Enclosure 7

International Meetings

The Third Zeldovich Meeting

An international conference in honor of Ya. B. Zeldovich in Minsk

National Academy of Sciences of Belarus

23-27 April 2018

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National Academy of Sciences of Belarus
Central European Initiative
ICRANet

The Third Zeldovich Meeting
SNAUPS-18

April 23-27, 2018, Minsk, Belarus

PROGRAM & ABSTRACTS

Минск
Институт физики НАН Беларуси
2018

Location

- Hall A – Conference hall of the Presidium of National Academy of Sciences of Belarus (Address: 66 Praspekt Nezalezhnastsi).
- Hall B – Great conference hall of the B. I. Stepanov Institute of Physics of National Academy of Sciences of Belarus (Address: 68-2 Praspekt Nezalezhnastsi).

Monday, 23 April

09:30 -11:00
Registration in front of the conference Hall A

Opening Ceremony (HALL A)

11:00—13:15 Chair*:* Sergei Kilin

11:00 Opening ceremony:
Vladimir Gusakov - Chairman of Presidium, National Academy of Sciences of Belarus
Remo Ruffini - Director of ICRANet
Ambassadors of Armenia, Brazil, Italy, Vatican

11:15-11:45
Vladimir Fortov. Warm Dense Matter, Generated by the Intense Shock and Rarefaction Waves

11:45-12:15
Remo Ruffini. Gamma-Ray Bursts

12:15-12:45
Arkady Galper. Gamma-400 project

12:45-13:15
Alexei Pozanenko. Observations of GRB 1170817A associated with LIGO/Virgo GW170817 in gamma-rays, optic and radio, and the model of prompt gamma-ray emission

13:15—15:00 Lunch

Gamma-Ray Bursts (HALL B)

15:00—18:20 Chair*:* Vedad Pasic

15:00-15:20
Daria Primorac. Structure of prompt emission in GRB 151027A within the fireshell model

15:20-15:40
David Melon Fuksman. Radiation transfer module for relativistic magnetohydrodynamics included in the PLUTO code

15:40-16:00
Rahim Moradi. Hard and soft X-ray flares in GRBs

16:00-16:20
Yerlan Aimuratov. GeV emission in GRBs

16:20—16:40 Coffee break

16:40-17:00
Mile Karlica. On a GRB afterglow model consistent with hypernovae observations

17:00-17:20
Mikalai Prakapenia. Numerical scheme for treatment of Uehling-Uhlenbeck equation for binary and triple interactions in relativistic plasma

17:20-17:40
Vladimir Leschevich. The influence of contaminating microparticles on auto-ignition of fuel/air mixtures

17:40-18:00
Victor Tikhomirov. To the current experiments on high-energy particle interaction with crystals

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Tuesday, 24 April

Gravitational Waves and Gamma-Ray Bursts (HALL B)

09:00—13:15 Chair*:* Alexander Gorbatsievich

09:00-09:30
Tomasz Bulik. Astrophysics of coalescing compact object binaries

09:30-10:00
István Rácz. A new method of constructing binary black hole initial data

10:30-10:30
Jorge Rueda. Latest news on the induced gravitational collapse scenario of long gamma-ray burst

10:30-11:00
Yu Wang. Early X-ray Flares in GRBs

11:00—11:15 Coffee-break

11:15-11:45
Laura Becerra. SPH simulations of the induced gravitational collapse scenario of long gamma-ray bursts associated with supernovae

11:45-12:15
Elena Panko. Regular substructures in the rich galaxy clusters

12:15-12:45
Andreas Krut. Novel constraints on fermionic dark matter from galactic observables

12:45-13:15
Vladimir Lipunov. The Discovery of gravitational waves: prediction and observation

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13:15—15:00 Lunch

Cosmology (HALL B)

15:00—18:20 Chair*:* Agnieszka Pollo

15:00-15:20
Igor Satsunkevich. Cosmic anapole

15:20-15:40
Yen Chen Chen. Morphology of Seyfert Galaxies

15:40-16:00
Yuri Vyblyi. Weak spherical gravitational waves

16:00-16:20
Igor Dudko. Self-interacting scalar field as a dark energy model

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16:20—16:40 Coffee break

16:40-17:00
Sergey Cherkas. Plasma Perturbations and Cosmic Microwave Background Anisotropy in the Linearly Expanding Milne-like Universe

17:00-17:20
Elena Ovsiyuk. Dirac, Majorana and Weyl Particles in Oscillating de Sitter Universe, Reflection from the Cosmological Barrier

17:20-17:40
Mirza Hadžimehmedovic. Lurent+Pietarinen Method in Baryon Spectroscopy

17:40-18:00
Maksim Usachonak. Parametric instabilities in microwave heating of plasma

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Conference banquet: 19:00, Café Academicheskae banquet hall

Wednesday, 25 April

High Energy Physics, Cosmology and Gravitation (HALL B)

09:00—13:15 Chair: Yurii Kurochkin

09:00-09:30
Jaroslaw Stasielak. Highlights on the ultra-high energy cosmic rays studies at the Pierre Auger Observatory

09:30-10:00
Oleg Zaslavski. Ultra-high energy particle collisions near black holes and singularities and super-Penrose process

10:30-10:30
Agnieszka Pollo. How luminous galaxies trace the dark Universe

10:30-11:00
Noam Libeskind Tracing the cosmic web - comparative methods for classification

11:00—11:15 Coffee-break

11:15-11:45
Gennady Bisnovatyi-Kogan. Strong shock in a uniformly expanding universe

11:45-12:15
Sergei Moiseenko. Numerical technique for the simulations of magnetorotational astrophysical flows

12:15-12:45
Gyula Fodor. Localized objects formed by self trapped gravitational waves (geons)

12:45-13:15
Narek Sahakyan. High energy emission from AGNs

13:15—15:00 Lunch

Gravitation (HALL B)

15:00—18:20 Chair*:* Sergei Moiseenko

15:00-15:20
Alexander Garkun. On spherically symmetric gravitating systems in Riemann-Cartan space-time

15:20-15:40
Manuel Hohmann. Gravitational waves in teleparallel theories of gravity

15:40-16:00
Michael A. Ivanov. Low-energy quantum gravity and cosmology without dark energy

16:00-16:20
Lev Tomilchik. On two-particle gravitational interaction

16:20—16:40 Coffee break

16:40-17:00
Volodymyr Pelykh. A class of exact solutions of Maxwell equations in Kerr space-time and their physical manifestations

17:00-17:20
Halina Grushevskaya. Bubble nucleation rate in a geometrothermodynamic Finsler model of cosmological first-order phase transitions

17:20-17:40
Vladimir Makarenko. Search for new physics in background photon collisions at future linear collider

17:40-18:00
Aliaksandr Leonau. Analytical orthonormal hydrogen-like basis for calculation of observable characteristics of many-electron atoms and ions

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Thursday, 26 April

Relativistic Astrophysics and Explosions (HALL B)

09:00—13:15 Chair*:*George Krylov

09:00-09:30
Mikhail Lisakov. Recent results from RadioAstron

09:30-10:00
Andrzej Zdziarski. Inner accretion flows and connection to jets in black-hole binaries

10:30-10:30
Nikolai Shakura. Ya. B. Zeldovich and background of the accretion processes theory in the Universe

10:30-11:00
Evgeny Derishev. Radiation-mediated shocks: kinetic processes and transition to collisionless shocks

11:00—11:15 Coffee-break

11:15-11:45
Kuantay Boshkayev. Nonvalidity of I-Love-Q Relations for Hot White Dwarf Stars

11:45-12:15
Alexey Aksenov. Mechanism of the explosion of the collapsing supernovae and numerical simulations of the neutrino transport

12:15-12:45
Oleg Penyazkov. Flame dynamics at deflagration to detonation transitions in smooth tubes

12:45-13:15
Valery Chechetkin. Asymmetric nucleosynthesis

13:15—15:00 Lunch

Trip to Nyasvizh castle

Friday, 27 April

Cosmology (HALL B)

09:00—13:15 Chair*:* Albert Minkevich

09:00-09:30
Bronislav Rudak. Science highlights from H.E.S.S.

09:30-10:00
Alexei Starobinsky. New results on inflation and previous evolution of the Universe

10:30-10:30
Gregory Vereshchagin. Loop Quantum Cosmology and probability of inflation

10:30-11:00
Artur Chernin. Dark energy in Zeldovich Local Pancake

11:00—11:15 Coffee-break

11:15-11:45
Bohdan Novosyadlyj. Can data on structure of voids unveil the nature of dark energy?

11:45-12:15
Andrey Doroshkevich. The Ly-alpha forest as elements of the structure of the Universe

12:15-12:45
Tanja Petrushevska. Supernovae seen through gravitational telescopes

12:45-13:15
Ivan Siutsou. Kinetic description of thermalization in degenerate relativistic plasma

13:15—15:00 Lunch

Gravitation and High Energy Physics (HALL B)

15:00—18:20 Chair*:* Oleg Zaslavski

15:00-15:20
Oleg Boyarkin. Neutrino sector structure of the left-right symmetric model

15:20-15:40
Viktor Red'kov. Frobenius solutions and analysis of the tunneling effect for spin 1/2 particles through the Schwarzschild barrier

15:40-16:00
Vladimir Soloviev. Hamiltonian approach to cosmology in bigravity

16:00-16:20
Mikhail Korjik. Novel scintillation materials for gamma-spectroscopy and calorimetry in space

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16:20—16:40 Coffee break

16:40-17:00
Viktor Otchik. Nonrelativistic particle with spin in the Lobachevsky space

17:00-17:20
Vadzim Haurysh. Radiative decays of meson in point form of PiQM

17:20-17:40
Andrei Manko. The two-photon production W bosons pair at colliders at the leading and the next-to-leading order

17:40-18:00
Stas Komarov. Time dependence of the redshift of light from a source in binary star that moves in the field of Kerr black hole

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ABSTRACTS

1. Vladimir Fortov. Warm Dense Matter, Generated by the Intense Shock and Rarefaction Waves

Abstract

Warm Dense Matter, Generated by the Intense Shock and Rarefaction Waves. The behavior of matter at extremely high densities is very important for understanding of the structure and evolution of astrophysical objects and many modern energy technologies. Dynamic methods of generation of warm dense matter at extremely high pressures, based on the compression and heating of matter in intense shock waves, adiabatic expansion of shock-compressed matter and quasi-isentropic compression are considered. To generate shock waves in the terapascal pressure range, the cylindrical and spherical systems of condensed explosives, laser and particle beams, high velocity impacts, and soft X-rays were used. The high temporal-resolution diagnostics of the extreme states of plasma were carried out with laser interferometry of velocity-meters, fast acting electron-optical transducers, pyrometers, and high-speed spectrometers equipped with the electron-optical transmission lines. Experimental data obtained and the physical models of plasma behavior at extremely high pressures, temperatures and strain rates are considered. Effects of metallization and dielectrization of strongly coupled matter, high energy density thermodynamics and phase transitions, including plasma phase transitions are discussed. Shear viscosity of matter as an indicator of particles correlations in a broad region of parameters from Plank's scale to laboratory conditions is analyzed. Wide-range semi-empirical equations of state and models are constructed, which were used for multidimensional numerical simulation of shock-wave processes.

2. Remo Ruffini. Gamma-Ray Bursts

Abstract

The fundamental role of LAT Observations by the FERMI satellite in identifying the birth of a Black Hole (BH) in Binary Driven Hipernovae (BdHNe) and short-GRBs leads to the measure of the mass and spin of the BH.

3. Arkady Galper. Gamma-400 project

Abstract

High energy gamma ray (HEGR) study can answer many keyset questions about the existence and development of active astrophysical objects ranging from galaxy clusters to Solar system, including the dark matter. The HEGR flux is several degrees of magnitude less than particle and nuclei flux, necessitating the need to register each individual gamma quantum and differentiate it from the background space radiation. As of this moment, there are several thousand registered discrete astrophysical sources of gamma quanta with energy up to 10GeV and several hundreds of sources of more energetic gamma quanta.

Currently a qualitatively new understanding of active astrophysical object source and nature is required, with the foremost of such objects being the center of the Milky Way galaxy where possible traces of dark matter are registered. «GAMMA-400» is a next generation gamma-telescope, which will be able to register gamma radiation in the 20MeV – 2TeV range and will have angular and energy resolution several times better than all existing or perspective gamma-telescopes in more than 10GeV energy range. «GAMMA-400» observation program includes detailed observations of the Galaxy, including no less than two months of uninterrupted observations of each area of the galactic plane and long-term uninterrupted observations of the center of the galaxy. Observations in the x-ray range (5-30KeV) are

performed concurrently with the gamma range observation by the x-ray telescope ART-XC which is a part of the astrophysical laboratory «GAMMA-400»

4. Alexei Pozanenko. Observations of GRB 1170817A associated with LIGO/Virgo GW170817 in gamma-rays, optic and radio, and the model of prompt gamma-ray emission

Abstract

Short duration GRB 1170817A was detected about 2 s after LIGO/Virgo gravitational wave event GW170817. GRB 1170817A was observing in gamma-, X-rays, optic and radio. We discuss results of own observations in radio at 110 MHz using the Big Scanning Antenna and in optic using telescopes of Chilescope observatory. We also discuss observations of GBM/Fermi in gamma-ray domain and suggest the model of prompt gamma-ray emission.

