA) and ICRA.

ICRANet organizes international meetings such as Marcel Grossmann meetings, Galileo-Xu Guangqi meetings, Italo-Korean Symposia on Relativistic Astrophysics, Zeldovich meetings and other conferences.

Since 2005 ICRANet co-organizes an International Relativistic Astrophysics Ph.D. Program, IRAP-PhD, the first joint PhD astrophysics program awarded the Erasmus Mundus label and funded by the European Commission in 2010-2017.

About National Academy of Sciences of Belarus

Founded in October 1928 as the Belarusian Academy of Sciences and solemnly opened on January 1, 1929, it unites full members (academicians), corresponding members of the Academy of Sciences, other members of the General Assembly of the Academy of Sciences, honorary and foreign members of the Academy of Sciences, as well as departments of the Academy of Sciences, the apparatus of the Academy of Sciences, scientific organizations, including the scientific and practical centers of the Academy of Sciences, and other legal entities subordinated to the Academy of Sciences. The Academy of Sciences employs about 16.0 thousand people, whose average age is less than 47 years. Among them are about 5,507 researchers, 387 Doctors of Science and 1,611 candidates of science, including 207 professors and 518 associate professors.

The National Academy of Sciences of Belarus organizes and coordinates basic and applied scientific research carried out by all subjects of scientific activity, conducts basic and applied sciencific research and development in the most important areas of natural, technical, humanitarian, social sciences and arts in order to obtain new knowledge about man, society, nature and artificially created objects to increase the scientific, technical, intellectual and spiritual potential of the Republic of Belarus.

The National Academy of Sciences of Belarus is the highest state scientific organization of the Republic of Belarus. Subordinate to the President of the Republic of Belarus, accountable to the Council of Ministers of the Republic of Belarus.

Invited speakers at the 4th Zeldovich meeting

Marika Asgari, Royal Observatory Edinburgh, UK
Abhay Ashtekar, Institute for Gravitation & the Cosmos, Penn State University, USA
Artem Burdanov, Massachusetts Institute of Technology, USA
Rong-Gen Cai, Institute of Theoretical Physics, Chinese Academy of Sciences, China
Daniela Calzetti, University of Massachusetts, Amherst, USA
Jens Chluba, Jodrell Bank Centre for Astrophysics, University of Manchester, UK
Alexander Dolgov, Novosibirsk State University and ITEP, Russia
Jaan Einasto, Tartu Observatory, Estonia
Katherine Freese, University of Texas, Austin, USA
Chris Fryer, Los Alamos National Laboratory, USA
Stefan Gillessen, Max Planck Institute for Extraterrestrial Physics, Germany
Luca Izzo, DARK - Niels Bohr Institute, Denmark
Joanna Kiryluk, Stony Brook University, USA
Claus Lämmerzahl, ZARM, Germany
Vladimir Lipunov, Moscow State University, Russia
Andrea Merloni, Max Planck Institute for extraterrestrial Physics, Germany
Felix Mirabel, CEA Saclay, France
Razmik Mirzoyan, Max Planck Institute for Physics, Germany
Slava Mukhanov, Ludwig-Maximilians-Universität München, Germany
Piero Rosati, University of Ferrara, Italy
Jorge Rueda, ICRANet, Italy
Remo Ruffini, ICRANet, Italy
Nikolay Shakura, Sternberg Astronomical Institute of the Moscow State University, Russia
Joseph Silk, University of Oxford, UK
Ignas Snellen, University of Leiden, Netherlands
Rashid Sunyaev, Space Research Institute, Moscow, Russia
Dmitry Sokoloff, Moscow State University, Russia

Alexey Starobinsky, Landau institute for theoretical physics, RAS, Russia
Amaury Triaud, University of Birmingham, UK
Ye-Fei Yuan, University of Science and Technology, Hefei, China
Shuang-Nan Zhang, Institute of High Energy Physics, CAS, China

Participants of the 4th Zeldovich meeting

Afroz, Anum, Quaid-i-Azam University, Islamabad, Pakistan
Alexeyev, Stanislav, Sternberg Astronomical Institute of Lomonosov Moscow State University
Aljaf, Muhsin, University of Science and Technology of China
Amati, Lorenzo, INAF - OAS Bologna
Arbuzova, Elena, Dubna State University, Novosibirsk State University
Arguelles, Carlos, UNLP - CONICET
Arkhangelskaja, Irene, MEPhI, Moscow, Russia
Asgari, Marika, University of Edinburgh
Ashtekar, Abhay, Institute for Gravitation & the Cosmos, Penn State University, USA
Avakyan, Arthur, Lomonosov Moscow State University, Sternberg Astronomical Institute
Bahamonde, Sebastian, University of Tartu
Balakina, Elena, Faculty of Physics of Lomonosov Moscow State University
Bambi, Cosimo, Fudan University
Beckwith, Andrew, Chongqing University Department of physics
Bedic, Suzana, ICRANet- Pescara, Sapienza University of Rome
BELKHADRIA, Zakaria, University of Tours
Berezhiani, Zurab, University of L'Aquila
Beylin, Vitaly, Research Institute of Physics, Southern Federal University
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