5. Yerlan Aimuratov. GeV emission in GRBs

Abstract

GeV emission in gamma-ray bursts. We summarize main observational features of high-energy photons from gamma-ray bursts and draw basic phenomenological correlations.

6. Mile Karlica. On a GRB afterglow model consistent with hypernovae observations

Abstract

Afterglow phase of gamma-ray burst (GRB) within the paradigm of the binary driven hypernova (BdHN) clearly points to its mildly relativistic regime which is confirmed by early X-ray thermal component measurements around 100 seconds and optical emission lines measurement around 10^6 seconds. Optical and X-ray band radiation of the GRB afterglow within this paradigm arise from the synchrotron radiation of relativistic electrons inside hypernova (HN) ejecta mainly magnetised by a newly created neutron star (νNS). To model the temporal behaviour of the GRB afterglow spectra we developed a kinetic equation code which tracks the evoultion of accelerated electrons inside HN ejecta taking into account all the important energy losses and their temporal dependence. In this talk we present the basic physical elements of our code and the relevant results for GRB130427A as a clear example.

7. Daria Primorac. Structure of prompt emission in GRB 151027A within the fireshell model

Abstract

Long gamma-ray burst GRB 151027A was observed by all three detectors onboard Swift spacecraft, and many more, including MAXI, Konus-Wind and Fermi GBM/LAT instruments. This reviled a complex structure of the prompt and afterglow emission, consisting of a double-peak gamma-ray prompt with a quiescent period and a HRF/SXF within the X-ray afterglow, together with multiple BB components seen within time-resolved spectral analysis. We show that these features, analysed within the fireshell model, are the manifestation of the same physical process viewed at different angles regarding to the HN ejecta. Performing the time-resolved and time-integrated spectral analysis, we determine energy of the plasma E and the baryon load B, which describe the dynamics of the fireshell up to transparency point. We proceed with the light-curve simulation from which CBM density values and it's inhomogeneities are deduced.We also investigate the properties of GRB 140206A, which prompt emission exhibits similar structure, and compare them to the obtained results.

8. David Melon Fuksman. Radiation transfer module for relativistic magnetohydrodynamics included in the PLUTO code

Abstract

Radiation transport plays a crucial role in most high-energy astrophysical processes, such as black hole accretion disks, jets, pulsar winds, core-collapse supernovae and gamma-ray bursts. In some of these, for instance in the so-called shock breakouts that occur in

supernovae when radiation-mediated shocks reach a star's photosphere, radiation is transported between optically-thick and optically-thin regions. Therefore, it is optimal to approach such problems using methods that are able to describe both regimes, which is not a trivial task, since that requires the handling of timescales that sometimes can differ in several orders of magnitude. Also, in most of these phenomena, matter dynamics is severely influenced by the presence of strong electromagnetic fields. We present in this work a numerical code applicable to radiation transfer problems in relativistic hydrodynamics and magnetohydrodynamics, which we have designed as an independent module to be included in the freely-available PLUTO code.

9. Rahim Moradi. Hard and soft X-ray flares in GRBs

Abstract

Corresponding to the three different processes in the fromation of Binary Driven Hypernovae (BdHNe) there are three associated different thermal components. Here we give a short summary of the observational properties of these thermal components and finally we present their theoretical interpretation through the IGC scenario.

10. Ivan Siutsou. Kinetic description of thermalization in degenerate relativistic plasma

Abstract

We present novel results about thermalization of degenerate relativistic electron-positron-photon plasma isotropic in momentum space with drastic improvement in computation time with respect to existing methods due to use of massively parallel GPU computing. Using Uehling-Uhlenbeck collision integral calculated from the first principles of quantum electrodynamics we succeeded to take into account all two- and three-particle interactions. We show that rates of three-particle interactions for temperatures $kT \geq m_e c^2$ dominate over two-particle ones in the low-energy part of spectrum. This substantially changes plasma path to thermal equilibrium, excluding previously found state of kinetic equilibrium for such temperatures.

11. Mikalai Prakapenia. Numerical scheme for treatment of Uehling-Uhlenbeck equation for binary and triple interactions in relativistic plasma

Abstract

We present a new efficient method to compute Uehling-Uhlenbeck collision integral for all two-particle and three-particle interactions in relativistic plasma with drastic improvement in computation time with respect to existing methods. Plasma is assumed isotropic in momentum space. The set of reactions consists of: Moeller and Bhabha scattering, Compton scattering, two-photon pair annihilation/production and double compton scattering, bremsstrahlung, three-photon annihilation, radiative pair creation/annihilation, which are described by QED matrix elements. In our method exact energy and particle number conservation laws are satisfied. Reaction rates are compared, where possible, with the corresponding analytical and another numerical expressions and convergence of numerical rates is demonstrated.

12. Maksim Usachonak. Parametric instabilities in microwave heating of plasma

Abstract

In the recent decade there has been accumulated a substantial number of observations in the ECR plasma heating experiments in tokamaks and stellarators that do not fit into a simple linear picture. In the present report the low-threshold two-UH-plasmon PDI s experimentally modelled. The decay occurs in a plasma filament extended in the directon of the magnetic field and produced by high-frequency discharge in long quartz tube filled by argon under influence of incident X-microwave. The threshold and growth rate of the parametric phenomena are

determined and compared to the theory predictions. Efficiency of the X-mode anomalous absorption in the plasma filament associated with the two upper-hybrid-plasmon decay is established.

13. Mirza Hadžimehmedovic. Lurent+Pietarinen Method in Baryon Spectroscopy
Abstract
We present a new approach to quantifying pole parameters of single-channel processes based on a Laurent expansion of partial-wave T matrices in the vicinity of the real axis. Instead of using the conventional power-series description of the nonsingular part of the Laurent expansion, we represent this part by a convergent series of Pietarinen functions. As the analytic structure of the nonsingular part is usually very well known (physical cuts with branch points at inelastic thresholds, and unphysical cuts in the negative energy plane), we find that one Pietarinen series per cut represents the analytic structure fairly reliably. The number of terms in each Pietarinen series is determined by the quality of the fit. The method is tested in two ways: on a toy model constructed from two known poles, various background terms, and two physical cuts, and on several sets of realistic π N elastic energy-dependent partial-wave amplitudes.

14. Vladimir Lipunov The Discovery of gravitational waves: prediction and observation
Abstract
The discovery of gravitational waves (GW150914) by the international collaboration LIGO/Virgo on the one hand is a triumphant confirmation of the general theory of relativity, and on the other confirms the general fundamental ideas on the nuclear evolution of baryon matter in the Universe concentrated in binary stars. LIGO/Virgo may turn out to be the first experiment in the history of physics to detect two physical entities, gravitational waves and black holes. The Multimessenger GW170817 / GRB170817A discovery of the merger of two neutron stars on 17th August 2017 accompanied by a gamma-ray burst and an optical kilonova event is a triumph of the ideas about the evolution of the baryon component in the Universe. Despite the current uniqueness of this observation, the variety of the experimental data obtained makes it possible right now to draw important theoretical conclusions about the origin of the double neutron star, its merger, and the subsequent flare-up of electromagnetic radiation. We demonstrate that the discovery of the merger at a distance of 40 Mpc is entirely consistent with the very first calculations of the Scenario Machine (Lipunov et al. 1987). In modern terms, the predicted rate is ~10000 Gpc^{-3}.

15. Tomasz Bulik. Astrophysics of coalescing compact object binaries
Abstract
Coalescences of compact object binaries have been detected in gravitational waves. The questions I will attempt to answer are: What is the astrophysical origin of these objects? What do these detections tell us about the formation of black holes and neutron stars? What are the main problems that they pose? What to expect in the coming gravitational observations?

16. Gyula Fodor. Localized objects formed by self-trapped gravitational waves (geons)
Abstract
Localized objects formed by self-trapped gravitational waves (geons) Geons are localized horizonless objects formed by gravitational waves, held together by the gravitational attraction of their own field energy. In many respects they are similar to scalar field pulson/oscillon configurations, which were found numerically in 1976 by Kudryavtsev, Bogolyubskii and Makhankov. If there is a negative cosmological constant, the spacetime of geons asymptotically approaches the anti-de Sitter (AdS) metric. AdS geons are time-periodic regular localized vacuum solutions without any radiation loss at infinity. A higher order

perturbative construction in terms of an amplitude parameter shows that there are one-parameter families of AdS geon solutions emerging from combinations of identical-frequency linear modes of the system.

17. István Rácz. A new method of constructing binary black hole initial data

Abstract

By applying a parabolic-hyperbolic formulation of the constraints and superposing Kerr-Schild black holes, a simple method is introduced to initialize time evolution of binary systems. As the input parameters are essentially the same as those used in the post-Newtonian (PN) setup the proposed method interrelates various Kuantay Boshkayev. Nonvalidity of I-Love-Q Relations for Hot White Dwarf Stars

18. Jorge Rueda. Latest news on the induced gravitational collapse scenario of long gamma-ray burst

Abstract

The induced gravitational collapse (IGC) scenario of long gamma-ray bursts (GRBs) associated with supernovae (SNe) conceives as progenitor a binary system composed of a carbon-oxygen (CO) core and a neutron star (NS) companion in close orbit. The SN explosion triggers a hypercritical accretion process onto the NS companion with a copious emission of neutrino-antineutrino pairs and hydrodynamic processes in the accretion region near the NS surface. In this talk I give an overview of the theoretical developments of this scenario for the explanation of low-energy GRBs (X-ray flashes - XRFs with $<10^{52}$ erg) and high-energy GRBs (binary-driven hypernovae - BdHNe with >1052 erg) including the numerical 1D to the latest 3D smoothed-particle-hydrodynamics (SPH) simulations and the NS physics involved. The consequences of the neutrino, the X- and gamma-ray emission as well as the gravitational wave emission are discussed.

19. Yu Wang. Early X-ray Flares in GRBs

Abstract

Gamma-ray bursts (GRBs) are traditionally classified in short GRBs and long GRBs. Following the ever increasing evidence of spatial and temporal correlation of long GRBs and supernovae (SNe), we have identified a subclass of very energetic long GRBs which makes explicit the role of a binary system, and of a SN as the progenitor: the Binary-driven Hypernovae or BdHNe. Such long burst subclass originate in tight binary systems composed of a carbon-oxygen core (CO$_{\rm core}$) undergoing a SN explosion and a companion neutron star (NS). The SN ejecta triggers hypercritical accretion onto the companion NS, leading it to collapse to a BH and to form a relativistic e^+e^- plasma. Here we focus on the impact of the e^+e^- plasma on the SN ejecta, generating an extended thermal emission occurring around the gamma-ray flare. Using appropriate relativistic transformations we evidence that such a thermal emission indicates the occurrence of a total new phenomenon: the transition from a supernova into a hypernova (HN).

20. Laura Becerra SPH simulations of the induced gravitational collapse scenario of long gamma-ray bursts associated with supernovae

Abstract

We present the three-dimensional smoothed-particle-hydrodynamics (SPH) simulations of the induced gravitational collapse (IGC) scenario of long-duration gamma-ray bursts associated with supernovae (SNe). We simulate the SN explosion of a carbon-oxygen core forming a binary system with a neutron star (NS) companion. We follow the evolution of the SN ejecta, including their morphological structure, subjected to the gravitational field of both the new-NS formed at the center of the SN, and the one of the NS companion. We compute the

accretion rate of the SN ejecta onto the NS companion as well as onto the new-NS from SN matter fallback. We determine the fate of the binary system for a wide parameter space and evaluate, for selected nuclear equations-of-state of NSs, if the accretion process leads the NSs either to the mass-shedding limit, or to the secular axisymmetric instability for gravitational collapse to a black hole (BH), or to a more massive, fast rotating, but stable NS.

21. Narek Sahakyan. High energy emission from AGNs

Abstract

The recent observations in the High Energy gamma-ray band show that the extragalactic gamma-ray sky is dominated by the emission from Active Galactic Nuclei (AGN) of different types. The majority of detected sources are blazars- an extreme class of AGNs with jets forming a small angle with respect to the line of sight, which makes their emission strongly Doppler boosted. After the launch of Fermi Large Area Telescope the gamma-ray emission from other types of AGNs, e.g., which do not show a clear evidence for optical blazar characteristics or have jets pointing away from the observer (non- blazar AGNs) also have been detected. In this presentation, I will discuss the spectral and temporal properties of gamma-ray emission from AGNs as well as the origin of multiwavelength emission.

22. Igor Satsunkevich. Cosmic anapole

Abstract

If dark matter particle is fermion and has minimal electromagnetic interaction, this particle might be a Majorana fermion with anapole type interaction.

23. Andreas Krut. Novel constraints on fermionic dark matter from galactic observables

Abstract

In order to explain galactic structures we consider a self-gravitating system, composed of massive fermions in spherical symmetry. The finite mass distribution of such component is obtained after solving the Einstein equation for a thermal and semi-degenerate fermionic gas, described by a perfect fluid in hydrostatic equilibrium and exposed to cutoff effects (e.g. evaporation). Within this more general approach a new family of density profiles arises which explains dark matter halo constraints of the Galaxy and provides at the same time an alternative to the central black hole scenario in SgrA*. This analysis narrows the allowed particle mass to $mc^2 = 48 - 345$ keV. It is bolstered by the successful application (for $mc^2 = 48$ keV) to different galaxy types from dwarfs to ellipticals. The key result is that there is a continuous underlying dark matter distribution, covering the whole galactic extent. It governs the dynamics of the galactic center (e.g. nuclei) as well as the galactic halo. Of great importance is the natural outcome of the observationally confirmed link between a central dark object and its harboring dark matter halo. Interestingly, the very same dark matter distributions provide a satisfactory explanation for the constancy of the central dark matter surface density, valid for various galaxy types.

24. Elena Panko. Regular substructures in the rich galaxy clusters

Abstract

Galaxy clusters are the largest elements of the large scale structure of the Universe that have baryonic (galaxies and hot gas) and dark matter as principal components. Both theoretical predictions and various numerical simulations indicate a connection between distributions both galaxies and DM inside a cluster. We performed a detailed analysis of 2D distribution of galaxies inside the rich clusters for determining their morphological types. The standard approach allows one to describe the morphology of a cluster as C-I-O according to the concentration toward the center, as well as F-L according to the presence of overdense belt. However, we found some number of clusters that have statistically significant regular

peculiarities, such as two crossing belts, curved strips or Y-type substructures. We suppose these types of morphology correspond to non-uniform DM distribution inside the peculiar galaxy clusters.

25. Yen Chen Chen. Morphology of Seyfert Galaxies

Abstract

We probed the relation between properties of Seyfert nuclei and morphology of their host galaxies. We selected Seyfert galaxies from the Sloan Digital Sky Survey with redshifts less 0.2 identified by the Véron Catalog (13th). We used the “FracDev” parameter from SDSS galaxy fitting models to represent the bulge fractions of the Seyfert host galaxies. We found that the host galaxies of Seyfert 1 and Seyfert 2 are dominated by large bulge fractions, and Seyfert 2 galaxies are more likely to be located in disk galaxies whereas most of the Seyfert 1 galaxies are located in bulge-dominant galaxies. These results indicate that the types of AGNs are related to their host galaxies and can not be explained by the traditional unification model of Seyfert galaxies.

26. Sergey Cherkas. Plasma Perturbations and Cosmic Microwave Background Anisotropy in the Linearly Expanding Milne-like Universe

Abstract

We expose the scenarios of primordial baryon-photon plasma evolution within the framework of the Milne-like universe models. Recently, such models find a second wind and promise an inflation-free solution of a lot of cosmological puzzles including the cosmological constant one. Metric tensor perturbations are considered using the five-vectors theory of gravity admitting the Friedmann equation satisfied up to some constant. The Cosmic Microwave Background (CMB) spectrum is calculated qualitatively.

27. Elena Ovsiyuk. Dirac, Majorana and Weyl Particles in Oscillating de Sitter Universe, Reflection from the Cosmological Barrier

It is known that geometry of the Lobachevsky space acts on particles with spins 0, 1/2, 1 as an ideal mirror distributed in the space. The depth of penetration of the field in such an effective medium increases with increasing field energy, also this penetration depends on the radius of curvature of the Lobachevsky space. Since the Lobachevsky model is a constituent element in some cosmological models, this property means that in such models it is necessary to take into account the effect of the presence of a "cosmological mirror"; it must effectively lead to a redistribution of the particle density in the space. The earlier analysis assumed the static nature of the space-time geometry. In this paper we generalize the investigation for the spin $1/2 $ field in the case of the oscillating de Sitter universe. The Dirac equation is solved in non-static quasi-Cartesian coordinates. At this we substantially use a generalized helicity operator. The wave functions of the particle depend nontrivially on the time, however the effect of the complete reflection of the particles from the effective potential barrier is preserved. For real Majorana 4-spinor field similar results are valid. For construction of the solutions describing the reflection effect we need to use linear combinations of solutions with opposite helicities. Such a combination is forbidden for 2-component Weyl particles, by this reason such particles cannot be reflected by the cosmological barrier.

28. Yuri Vyblyi. Weak spherical gravitational waves

Abstract

The spherically-symmetric exact wave-type solution of system of linearized Einstein equations and Hilbert conditions is presented. In the connection with Birkhoff theorem the sense of this solution in General Relativity is discussed.

29. Igor Dudko. Self-interacting scalar field as a dark energy model

Abstract

Scalar-tensor theory of gravitation with the scalar source being the stress-energy tensor trace of the scalar field itself and the matter, is considered. The example of numerical solution of the cosmological equations shows that at some special choice of scalar parameters slow-roll regime, in which the scalar field provides acceleration expansion of the Universe, exists.

30. Jaroslaw Stasielak. Highlights on the ultra-high energy cosmic rays studies at the Pierre Auger Observatory

Abstract

Pierre Auger Observatory, covering an area of about 3000 km2, is the world's largest operating ultra-high energy cosmic rays (UHECRs) detection system. It combines multiple detection techniques, which enable unprecedented precision of measurements. The data collected at the Observatory over the last decade have led to a number of major breakthroughs. However, by discovering part of the mystery, new questions emerged. A suppression of the cosmic ray flux at energies above 4x10^19 eV has been established unambiguously. On the other hand, it is still unclear if this suppression is caused by the propagation of cosmic rays or rather by energy limitation of their sources. Determination of UHECRs composition is the key to resolving this issue. The other mystery is the origin of UHECRs. Some clues can be drawn from studying the distribution of their arrival directions. In particular, the recently observed dipole anisotropy has an orientation which indicates an extragalactic origin of UHECRs. Moreover, the limits on ultra-high energy photon and neutrino fluxes, obtained at the Observatory, severely constrain exotic scenarios of the UHECRs origin, such as the decay of super-heavy particles. Recent results on the energy spectrum, mass composition and arrival directions of cosmic rays measurements will be presented.

31. Oleg Zaslavski. Ultra-high energy particle collisions near black holes and singularities and super-Penrose process

Abstract

A brief review of the effect of acceleration of particles to unbounded energies in their centre of mass frame due to collision is suggested. The main emphasis is made on the properties of debris after collision that can be observed at infinity. When collission occurs near a black hole, the efficiency of the process is limited. However, near singularities an unbounded efficiency (the so-called super-Penrose process) becomes possible. Consideration applies to a wide class of axially symmetric stationary rotating spacetimes.

32. Agnieszka Pollo. How luminous galaxies trace the dark Universe

Abstract

Modern cosmology usually assumes that we live in the Universe dominated by its "dark sector" - namely, dark matter and dark energy. Yet most of the information which is observationally available to us comes from luminous baryonic objects - galaxies. However, galaxies are not only biased tracers of underlying galaxy dark matter field but this biased is related to galaxy evolution in a way which is far from trivial. I will present the picture of large scale structure and galaxy co-evolution which emerges from the recent deep galaxy surveys (including VIPERS, VUDS) and discuss furture prospects.

33. Noam Libeskind Tracing the cosmic web - comparative methods for classification

Abstract

The cosmic web is one of the most striking features of the distribution of galaxies and dark matter on the largest scales in the Universe. It is composed of dense regions packed full of galaxies, long filamentary bridges, flattened sheets and vast low-density voids. The study of

the cosmic web has focused primarily on the identification of such features, and on understanding the environmental effects on galaxy formation and halo assembly. As such, a variety of different methods have been devised to classify the cosmic web – depending on the data at hand, be it numerical simulations, large sky surveys or other. In this talk, we bring 12 of these methods together and apply them to the same data set in order to understand how they compare. In general, these cosmic-web classifiers have been designed with different cosmological goals in mind, and to study different questions. Therefore, one would not a priori expect agreement between different techniques; however, many of these methods do converge on the identification of specific features. I will focus on the agreements and disparities of the different methods. For example, each method finds that knots inhabit higher density regions than filaments, etc. and that voids have the lowest densities. Libeskind et al 2018 (MNRAS 473, 1195–1217)

34. Gennady Bisnovatyi-Kogan. Strong shock in a uniformly expanding universe

Abstract

Self-similar solution is obtained for propagation of a strong shock, in a flat expanding dusty Friedman universe. Approximate analytic solution is obtained [1], using relation between self-similar variables, equivalent to the exact energy conservation integral, which was obtained by L.I. Sedov for the strong explosion in the static uniform medium. Numerical integration of self-similar equation gives an exact solution of the problem, which is rather close to the approximate analytic one [2]. The differences between these solutions are most apparent in the vicinity of the shock. For polytropic equation of state, self-similar solutions exist in more narrow interval of the adiabatic power than in the static case. Dependence of the density, and velocity of the polytropic gas behind the shock wave on time and radius are obtained. The velocity of the shock in the expanding medium decreases as $\sim t^{-1/5}$, slower than the shock velocity in the static uniform medium $\sim t^{-3/5}$, and its radius increases $\sim t^{4/5}$, more rapidly than in the uniform non-gravitating medium $\sim t^{2/5}$. So, the shock propagates in the direction of decreasing density with larger speed, than in the static medium, due to accelerating action of the decreasing density, even in presence of a self-gravitation. 1. G.S. Bisnovatyi-Kogan (2015) Gravitation and Cosmology, Vol. 21, No. 3, pp. 236–240. 2. G.S. Bisnovatyi-Kogan and S.A Panafidina (2018) in preparation.

35. Evgeny Derishev. Radiation-mediated shocks: kinetic processes and transition to collisionless shocks

Abstract

Radiation mediated shocks are those, where photons play dominant role in determining the shock front structure. Such shocks form inside exploding supernovae and, likely, in the Gamma-Ray Burst progenitors. We review current state-of-art in understanding the physics of radiation-mediated shocks, paying more attention to the case of fast (sub-relativistic or relativistic) shocks. It is shown that at large enough speed, optically radiation-mediated shocks can develop kinetic instabilities at their front and thereby undergo transition to collisionless shocks. We also discuss a possibility to extend the concept of radiation-mediated shocks to optically thin shocks.

36. Vedad Pasic. Purely axial torsion waves in metricaffine gravity

Abstract

The approach of metric-affine field theory is viewing spacetime as a real oriented 4-manifold equipped with a metric and an independent affine connection. The 10 independent components of the metric tensor and the 64 connection coefficients are our unknowns. We observe spacetimes whose connection is generated by torsion which is purely axial with Minkowski metric. We show that this connection is necessarily metric-compatible and

provide explicit formula for the torsion of such spacetimes. We describe and provide the full characterisation of the properties of curvature of such spacetime, presenting explicit formulae for all possible irreducible pieces of curvature. We also provide possible applications of these general results to concrete cases of solutions of metric-affine gravity. Special attention is given to the possible applications to the (massless) Dirac equation and operator.

37. Albert Minkevich. Gravitational interaction and gauge gravitation theory in Riemann-Cartan space-time

Abstract

Physical aspects of gauge gravitation theory in Riemann-Cartan space-time connected with the change of gravitational interaction by certain conditions (in comparison with general relativity theory (GR)) that allows to solve some principal problems of GR are discussed.

38. Alexander Garkun. On spherically symmetric gravitating systems in Riemann-Cartan space-time

Abstract

Gravitating systems with spherically symmetry are considered in the frame of Poincare gauge theory of gravity under a certain choice of the gravitational Lagrangian. The gravitational equations are obtained and numerically investigated. Properties of the numerically obtained solutions are analyzed.

39. Manuel Hohmann. Gravitational waves in teleparallel theories of gravity

Abstract

In my talk I will consider the most general class of teleparallel theories of gravity in their covariant formulation in terms of a tetrad and flat spin connection. The gravitational wave will be treated as a linear perturbation around a flat background. I will discuss different properties, such as the velocity of propagation and the possible polarization modes.

40. Michael A. Ivanov. Low-energy quantum gravity and cosmology without dark energy

Abstract

The model of low-energy quantum gravity leads to small additional effects having essential cosmological consequences: redshifts of remote objects and the additional dimming of them may be interpreted without any expansion of the Universe and without dark energy. The theoretical luminosity distance of the model fits the observational Hubble diagrams with high confidence levels. In the model, the ratio $H(z)/(1+z)$ should be equal to the Hubble constant. The constancy of this ratio is confirmed with 99.9999 % C.L. by fitting the compilation of 40 $H(z)$ observations from the paper by Zhang and Xia [arXiv:1606.04398]. A deceleration of massive bodies due to forehead and backhead collisions with gravitons is re-computed here.

41. Lev Tomilchik. On two-particle gravitational interaction

Abstract

It is shown that Gibbons maximum tension principle allows to remove singularity in the general relativistic two-particle gravitational interaction energy, leading to a bounded minimum. It is shown that Gibbons maximum force treated in a purely mechanical context possess the explicit parametric dependence on the interacting masses ratio.

42. Alexander Burinskii. On the Crucial Role of Spin in Gravitational Interactions

Abstract

It is commonly accepted that gravity is a weakest interaction in particle physics. This is confirmed with Schwarzschild solution and turned in a indisputable truth. Meanwhile, the Kerr solution shows that spin deforms space along with mass, and this should be taken into

account, because the spin/mass ratio for elementary particles is huge (about 20-22 orders in dimensionless units). In our talk we consider this phenomenon in details, and show that in the Nambu-Goto string model, spin shifts scale of gravitational interaction from Planck to Compton distances. A. Burinskii, "Illusion about weakness of gravity hides new way to unify gravity with particle physics", J. of Phys.: Conf.Series, 942, 012006 (2017), doi:10.1088/1742-6596/942/1/012006.

43. Volodymyr Pelykh. A class of exact solutions of Maxwell equations in Kerr space-time and their physical manifestations

Abstract

We have found for the first time in analytic form an exact general solution and solution with separated variables for a class of Maxwell field on Kerr space-time background and have investigated some of their properties and physical consequences. The general solution generalizes the known solutions of other authors in Minkowski space-time. From solution with separated variables we deduce the supressing of right-polarized electromagnetic waves (and rotation of plane of polarization) as well as expression for phase shift.

44. Stas Komarov. Time dependence of the redshift of light from a source in binary star that moves in the field of Kerr black hole

Abstract

Time dependence of the redshift of light from a source in binary star that moves in the field of Kerr black hole Stanislav Komarov, Alexander Gorbatsievich and Alexander Tarasenko The existense of the supermassive black hole in the Galactic Center region gives possibilities for testing general relativity in strong field regime by observing the stars moving in the field of the black hole. In the present work the redshift of light that is emitted by the source in binary star that moves in strong external gravitational field is considered. The numerical analisys of motion of such star in field of a Kerr black hole is performed. The corresponding redshift as a function of time of observation is calculated. The general analisys of this function is performed and the properties of the redshift that are useful for the solution of problem of reconstruction of motion of the binary star are described.

45. Halina Grushevskaya. Bubble nucleation rate in a geometrothermodynamic Finsler model of cosmological first-order phase transitions

Abstract

Geometrothermodynamic model of cosmological first-order phase transition has been proposed. Nucleation and following evolution of true-vacuum bubbles in a vacuum cosmology model with axially symmetric metrics have been considered. A manifold of evolving bubbles presents itself a Finsler statistical manifold of such thermodynamic system. It has been shown that using the contact statistical 5-dimensional manifold, which describes phase transitions proceeding in the interface systems with an electrocapillary mechanism of energy dissipation, allows us to construct the theory of cosmological models with axially symmetric metrics which is similar to Newman–Unti–Tamburino (NUT) one. These metrics are that of 4-dimensional surfaces in the 5-dimensional manifold. We has shown that the NUT-theory parameter n is the gauge parameter of the scalar field which plays a role of fifth dimension. The metrics in 5D world are similar to the (anti) de Sitter metrics at large values of n.

46. Mikhail Lisakov. Recent results from RadioAstron

Abstract

During six recent years RadioAstron is a desired facility for cutting-edge science of the finest angular resolution. An orbiting 10-meter antenna in pair with the most sensitive ground radio telescopes forms the largest ever scientific instrument and provides angular resolution up to

8 microarcseconds, the best achieved to date. RadioAstron allows to perform monitoring and imaging of active galactic nuclei, studies of pulsars and masers, investigation of interstellar scattering, and also gravitational experiments. Among the results to be highlighted: violation of the dominating emission model in relatiivistic jets, a super-wide and hollow jet of 3C 84, a discovery of interstellar scattering substructure in pulsars and quasars, resolving of ultra-compact details in water megamasers.

47. Nikolai Shakura. Ya. B. Zeldovich and background of the accretion processes theory in the Universe

Abstract

Outstanding scientist of 20th century Academician Ya. B. Zeldovich widely well known by his unique works in a great variety of the spheres of the modern science from the chemical physics up to elementary particles and cosmology. The report presents the scientific way of Academician Ya. B. Zeldovich beginning from the 60th of the 20th century, when he was invited as professor of physics to work in Lomonosov Moscow State University, where he organized now well known all over the world his scientific school of relativistic astrophysics.

48. Andrzej Zdziarski. Inner accretion flows and connection to jets in black-hole binaries

Abstract

I will discuss selected aspects of observations and theory of jets in accreting black-hole binaries. Their radio and gamma-ray emission differs significantly between their hard and soft spectral states, which appears to be due to the coupling between the accretion flow and jets. Also, high-energy gamma-ray emission is observed only from high-mass X-ray binaries, which appears to be due to jet-wind interaction (in particular, formation of recollimation shocks). Then, the jet radio emission can be significantly absorbed in the stellar wind of the donors in high-mass binaries, which allows to constrain the location of the emission site. I will present a theoretical model of the broad-band jet emission, taking into account all relevant radiative processes and the electron advection along the jet, and allowing to determine the jet power. These results will be used for modelling of the jet emission of Cyg X-1 and GRS 1915+105, and to constrain the role of magnetic fields and black-hole spin. Finally, I will present new results on the jet emission of the puzzling system Cyg X-3.

49. Sergei Moiseenko. Numerical technique for the simulations of magnetorotational astrophysical flows

Abstract

We represent results of simulations of magnetorotational(MR) supernova explosion by specially developed Lagrangian technique on a triangular grid of variable structure. Examples of successful core collapsed supernova explosions will be given. Special attention in the talk will be paid to the procedure of completely conservative remapping of grid functions. We developed a new procedure for the remapping of the magnetic field components taking into account conservation of components of magnetic energy and zero divergence of the magnetic field.

50. Kuantay Boshkayev. Nonvalidity of I-Love-Q Relations for Hot White Dwarf Stars

Abstract

Nonvalidity of I-Love-Q Relations for Hot White Dwarf Stars The equilibrium configurations of uniformly rotating white dwarfs at finite temperatures are investigated, exploiting the Chandrasekhar equation of state for different isothermal cores. The Hartle formalism is applied to construct white dwarf configurations in the framework of Newtonian physics. The equations of structure are considered in the slow rotation approximation and all basic parameters of rotating hot white dwarfs are computed to test the so-called moment of

inertia, rotational Love number and quadrupole moment (I-Love-Q) relations. It is shown that even within the same equation of state the I-Love-Q relations are not universal for white dwarfs at finite temperatures.

51. Alexey Aksenov. Mechanism of the explosion of the collapsing supernovae and numerical simulations of the neutrino transport

Abstract

Mechanism of the explosion of the collapsing supernovae and numerical simulations of the neutrino transport. We present the numerical methods for the carry out the radiative hydrodynamic with taking into account the neutrino transport. In the spherically symmetric case we can solve the kinetic Bolzmann equations for the neutrino of the different kinds with taking into account all reactions of the weak interactions and GR effects. To take into account multidimensional instabilities we consider multi -component multi-temperature approach with the neutrino transport in diffusion approximation with the flux limiters. The application of codes to the gravitational collapse demonstrates the large scale convection. The interesting result of the simulations is the prediction of the high-energy neutrino have to be registered in compare with the radiation from the neutrinosphere 10 MeV in spherically symmetric calculations. The developed multidimensional code utilities the original Riemann problem solver for the multiphase gas. It can operates with the large time steps in the case of the large optical paths of neutrino.

52. Oleg Penyazkov. Flame dynamics at deflagration to detonation transitions in smooth tubes

Abstract

53. Bronislav Rudak. Science highlights from H.E.S.S.

Abstract

The High Energy Stereoscopic System (H.E.S.S.) is an array of five imaging atmospheric Cherenkov telescopes operating in Namibia. Its observational performance has lead to many discoveries in the domain of Very High Energy astronomy. The talk will present the most important result obtained recently with H.E.S.S. in galactic and extragalactic astronomy as well as in astroparticle physics.

54. Alexei Starobinsky. New results on inflation and previous evolution of the Universe

Abstract

New results on inflation and preceding evolution of a universe in f(R) gravity are presented. f(R) gravity where R is the Ricci scalar represents the simplest purely geometrical generalization of the Einstein general theory of relativity without undesirable ghosts. For a RLRW spatially flat isotropic cosmological model in the absence of matter, its equations can be reduced to one first order differential equation that first shown in Starobinsky (1980) for the special case of the R+R^2 model (even with some additional geometric term). This model represents the pioneer inflationary model, too. It contains only one adjustable parameter taken from observations, has a graceful exit from inflation and a natural mechanism for creation and heating of matter after its end, and produces a very good fit to existing observational data on the power spectrum of primordial scalar (adiabatic density) perturbations. More generally, all viable slow-roll inflationary models in f(R) gravity should be close to this model over some range of R. We consider the inverse problem of reconstruction of inflationary models in f(R) gravity using information on the power spectrum of scalar perturbations only, ambiguity in this procedure and how it can be fixed by some aesthetic assumptions on the absence of new physical scales during and after inflation. The forms of f(R) for which the exact constant-roll solutions generalizing slow-roll ones can be

realized are found. Also studied is the problem of inflation formation from preceding generic classical curvature singularity, and which conditions are needed for this. Some exact anisotropic solutions describing it are presented. Since this process is generic, too, for inflation to begin inside a patch including the observable part of the Universe, causal connection inside the whole patch is not necessary. However, it becomes obligatory for a graceful exit from inflation in order to have practically the same number of e-folds during inflation inside this patch.

55. Gregory Vereshchagin. Loop Quantum Cosmology and probability of inflation
Abstract
We discuss the issue of initial conditions in Loop Quantum Cosmology, focusing on different definitions of their measure. We found that if the prebounce evolution is described by the modified Friedmann equations with massive scalar field, there is unique asymmetric in time cosmological solution with successful inflation.

56. Artur Chernin. Dark energy in Zeldovich Local Pancake
Abstract
Our computer model of the Zeldovich Local Pancake demonstrates that universal dark energy dominates in the dynamics of the system.

57. Bohdan Novosyadlyj. Can data on structure of voids unveil the nature of dark energy?
Abstract
The formation of large isolated voids as elements of large scale structure of the Universe is analyzed in the cosmological models with dynamical dark energy. We assume that initial perturbations are spherical and all components of the Universe (radiation, matter and dark energy) are continuous media with ideal fluid energy-momentum tensors, which interact only gravitationally. Equations of the evolution of perturbations for every component in the co-moving to cosmological background reference frame are obtained from equations of energy and momentum conservation and Einstein's ones and are integrated numerically. Initial conditions are set at the early stage of evolution in the radiation-dominated epoch, when the scale of perturbation is much larger than the particle horizon. Results show how the profiles of density and velocity of matter and dark energy are formed and how they depend on parameters of dark energy and initial conditions. An important feature of voids formation from the analyzed initial amplitudes and profiles is establishing the surrounding over-density shell. We have shown that the ratio of the peculiar velocity in units of the Hubble flow to the density contrast in the central part of a void is sensitive to the values of dark energy parameters and can be used to find them based on the observational data on mass density and peculiar velocities of galaxies in the voids.

58. Andrey Doroshkevich. The Ly-alpha forest as elements of the structure of the Universe
Abstract
The Ly-alpha forest as elements of the structure of the Universe" We analyzed four observed samples of Ly-alpha and metal lines (two at z> 2 and two at z< 0.2). We describe evolution of the observed Doppler parameters and absorbers separation in the framework of a two component model: the first population contains sets of lines identified with compact DM clouds with uncorrelated spatial distribution, and the second population includes absorbers with two, three and more absorption lines formed in the same extended DM cloud. All absorption lines are formed in gaseous caustics created in DM clouds and are described by two local characteristics -- the Doppler parameter and the column density of neutral hydrogen. We show that evolution of the Doppler parameter is very slow and its mean value increases by a factor ~ 1.5 at redshifts z< 3$. So slow evolution indicates high stability of caustics and

conditions within the clouds of the first population. In contrast the number density of DM clouds varies as <n_{cl}> (1+z)^3 and its distribution along the line of sight is similar to 1D Poissonian. The absorbers of the second population can be identify with circum galactic medium and elements of the Large Scale Structure of the Universe. For both populations we approximately estimate the mass and density of DM clouds and we compare them with properties of luminous objects.

59. Tanja Petrushevska. Supernovae seen through gravitational telescopes
Abstract
Supernovae seen through gravitational telescopes Galaxies, and clusters of galaxies, can act as gravitational lenses and magnify the light of objects behind them. The effect enables observations of very distant supernovae, that otherwise would be too faint to be detected by existing telescopes, and allows studies of the frequency and properties of these rare phenomena when the universe was young. Under the right circumstances, multiple images of the lensed supernovae can be observed, and due to the variable nature of the objects, the difference between the arrival times of the images can be measured. Since the images have taken different paths through space before reaching us, the time-differences are sensitive to the expansion rate of the universe. One class of supernovae, Type Ia, are of particular interest to detect. Their well known brightness can be used to determine the magnification, which can be used to understand the lensing systems. I will also report our discovery of the first resolved multiply-imaged gravitationally lensed supernova Type Ia.

60. Valery Chechetkin. Asymmetric nucleosynthesis
Abstract

61. Oleg Boyarkin. Neutrino sector structure of the left-right symmetric model
Abstract
Within the left-right symmetric model the neutrino sector structure is investigated. In this model apart from the ordinary light neutrinos $\nu_{lL}\ (l=e,\mu,\tau$) three heavy neutrinos N_{lR} being partners of ν_{lL} on the see-saw mechanism are in existence. The resonance conversions with the solar neutrinos are considered. The decays of the Higgs boson and Z boson going with the lepton-flavor violations are investigated as well. The analysis of the obtained results leads to the following conclusions: (i) the heavy neutrino masses are hierarchical; (ii) the heavy-light mixing angle is not equal to zero; (iii) the heavy-heavy neutrino mixing angle is maximal ($\theta_N=\pi/4$).

62. Viktor Red'kov. Frobenius solutions and analysis of the tunneling effect for spin 1/2 particles through the Schwarzschild barrier
Abstract
For Dirac particle, the general mathematical study of the particle tunneling process through effective potential barrier generated by Schwarzschild black hole background is done. The study is based on the use of 8 Frobenius solutions of related 2-nd order differential equation with 3 regular and 2 irregular singularities of the rank 2. Solutions of the radial equations are constructed in explicit form, and convergence of the involved power series is proved in the physical region of the variable r \in (1,+\infty). Results for tunneling effect significantly differ for two situations: one when the particle falls on the barrier from within and another when the particle falls from outside. Mathematical structure of the derived asymptotic relations is exact, however analytical expressions for involved convergent powers series are not known, and further study of transmission and reflection coefficients should be based on numerical summing the power series.

63. Victor Tikhomirov. To the current experiments on highenergy particle interaction with crystals

Abstract

The scientific school of particle interaction with matter has been developing in Belarus since 60-th. Numerous effects in x- and γ-ray, neutron and charged particle interaction with matter, and crystals in particular, have been predicted since then. This talk is reduced to a review of the predictions which cause the most interest at present and are connected with current or soon-planned experiments. Namely, we consider the anomalous development of electromagnetic showers in tungstate crystal, positron production by channeling radiation for their further acceleration to high energies in future electron-positron colliders, beam collimation of superconducting colliders, γ-background suppression in rear kaon decay experiments, short-lived charm and beauty magnetic and electric moment measurement and intense hard electromagnetic radiation generation.

64. Mikhail Korjik. Novel scintillation materials for gamma-spectroscopy and calorimetry in space

Abstract

Scientific problems of the origin and evolution of planetary bodies such as planets, their satellites and asteroids gain importance with our expansion in the solar system. Their spatial distribution in terms of concentrations of elements is an important clue for understanding the planetary history and evolution. The measurements of γ-rays, X-rays and neutrons emitted from the planet surface are the main abundant source of major elements and naturally radioactive γ-ray emitters. Planetary spectroscopy requires high sensitivity γ-ray and neutron detection. The requirement for high efficiency such type detectors are considered. Space physics makes use of scintillators in two different locations: low orbit satellites and space or interplanetary missions. The low orbit satellites are shielded by the Earth's magnetic field, relaxing therefore the requirement for radiation hardness of the scintillation material. Most of the scintillation materials can be used depending on the energy range of the detected γ-radiation. However, the payload limits the size of such detectors and not too dense materials are sometimes selected to reduce the weight. In the interplanetary space, the sun wind from charged particles strongly influences the detecting properties of the scintillation material. Here we discuss novel radiation hard scintillation materials, suitable to survive for the long space missions.

65. Aliaksandr Leonau. Analytical orthonormal hydrogen-like basis for calculation of observable characteristics of many-electron atoms and ions

Abstract

A fully analytical approximation for the observable characteristics of many-electron atoms is developed via a complete and orthonormal hydrogen-like basis with a single-effective charge parameter for all electrons of a given atom. The basis completeness allows us to employ the secondary-quantized representation for the construction of regular perturbation theory, which includes in a natural way correlation effects, converges fast and enables an effective calculation of the subsequent corrections. The hydrogen-like basis set provides a possibility to perform all summations over intermediate states in closed form, including both the discrete and continuous spectra. This is achieved with the help of the decomposition of the multi-particle Green function in a convolution of single-electronic Coulomb Green functions. We demonstrate that our fully analytical zeroth-order approximation describes the whole spectrum of the system, provides accuracy, which is independent of the number of electrons and is important for applications where the Thomas–Fermi model is still utilized. In addition already in second-order perturbation theory our results become comparable with those via a multi-configuration Hartree–Fock approach.

66. Viktor Otchik. Nonrelativistic particle with spin in the Lobachevsky space

Abstract

Nonrelativistic limit of wave equations with spins 1/2 and 1 on the background of space-time with Lobachevsky space as spatial part is considered. Separation of variables in the spherical coordinates is carried out and approximate formulas for energy levels are obtained.

67. Vadzim Haurysh. Radiative decays of meson in point form of PiQM

Abstract

In the course of the work the authors apply the obtained values of the constituent quark masses and the parameters of the wave functions to calculate the observed radiative decays of mesons with further analysis of the structure functions of the decay: a technique was demonstrated for obtaining the magnetic moments of light sector quarks in the case of the simplest mechanism of the $V\rightarrow P \gamma$ decay. This technique is generalized to the case of decay with subsequent numerical modeling of the behavior of the structure functions of hadronic transitions for this decay.

68. Andrei Manko. The two-photon production W bosons pair at colliders at the leading and the next-to-leading order

Abstract

The production W boson pairs in the approximation of equivalent photons (Weizsacker-Williams approximation) were studied at this report. These processes production were studied in the leading and the next-to-leading order at LHC. The total and differential cross sections of these processes production of particles are obtained for LHC and ILC(CLIC).

Alphabetic List of Participants

Aimuratov, Yerlan (Sapienza University of Rome, Italy)
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The Third Zeldovich Meeting
SNAUPS-18

April 23-27, 2018, Minsk, Belarus

PROGRAM & ABSTRACTS

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CELEBRATING THE 50TH ANNIVERSARY OF THE FIRST NEUTRON STAR DISCOVERY MARKING THE BIRTH OF RELATIVISTIC ASTROPHYSICS

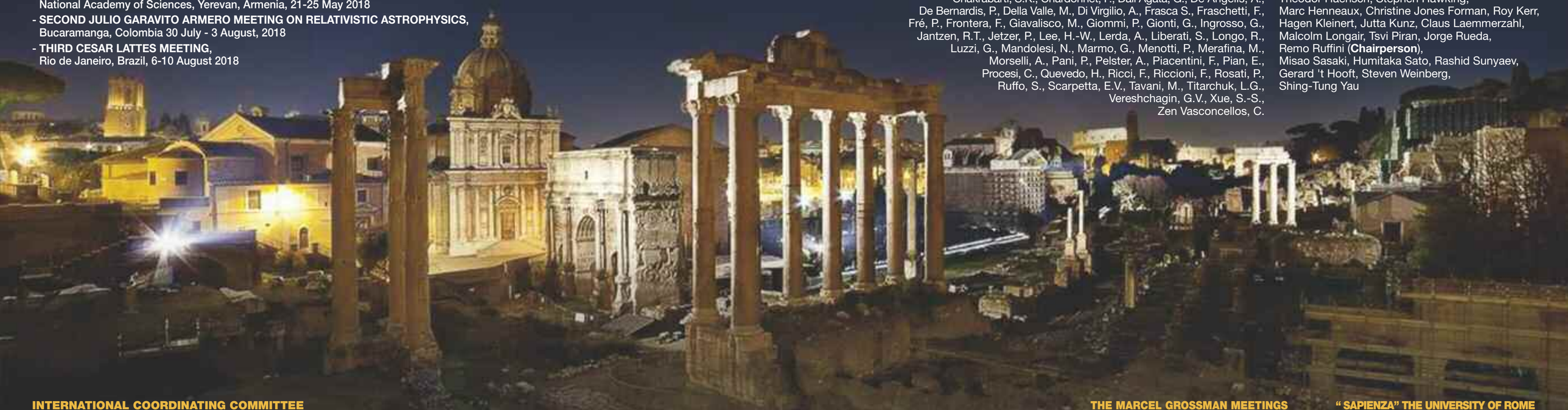
United Nations Educational, Scientific and Cultural Organization

FIFTEENTH MARCEL GROSSMANN MEETING

ON RECENT DEVELOPMENTS IN THEORETICAL AND EXPERIMENTAL GENERAL RELATIVITY, ASTROPHYSICS, AND RELATIVISTIC FIELD THEORIES

SATELLITE MEETINGS

- **THIRD ZELDOVICH MEETING,** National Academy of Sciences of Belarus, Minsk, Belarus, 23-27 April 2018
- **FIRST MARKARIAN MEETING,** National Academy of Sciences, Yerevan, Armenia, 21-25 May 2018
- **SECOND JULIO GARAVITO ARMERO MEETING ON RELATIVISTIC ASTROPHYSICS,** Bucaramanga, Colombia 30 July - 3 August, 2018
- **THIRD CESAR LATTES MEETING,** Rio de Janeiro, Brazil, 6-10 August 2018



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THE MARCEL GROSSMAN MEETINGS

Since 1975, the Marcel Grossman Meetings have been organized in order to provide opportunities for discussing recent advances in gravitation, general relativity and relativistic field theories, emphasizing mathematical foundations, physical predictions and experimental tests. The objective of these meetings is to elicit exchange among scientists that may deepen our understanding of space-time structures as well as to review the status of ongoing experiments aimed at testing Einstein's theory of gravitation and relativistic field theories either from the ground or from space. Previous meetings have been held in Trieste (1975) and (1979), Shanghai (1982), Rome (1985), Perth (1988), Kyoto (1991), Stanford (1994), Jerusalem (1997), Rome (2000), Rio (2003), Berlin (2006), Paris (2009), Stockholm (2012) and Rome (2015). Interested scientists should address a member from any one of the organizing committees or the conference secretariat.

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" SAPIENZA" THE UNIVERSITY OF ROME

With approximately 120,000 students and 60 Institutions, the University "la Sapienza", "Studium Urbis" in Latin, has become the largest center of learning in the Mediterranean. It was founded in 1303 by Pope Bonifacio VIII. In 1431 by the will of Pope Eugenio IV the University was given a fixed endowment. In 1527 the students gave origin to various Academies and the topics of teaching were further extended. In 1660 three major institutions were founded: the main library "Alessandrina", the splendid Botanical Garden on the Gianicolo Hills, both still operating today, the church "S. Ivo" and the palace of "la Sapienza", designed by Borromini, today part of the Senate of the Italian Republic. In 1935 part of the University was transferred to the new campus, designed by Piacentini, where Tullio Levi-Civita and Enrico Fermi were members of the Faculty of Sciences.

With the participation of

PROGRAM

MG

XV

STUDIUM URBIS

1 - 7 July 2018

Monday morning, July 2nd
Sapienza University, Rome - Aula Magna

09:00 - 09:35

Inaugural Session and delivery of Marcel Grossmann Award

Chairperson: Ruffini Remo

Plenary Session: Mathematics and General Relativity

Chairperson: Ruffini Remo

09:35 - 10:10 Lectio Magistralis	**Shing-Tung Yau** (Harvard University) Quasi-local mass at null infinity
10:10 - 10:45	**Rashid Sunyaev** (Max Planck Institute for Astrophysics)
10:45 - 11:15	**Coffee Break**
11:15 - 11:50	**Malcolm J. Perry** (University of Cambridge) Black Hole Entropy and Soft Hair
11:50 - 12:25	**Thomas Hertog** (KU Leuven) A smooth exit form eternal inflation
12:25 - 13:00	**Jean-Luc Lehners** (Max Planck Institute for Gravitational Physics) No smooth beginning for spacetime
13:00 - 13:35	**Ivan Agullo** (Louisiana State University) Loop Quantum Cosmology and the Cosmic Microwave Background
13:35	**Group Picture**
15:15 - 19:15	**Parallel Sessions**
19:30 - 20:00 Public Lecture	**Jeremiah Ostriker** (Columbia University) Ultra-light scalars as cosmological dark matter
20:00 - 20:30 Public Lecture	**Malcolm Longair** (University of Cambridge) Ryle and Hewish: 50 and 100 Year Anniversaries [Radio Astrophysics and the Rise of High Energy Astrophysics]

Monday afternoon, July 2nd

Code	Classroom	Title	Chairperson
Aula Magna - Discussions on plenary presentations			
AC1 A	GEO11	Spectral and Temporal properties of Black Holes and neutron stars and the theoretical models	Sandip Chakrabarti
BH2 A	FF4	Theoretical and observational studies of astrophysical black holes	Alexander Zakharov
BH5 A	GEO8	Black hole thermodynamics	Hernando Quevedo
AT1 A	CNR/Marc	Extended Theories of Gravity and Quantum Cosmology	Salvatore Capozziello, Mariafelicia De Laurenti
AT1 E	CNR/Poli	Extended Theories of Gravity and Quantum Cosmology	Salvatore Capozziello, Mariafelicia De Laurenti
AT3 A	GEO1	Wormholes, Energy Conditions and Time Machines	Francisco Lobo, Diego Rubiera-Garcia
AT7 A	ChA	Theories of gravity: alternatives to the cosmological and particle standard models	Stefano Bellucci, Valerio Faraoni and Orlando Luongo
DM1 A	ChC	Interacting Dark matter	Nikolaos Mavromatos
DE1 A	FF6	Dark Energy and the accelerating universe	Alexei Starobinsky, David Polarski
CM5 A	Amaldi	Present and future of CMB observations	Marco Bersanelli and Aniello Mennella
GW1 A	FF3	Sources of Gravitational Waves	Andrew Melatos
GW7	Cabibbo	Ground-based detectors: from second to third generationm	Giovanni Losurdo
GB4	FF2	Photospheric emission in GRBs	Gregory Vereshchagin, Damien Begue
CM2	Careri	Cosmic Backgrounds from radio to far-IR	Carlo Burigana
GB8	Conversi	GRB 130427A, 160509A, 160625B, The Polar View of BdHNe Morphology	Binbin Zhang, Yu Wang
EU2 A	MATHPic	Quantum Fields	Vladimir Belinski
ES3	MATH4	Exact Solutions (including higher dimensions)	Susan Scott
QG2 A	ChIV	Quantum Gravity Phenomenology	Giovanni Amelino-Camelia
PT2 A	FF5	Gravitational lensing and shadows	Perlick Volker, Oleg Tsupko
PT3 A	FF7	Experimental Gravitation	Angela di Virgilio, Claus Laemmerzahl
HE7	CNR/Conv	Future missions for high-energy astrophysics	Lorenzo Amati, Enrico Bozzo
HR2	MATH5	Angelo Secchi and Astrophysics	Paolo De Bernardis, Gabriele Gionti, Costantino Sigismondi

Tuesday morning July 3rd
Sapienza University, Rome - Aula Magna

Plenary Session: Kilonovae and Gravitational Waves

Chairperson: Enrico Costa

09:00 - 09:35	**Elena Pian** (IASF Bologna) Kilonovae: the cosmic foundries of heavy elements
09:35 - 10:10	**Nial Tanvir** (University of Leicester) A new era of gravitational-wave/electromagnetic multi-messenger astronomy
10:10 - 10:45	**Tsvi Piran** (Hebrew University of Jerusalem) Mergers and GRBs: past present and future
10:45 - 11:15	**Coffee Break**
11:15 - 11:50	**Stephan Rosswog** (Stockholm University) Neutron star mergers as heavy element production site
11:50 - 12:25	**David Shoemaker** (MIT LIGO Laboratory) LIGO's past and future observations of Black Hole and Neutron Star Binaries
12:25 - 13:00	**Wang Yu** (ICRANet) On the role of binary systems in GW170817/GRB170817A/AT2017gfo
13:00 - 13:35	**Hao Liu** (University of Copenhagen) An independent investigation of gravitational wave data
15:15 - 19:15	**Parallel Sessions**
19:30 - 20:00 Public Lecture	**Marc Henneaux** (Université Libre de Bruxelles) The cosmological singularity
20:00	**SYSU Connection** Reception sponsored by the Sun Yat-Sen University - China

Tuesday afternoon, July 3rd

Code	Classroom	Title	Chairperson
		Aula Magna - Discussions on plenary presentations	
AC1 B	GEO11	Spectral and Temporal properties of Black Holes and neutron stars and the theoretical models	Sandip Chakrabarti
BH2 B	FF4	Theoretical and observational studies of astrophysical black holes	Alexander Zakharov
BH5 B	GEO8	Black hole thermodynamics	Hernando Quevedo
AT1 B	CNR/Marc	Extended Theories of Gravity and Quantum Cosmology	Salvatore Capozziello, Mariafelicia De Laurentis
AT2	MATH4	The Einstein-Infeld-Hoffmann Legacy in Mathematical Relativity	Shadi Tahvildar-Zadeh, Michael Kiessling
AT3 B	GEO1	Wormholes, Energy Conditions and Time Machines	Francisco Lobo, Diego Rubiera-Garcia
AT7 B	ChA	Theories of gravity: alternatives to the cosmological and particle standard models	Stefano Bellucci, Valerio Faraoni and Orlando Luongo
DM1 B	ChC	Interacting Dark matter	Carlos Arguelles
DE1 B	FF6	Dark Energy and the accelerating universe	Alexei Starobinsky, David Polarski
CM4 A	FF5	Tensions on LCDM cosmological model and model-independent constraints	Joan Solà Peracaula, Luca Amendola
CM5 B	Careri	Present and future of CMB observations	Marco Bersanelli, Aniello Mennella
CM3	Amaldi	Future Steps in Cosmology with CMB Spectral Distortions	Jens Chluba
GW1 B	FF3	Sources of Gravitational Waves	Andrew Melatos
GW4	Cabibbo	Middle-Frequency (0.1 Hz to 10 Hz)Gravitational Wave (GW) Detection and its Sources	Wei-Tou Ni
GB3	CNR/Conv	Cosmology and multi-messenger astrophysics with Gamma-Ray Bursts	Lorenzo Amati, Massimo Della Valle, Paul O'Brien
GB1	CNR/Poli	Fast radio bursts: observations ideas and prospects	Bing Zhang, Duncan Lorimer
GB9	Conversi	GRB 151027A and GRB 090618, the equatorial view of BdHNe	Grant Mathews
EU2 B	MATH1	Quantum Fields	Alexander Kamenshchik
QG2 B	ChIV	Quantum Gravity Phenomenology	Giovanni Amelino-Camelia
NS1-2	FF2	Observational Constraints on the Micro and Macroscopic Properties of Compact Stars New States of Matter in the Universe - From quarks to the Cosmos	Jorge Rueda, Rodrigo Negreiros Aurora Perez Martínez, Cesar Augusto Vasconcello
PT4 A	Rasetti	Variation of the fundamental constants violation of the fundamental symmetries and dark matter	Victor Flambaum, Yevgeny Stadnik
PT3 B	FF7	Experimental Gravitation	Angela di Virgilio, Claus Laemmerzahl
PT5	CNR/Giac	Testing gravitation theories in space	Roberto Peron, Francesco Vespe
GW8	ChVIII	Dense stellar environments as sites of gravitational wave emission	Roberto Capuzzodolcetta, Manuel Arca Sedda
HE3	Lauree	The first Chinese X-ray astronomy mission Insight-HXMT at MGXV	Filippo Frontera, Shu Zhang
HE8	MATH5	Astronomical Data in the Multi-messenger era	Ulisses Barres de Almeida, Andy Pollock
HR1	FF8	History of Relativity and Cosmology	Christian Bracco, Tilman Sauer
SF1	ChD	Strong (EM) Fields Physics and Laboratory Astrophysics	Sang Pyo Kim, She-Sheng Xue

Wednesday morning, July 4th
Sapienza University, Rome - Aula Magna

Plenary Session: Future Precision Tests of GR

Chairperson: Laemmerzhal Claus

09:00 - 09:35	**Stefano Vitale** (University of Trento) Gravitation Wave Astronomy in ESA science programme
09:35 - 10:10	**Takaaki Kajita** (University of Tokyo) Status of KAGRA and its scientific goals
10:10 - 10:45	**Masaki Ando** (University of Tokyo) DECIGO: Gravitational-Wave Observation from Space
10:45 - 11:15	**Coffee Break**
11:15 - 11:50	**Jun Luo** (Sun Yat-Sen University) TianQin: a space-borne gravitational wave detector
11:50 - 12:25	**Jo Van Den Brand** (Dutch National Institute for Subatomic Physics Nikhef, and VU University Amsterdam) Gravitational wave science and Virgo
12:25 - 13:00	**Ernst Maria Rasel** (Leibniz Universität Hannover)
13:00 - 13:35	**Manuel Rodrigues** The first results of the MICROSCOPE test of the equivalence principle in space
15:15 - 19:15	**Free afternoon**
19:30	**Official Banquet** **Palazzo Colonna**

Thursday morning, July 5th
Sapienza University, Rome - Aula Magna

Plenary Session: GRBs and CMB

Chairperson: Tavani Marco

09:00 - 09:35	**Victoria Kaspi** (McGill University) Fast Radio Bursts
09:35 - 10:10	**Bing Zhang** (University of Nevada) From gamma-ray bursts to fast radio bursts: unveiling the mystery of cosmic bursting sources
10:10 - 10:45	**Jean-Loup Puget** The Planck mission
10:45 - 11:15	**Coffee Break**
11:15 - 11:50	**Jorge Armando Rueda Hernandez** (ICRANet) Binary-driven hypernovae and the understanding of gamma-ray bursts
11:50 - 12:25	**Remo Ruffini** (ICRANet) TBD
12:25 - 13:00	**Heino Falcke** (Radboud University Nijmegen) Imaging Black Holes now and in the future
13:00 - 13:35	**Luc Blanchet** (Institut d'Astrophysique de Paris) Post-Newtonian Theory and Gravitational Waves
15:15 - 19:15	**Parallel Sessions**
19:30 - 20:00 Public Lecture	**Jean-Loup Puget** The Planck mission
20:00 - 20:30 Public Lecture	**Lyman Page** (Princeton University) Measuring the Cosmic Microwave Background

Thursday afternoon, July 5th

Code	Classroom	Title	Chairperson
Aula Magna - Discussions on plenary presentations			
AC3 A	GEO11	Accretion discs and jets	Eva Hackmann and Audrey Trova
BH2 C	FF4	Theoretical and observational studies of astrophysical black holes	Alexander Zakharov
BH7 A	GEO8	Black Holes in Higher Dimensions (Black Rings and Black Strings)	Jutta Kunz
AT1 C	CNR/Marc	Extended Theories of Gravity and Quantum Cosmology	Salvatore Capozziello, Mariafelicia De Laurentis
AT1 E	CNR/Poli	Extended Theories of Gravity and Quantum Cosmology	Salvatore Capozziello, Mariafelicia De Laurentis
AC2	ChD	MHD processes near compact objects	Sergey Moiseenko
AT4 A	GEO1	Massive gravity and related modifications of General Relativity	Michael Volkov
DM4	FF6	Self Gravitating Systems and Dark Matter	Marco Merafina
CM4 B	FF5	Tensions on LCDM cosmological model and model-independent constraints	Joan Solà Peracaula and Luca Amendola
GW5-6	FF3	DECIGO The Role of Numerical Relativity in Gravitational Wave Observations	Masaki Ando, Niegel Bishop
GW9	Cabibbo	Advanced Data-Analysis Techniques for Gravitational-Wave Detection	Sergio Frasca, Paola Leaci
GB7	MATH4	Lessons from GW170817 / GRB170817A	Jonathan Granot
BN8	FF7	Relativistic Binary Stars Merging: Population Synthesis &/or Multimessanger Observations	Vladimir Lipunov
BN3	Conversi	NS-NS and NS-WD mergers and kilonovae	Jorge Rueda, Chris Belczynski
EU2 C	MATHPic	Quantum Fields	Andrei Lebed
QG3	ChA	Loop quantum gravity: cosmology and black holes	Parampreet Singh, Jorge Pullin
NS3	FF2	Different aspects of the QCD phase diagram investigated with hadronic models	Debora Peres Menezes, Constança Providência
PT4 B	Rasetti	Variation of the fundamental constants, violation of the fundamental symmetries and dark matter	Victor Flambaum, Yevgeny Stadnik
BN6	CNR/IAC	Post-Newtonian expansion and analytic approximations	Luc Blanchet
CS1	ChIV	Cosmic Strings	Reinoud Jan Slagter
HE1	Amaldi	Very High Energy Gamma Rays	Razmik Mirzoyan, Alessandro De Angelis
HE2	Careri	High Energy Astrophysical Neutrino detection	Antonio Capone
ED1	MATH5	Teaching Einsteinian Physics to School Students	David Blair, Matteo Ruggiero
BS2 A	CNR/Conv	Scalar fields in cosmology	Alfredo Macias, Darío Núñez

Friday morning, July 6th
Sapienza University, Rome - Aula Magna

Plenary Session: Multimessanger Astrophysics

Chairman: Giommi Paolo

09:00 - 09:35	**Razmik Mirzoyan** (Max Planck Institute for Physics) Gamma-Ray and Multi-Messenger Highlights with MAGIC
09:35 - 10:10	**Elisa Resconi** (Technical University Munich) Neutrino Astronomy in the Multi-messenger Era
10:10 - 10:45	**Francis Halzen** (University of Wisconsin-Madison) IceCube: Opening a New Window on the Universe from the South Pole
10:45 - 11:15	**Coffee Break**
11:15 - 11:50	**Jin Chang** (Chinese Academy of Sciences) DAMPE and its latest results
11:50 - 12:25	**Ralph Engel** (Karlsruhe Institute of Technology) What have we learned about ultra-high-energy cosmic rays from the Pierre Auger Observatory?
12:25 - 13:00	**Paolo De Bernardis** (Sapienza - University of Rome)
13:00 - 13:35	**Fabio Gargano** *DAMP*E and its latest results
15:15 - 19:15	**Parallel Sessions**
19:30 - 20:00 Public Lecture	**Anne Archibald**[1] Does extreme gravity affect how objects fall?

20:00 - 20:30 **James Lattimer** (Stony Brook University)
The history of r -process

Friday afternoon, July 6th

Code	Classroom	Title	Chairperson
		Aula Magna - Discussions on plenary presentations	
AC3 B	GEO11	Accretion discs and jets	Eva Hackmann, Audrey Trova
BH2 D	FF4	Theoretical and observational studies of astrophysical black holes	Alexander Zakharov
BH7 B-BH8	GEO8	Black Holes in Higher Dimensions (Black Rings and Black Strings) Hawking radiation in analogue black-holes	Jutta Kunz, Jeff Steinhauer
AT1 D	CNR/Marc	Extended Theories of Gravity and Quantum Cosmology	Salvatore Capozziello, Mariafelicia De Laurentis
AT1 F	CNR/Giac	Extended Theories of Gravity and Quantum Cosmology	Salvatore Capozziello, Mariafelicia De Laurentis
AT5	CNR/Poli	Constructive gravity	Marcus Werner
AT4 B	GEO1	Massive gravity and related modifications of General Relativity	Michael Volkov
AT6	ChA	Applied Newton-Cartan Geometry	Eric Bergshoeff
DE2	ChIV	Dark Energy and Large Scale structure	Radouane Gannouji, Clement Stahl
PT6	FF3	Fundamental physics in Space	Meike List
DE1 C	FF6	Dark Energy and the accelerating universe	Alexei Starobinsky, David Polarski
PT4 C	Rasetti	Variation of the fundamental constants, violation of the fundamental symmetries and dark matter	Victor Flambaum, Yevgeny Stadnik
GB6	Careri	GeV emission from Gamma Ray Bursts	Francesco Longo
GB11	Conversi	Plasma acceleration and transparency in GRBs	She-Sheng Xue and Carlo Luciano Bianco
ES1	ChD	Exact Solutions in Four and Higher Dimensions: Mathematical Aspects	George Alekseev, Fabio Briscese
QG1	FF7	Loop Quantum Gravity	Jerzy Lewandowski, Marcin Kisielowski
NS4	Cabibbo	Pulsars' methodology for fundamental physics	Andrea Possenti
PT2 B	FF5	Gravitational lensing and shadows	Perlick Volker, Oleg Tsupko
WD2	ChC	Origin and physics of Soft Gamma-ray Repeaters and Anomalous X-ray Pulsars	Manuel Malheiro
HE6	MATHPic	cosmic ray acceleration and radiative dissipation in relativistic jets and IceCube	Federico Fraschetti, Matthew G. Baring
HE5	Amaldi	Neutrino Astronomy	Paolo Padovani, Paolo Giommi
BN9	CNR/IAC	Gravitational interaction of n-pole point particles and higher-spin fields	Donato Bini, Jan Steinhoff
DM2	MATH5	Dark Matter and rare processes	Rita Bernabei and Zurab Berezhiani
BN4	FF8	End of white dwarfs and type Ia supernova	Yukikatsu Terada, Keiichi Maeda

Saturday morning, July 7th
Sapienza University, Rome - Aula Magna

Plenari Session: The frontiers

Chair: Fulvio Ricci

09:00 - 09:35	**Markus Arndt** (University of Vienna) Experiments to Probe Quantum Linearity at the Interface to Gravity & Complexity
09:35 - 10:10	**Tobias Westphal** (University of Vienna) Micro-mechanical measurements of weak gravitational forces
10:10 - 10:45	**Shu Zhang** (Institute of High Energy Physics) Introduction to Insight-HXMT: China's first X-ray Astronomy Satellite
10:45 - 11:15	**Coffee break**
11:15 - 11:50	**Lorenzo Amati** (INAF - OAS Bologna) Cosmology and multi-messenger astrophysics with Gamma-Ray Bursts
11:50 – 12.25	**Elisabetta Cavazuti** (ASI – Roma) Gev LAT observations from GRBs and active galactic nuclei
12:25 – 13:00	**Remo Ruffini** (ICRANet) Concluding Remarks **Roy Kerr** Towards MG16

World Scientific Open Access Proceedings information is available at the meeting website "Proceedings" link on the right side navigation panel.

CU001 AULA MAGNA

CU033 PHYSICS (Fermi)
Aula Cabibbo/FF Cabibbo
Aula 2/FF2
Aula 3/FF3
Aula 4/FF4
Aula 5/FF5
Aula 6/FF6
Aula 7/FF7
Aula 8/FF8

CU013 PHYSICS (Marconi)
Aula Amaldi/FMAmaldi
Aula Rasetti/FMRasetti
Aula Careri/FMCareri
Aula Conversi/FMConversi
Sala Lauree

CU014 CHEMISTRY (Cannizzaro)
Aula A/ChA
Aula C/ChC
Aula D/ChD

CU032 CHEMISTRY (Caglioti)
Aula IV/ChIV
Aula VIII/ChVIII

CU006 MATHEMATICS (Castelnuovo)
Aula Picone/MATPicone
Aula I/MATI
Aula IV/MATIV
Aula V/MATV

CU005 EARTH SCIENCES - GEOLOGY
Aula 1/GEO1
Aula 8/GEO8
Aula 11/GEO11

MG15

MARCEL GROSSMANN AWARDS

ROME 2018

ICRANet and ICRA

MG XV

MARCEL GROSSMANN AWARDS

ROME 2018

and

TEST

The 15th Marcel Grossmann Meeting – MG XV

2nd July 2018, Rome (Italy)

Aula Magna – University "Sapienza" of Rome

Institutional Awards

Goes to:
PLANCK SCIENTIFIC COLLABORATION (ESA)
"for obtaining important constraints on the models of inflationary stage of the Universe and level of primordial non-Gaussianity; measuring with unprecedented sensitivity gravitational lensing of Cosmic Microwave Background fluctuations by large-scale structure of the Universe and corresponding B-polarization of CMB, the imprint on the CMB of hot gas in galaxy clusters; getting unique information about the time of reionization of our Universe and distribution and properties of the dust and magnetic fields in our Galaxy"

- presented to **Jean-Loup Puget**, the Principal Investigator of the High Frequency Instrument (HFI)

HANSEN EXPERIMENTAL PHYSICS LABORATORY AT STANFORD UNIVERSITY
"to HEPL for having developed interdepartmental activities at Stanford University at the frontier of fundamental physics, astrophysics and technology"

- presented to Research Professor **Leo Hollberg**, HEPL Assistant Director

Individual Awards

Goes to
LYMAN PAGE
"for his collaboration with David Wilkinson in realizing the NASA Explorer WMAP mission and as founding director of the Atacama Cosmology Telescope"

Goes to
RASHID ALIEVICH SUNYAEV
"for the development of theoretical tools in the scrutinising, through the CMB, of the first observable electromagnetic appearance of our Universe"

Goes to
SHING-TUNG YAU
"for the proof of the positivity of total mass in the theory of general relativity and perfecting as well the concept of quasi-local mass, for his proof of the Calabi conjecture, for his continuous inspiring role in the study of black holes physics"

Each recipient is presented with a silver casting of the TEST sculpture by the artist A. Pierelli. The original casting was presented to His Holiness Pope John Paul II on the first occasion of the Marcel Grossmann Awards.

PLANCK SCIENTIFIC COLLABORATION (ESA)
presented to **Jean-Loup Puget**, the Principal Investigator of the High Frequency Instrument (HFI).

"for obtaining important constraints on the models of inflationary stage of the Universe and level of primordial non-Gaussianity; measuring with unprecedented sensitivity gravitational lensing of Cosmic Microwave Background fluctuations by large-scale structure of the Universe and corresponding B-polarization of CMB, the imprint on the CMB of hot gas in galaxy clusters; getting unique information about the time of reionization of our Universe and distribution and properties of the dust and magnetic fields in our Galaxy"

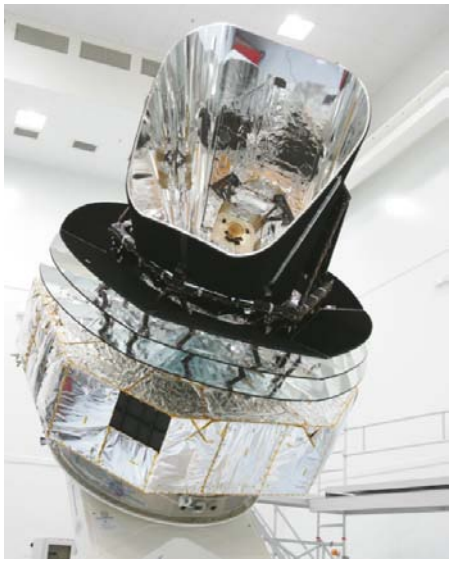
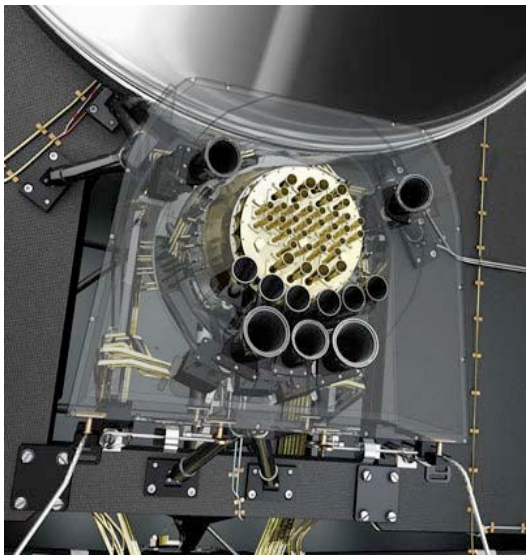


Photo of the Planck satellite (Courtesy of ESA).



Planck focal plane (Courtesy of ESA)

Planck ESA's mission, was designed to image the temperature and polarization anisotropies of the CMB over the whole sky, with unrivalled angular resolution and sensitivity, pushing the technology to unprecedent limits. In the framework of the highly precision experimental cosmology the legacy Planck results on testing theories of the early universe and the origin of cosmic structure, has provided a major source of information crucial to many cosmological and astrophysical issues. Planck carried out two instruments:

- the High Frequency Instrument (HFI), Principal Investigator: Jean Loup Puget;
- the Low Frequency Instrument (LFI), Principal Investigator: Nazzareno Mandolesi.

The instruments were complementary and using different technology to cross check independently final results and systematic errors. They worked together to produce the overall mission results. The Planck space mission (ESA) has been a wonderful example of Team effort in a large international collaboration, involving scientific, technical and managerial aspects. The unprecedented accuracy of the Planck measurements have established new standards in the determination of fundamental cosmological parameters, as well as new insight in Galactic and extragalactic astrophysics. The Planck full-sky maps in temperature and polarization will remain a lasting legacy for at least dozen years to come. More than 100 papers signed by Planck collaboration have already 30 000 citations in scientific literature. The success of Planck HFI and LFI would not have been possible without the contribution of a large number of talented and dedicated scientists and engineers from many countries of Europe, USA and Canada. HFI was designed to produce high-sensitivity, multi-frequency measurements of the diffuse radiation permeating the sky in all directions in the frequency range of 84 GHz to 1 THz cooled at 100 mK. The instrument consisted of an array of 52 bolometric detectors placed in the focal plane of the telescope. LFI, a microwave instrument, was designed to produce high-sensitivity, multi-frequency measurements of the microwave sky in the frequency range of 27 to 77 GHz. The instrument consisted of an array of 22 tuned radio receivers located in the focal plane of the telescope, cooled at 20 K.

Jean Loup Puget - PI of the HFI.

Nazzareno Mandolesi - PI of the LFI.

HANSEN EXPERIMENTAL PHYSICS LABORATORY AT STANFORD UNIVERSITY
presented to **Leo Hollberg**, HEPL Assistant Director
"to HEPL for having developed interdepartmental activities at Stanford University at the frontier of fundamental physics, astrophysics and technology"

Brief History of Stanford's HEPL and Ginzton Laboratories


1947: WW Hansen (right) and team with the Mark I linear accelerator

In 1947, working in the Stanford Physics Department's Microwave Lab, Physics Professor, William W. Hansen and his research team, along with Assistant Professor of Physics and microwave expert, Edward L. Ginzton, completed development on the world's first traveling wave electron linear accelerator. Dubbed the Mark I (see photo) it generated a 1.5 million electron volt (MeV) beam. Hansen's entire report to the U.S. Office of Naval Research (ONR) that funded the project was just one sentence: "We have accelerated electrons."
This successful first step in linear electron acceleration spawned the birth of Stanford's High Energy Physics Lab (HEPL) and Ginzton labs. In 1990, HEPL was renamed the WW Hansen Experimental Physics Lab (also HEPL). HEPL and Ginzton were setup as Stanford's first independent labs. They were organized to facilitate cross-disciplinary research, enabling scientists, engineers, staff and students to work towards common research goals using cutting edge lab equipment and technologies on medium-scale projects. For the past 70 years, the HEPL and Ginzton Labs have spearheaded Stanford's leadership in cross-disciplinary physics and become nurturing homes to a variety of physics-based, research projects: including the following examples:

Robert Hofstadter's Nobel Prize & Later Work
In 1961, Stanford Professor Robert Hofstadter was awarded the Nobel Prize for his HEPL Mark III Linear Accelerator work on nuclear form factors (nucleons). In the 1980s, Hofstadter became interested in astrophysics and helped design the EGRET telescope in the NASA Compton Gamma Ray Observatory (CGRO).

Gravity Probe B (GP-B)


2003: Francis Everitt (left) and Brad Parkinson holding a GP-B gyro

In 1959, Physics Department Chair, Leonard Schiff, became interested in using gyroscopes in a satellite to measure the Earth's geodetic effect and the miniscule frame-dragging effect predicted by Albert Einstein's general theory of relativity. Schiff discussed this project with Stanford cryogenic physicist, William Fairbank, and gyroscope expert, Robert Cannon (Aero-Astro department).
In 1962, Fairbank invited post-doc, Francis Everitt, to join the research effort. The team sent a proposal to NASA's Office of Space Sciences requesting funding to develop gyroscopes and a satellite to carry out this unprecedented test. It took 40 years of R&D at Stanford and other places to create and ready the cryogenic satellite and all of its cutting-edge technologies for launch. In 1975, Leonard Schiff moved the GP-B program to HEPL, breathing new life into the lab. In 1981, Francis Everitt became Principal Investigator, a position he still holds. In 1984, Brad Parkinson became Project Manager and a Co-PI, along with Co-PI's John Turneaure and Daniel DeBra.
On 20 April 2004, GP-B launched from Vandenberg AFB into a polar orbit. Data collection began on 28 August 2004 and lasted 50 weeks. Data analysis took five years in order to remove confounding factors in the data. The final results, published in PRL on 31 May 2011, yielded highly accurate geodetic and frame dragging measurements, with 0.28% and 19% margins of error, respectively.

GPS Spinoffs from GP-B
In the 1990s, Brad Parkinson's research on GPS solutions for positioning the GP-B satellite led to two revolutionary spin-off projects: 1) Wide Area Augmentation System (WAAS) provides highly precise positioning accuracy and itegrity for navigation and the automatic landing of airplanes and 2) Precision Farming adding GPS technology to tractors has enabled the automation of many aspects of farming and has spawned a $1 billion/year industry.

Fermi Gamma Ray Space Telescope (GLAST)


Peter Michelson, Fermi LAT Principal Investigator

Stanford Physics Professor, Peter Michelson, is a former HEPL Director and the Principal Investigator for the Large Area Telescope (LAT) on board NASA's Fermi Gamma Ray Space Telescope, the successor to CGRO/EGRET. Launched on 11 June 2008, Fermi has been highly successful mapping the gamma-ray sky. Under Michelson's guidance, HEPL's collaborations with Italy are noteworthy. The development of cryogenic bar detectors of gravitational waves, in collaboration with Edoardo Amaldi and his colleagues, established new stringent upper limits to the gravitational waves incident on the Earth. Likewise, the Fermi LAT was developed by a collaboration between Italian INFN and ASI, NASA, and international partners in France, Japan, and Sweden, and used tracking detectors developed, integrated, tested, and qualified for the mission by Italy. GP-B provided the first evidence of frame-dragging on a spinning, superconducting gyroscope. The Fermi detector offers the potential of seeing, through the GeV emission in the Binary Driven Hypernova subclass of long GRBs, the emission from a newly born Black Hole, originating in the induced gravitational collapse of a supernova hypercritically accreting on a binary neutron star companion.

Robert Byer's LIGO and ACHIP Projects

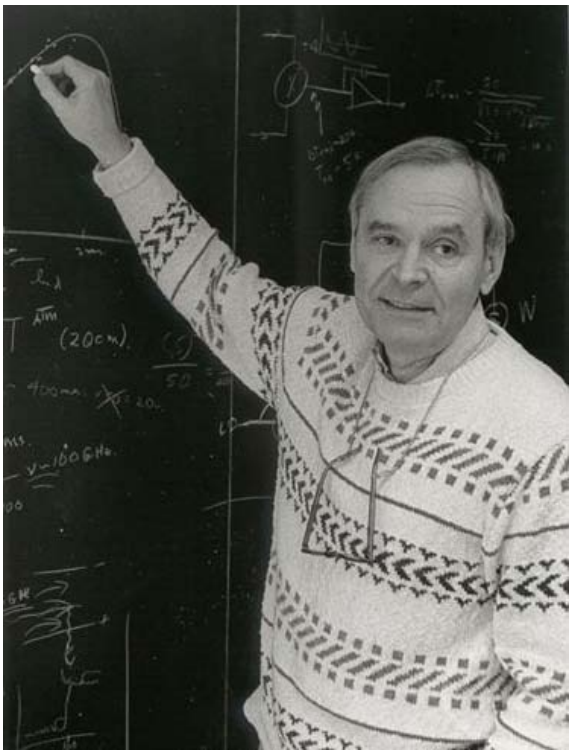

Professor Robert Byer

Robert Byer, former Stanford Dean of Research and former HEPL Director, nurtured the GP-B, GPS and Fermi programs to success during his tenure. He is currently an Applied Physics Professor specializing in lasers and optics. His LIGO Group provided seismic isolation, coatings and materials for the LIGO observatories. His ACHIP project is developing a particle accelerator on a microchip—bringing the HEPL/Ginzton Labs full circle to Hansen's 1947 research.

Professor **LYMAN PAGE**

"for his collaboration with David Wilkinson in realizing the NASA Explorer WMAP mission and as founding director of the Atacama Cosmology Telescope"

Lyman Page



David Wilkinson

This award is given in recognition of Lyman Page's pivotal role in transforming cosmic microwave background observations into a high-precision experimental science over the past two decades. In particular Page provided major contributions to the success of the Wilkinson Microwave Anisotropy Probe (WMAP) space mission, which delivered outstanding measurements of the CMB anisotropy and polarization pattern. He is now continuing his effort by promoting a new generation of experiments like the Atacama Cosmology Telescope to study CMB polarization to greater precision.

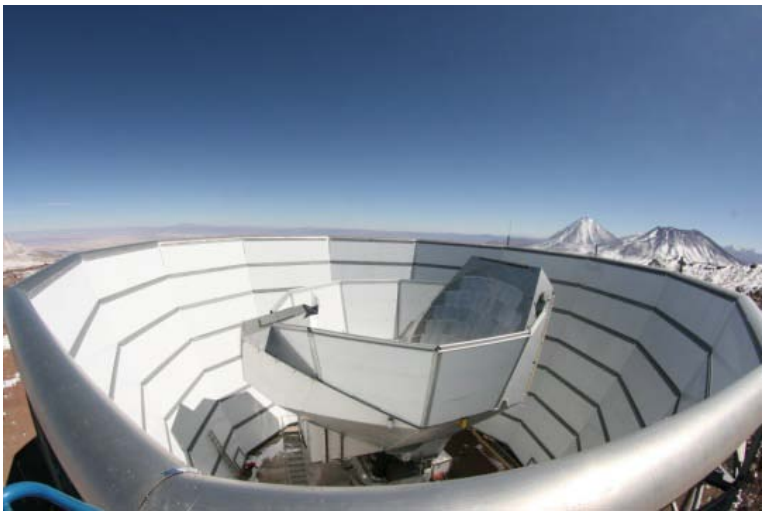


Photo of the Atacama Cosmology Telescope

The CMB, the faint afterglow of the Big Bang, is the most powerful probe of the early universe. From its study, we have learned the age of the universe, its major constituents, and have characterized the fundamental fluctuations in gravity that gave rise to cosmic structure. The desire to measure the CMB ever more precisely has driven the development of extraordinary detectors and techniques which will be reviewed in the Lectio Magistralis by Lyman Page. He will describe what we might hope to learn from the CMB in the next decade, including detecting gravitational waves from the birth of the universe if they exist at sufficient amplitude.

Professor **RASHID ALIEVICH SUNYAEV**

"for the development of theoretical tools in the scrutinising, through the CMB, of the first observable electromagnetic appearance of our Universe"

Rashid Sunyaev

Rashid Sunyaev and
Yakov Borisovich Zeldovich

Rashid Sunyaev gave extraordinary contributions to the understanding of physical processes in the universe which identified new and uniquely informative targets for observational cosmology. In particular, the Sunyaev-Zeldovich effect, now observed in thousands of clusters of galaxies over the entire sky, has become a cornerstone of cosmology and extragalactic astrophysics, so much so that it is now considered a research field in its own right. Furthermore, Sunyaev's studies of processes in the early universe responsible for angular anisotropy and frequency distortions of the cosmic microwave background have left a profound and lasting legacy for cosmology. In particular, Sunyaev and Zeldovich predicted the presence of acoustic peaks in the CMB angular fluctuation power spectrum and the existence of baryonic acoustic oscillations.
He is currently the project scientist leading the scientific team of the international high-energy astrophysics observatory Spektr-RG being built under the direction of the Russian Space Research Institute.

Yakov Zeldovich and Remo Ruffini at the audience with Pope John Paul II

Professor **SHING-TUNG YAU**
"for the proof of the positivity of total mass in the theory of general relativity and perfecting as well the concept of quasi-local mass, for his proof of the Calabi conjecture, for his continuous inspiring role in the study of black holes physics"

Shing-Tung Yau

Shing-Tung Yau has made fundamental contributions to differential geometry which have influenced a wide range of scientific disciplines, including astronomy and theoretical physics. With Richard Schoen, Yau solved a longstanding question in general relativity by proving that the combined total energy of matter and gravitational field in an asymptotically flat universe is positive. In 1982 Yau was awarded the Fields Medal, the highest award in mathematics, and in 1994 he shared with Simon Donaldson the Crafoord Prize of the Royal Swedish Society in recognition of his development of nonlinear techniques in differential geometry leading to the solution of several outstanding problems.

Another outstanding achievement of Yau is his proof of the Calabi conjecture which allowed physicists to show that string theory is a viable candidate for a unified theory of nature. Furthermore in 2008 Yau (with M.T. Wang) introduced the concept of "quasi-local mass" in general relativity which can be of help to get around the old conundrum — the non-locality of the energy density in relativistic gravity.

During his scientific carrier Yau had more than 50 successful PhD students. At present he is a professor of mathematics at Harvard University where along with research he continues many pedagogical activities. For example, he has created the "Black Hole Initiative", an interdisciplinary center at Harvard University involving a collaboration between principal investigators from the fields of astronomy (Sheperd Doeleman, Avi Loeb and Ramesh Narayan), physics (Andrew Strominger), mathematics (Shing-Tung Yau) and philosophy (Peter Galison). This "Black Hole Initiative" is the first center worldwide to focus on the study of the many facets of black holes.

MG16 in 2021 will mark the 50^{th} anniversary of the mass-energy formula for black holes based on the Kerr metric. This timing is an omen that Yau and his school will soon further enlarge our knowledge of this formula with their powerful mathematical analysis.

14th Marcel Grossmann Meeting
July 2015, Rome, Italy

Institutional Award
EUROPEAN SPACE AGENCY (ESA)
"for the tremendous success of its scientific space missions in astronomy, astrophysics, cosmology and fundamental physics which have revolutionized our knowledge of the Universe and hugely benefited science and mankind"

- presented to its Director General Johann-Dietrich Woerner

Individual Awards
KEN'ICHI NOMOTO
"for heralding the role of binary systems in the evolution of massive stars"

MARTIN REES
"for fostering Research in black holes, gravitational waves and cosmology"

YAKOV G. SINAI
"for applying the mathematics of chaotic systems to physics and cosmology"

SACHIKO TSURUTA
"for pioneering the physics of hot neutron stars and their cooling"

FRANK C.N. YANG
"for deepening Einstein's geometrical approach to physics in the best tradition of Paul Dirac and Hermann Weyl"

T.D. LEE (award received by Yu-Qing Lou on behalf of Prof. T.D. Lee)
"for his work on white dwarfs motivating Enrico Fermi's return to astrophysics and guiding the basic understanding of neutron star matter and fields"

13th Marcel Grossmann Meeting
July 2012, Stockholm, Sweden

Institutional Award
ALBANOVA
for its innovative status as a joint institute established by Stockholm University and the Royal Institute of Technology and for fostering contributions to cosmology and astrophysics in the profound scientific tradition established by Oskar Klein.

- presented to the Rector of Stockholm University, Prof. Kåre Bremer.

Individual Awards
DAVID ARNETT
for exploring the nuclear physics and yet unsolved problems of the endpoint of thermonuclear evolution of stars, leading to new avenues of research in physics and astrophysics.

VLADIMIR BELINSKI and I.M. KHALATNIKOV
for the discovery of a general solution of the Einstein equations with a cosmological singularity of an oscillatory chaotic character known as the BKL singularity.

FILIPPO FRONTERA
for guiding the Gamma-ray Burst Monitor Project on board the BeppoSAX satellite, which led to the discovery of GRB X-ray afterglows, and to their optical identification.

12th Marcel Grossmann Meeting
July 2009, Paris, France

Institutional Award
INSTITUT DES HAUTES ÉSTUDES SCIENTIFIQUE (IHÉS)
for its outstanding contributions to mathematics and theoretical physics, and notably for having renewed basic geometrical concepts, and having developed new mathematical and physical aspects of spacetime.
- presented to Prof. Jean-Pierre Bourguignon

Individual Awards
JAAN EINASTO
for pioneering contributions in the discovery of dark matter and cosmic web and fostering research in the historical Tartu Observatory.

CHRISTINE JONES
for her fundamental contributions to the X-ray studies of galaxies and clusters tracing their formation and evolution and for her role in collaborations using clusters to study dark matter and in analyzing the effects of outbursts from supermassive black holes on the intracluster gas.

MICHAEL KRAMER
for his fundamental contributions to pulsar astrophysics, and notably for having first confirmed the existence of spin-orbit precession in binary pulsars.

11th Marcel Grossmann Meeting
July 2006, Berlin, Germany

Institutional Award
FREIE UNIVERSITÄT BERLIN
for the successful endeavor of re-establishing — in the spirit of the Humboldt tradition — freedom of thinking and teaching within a democratic society in a rapidly evolving cosmos
- presented to Dr. Dieter Lenzen, President of FUB

Individual Awards
ROY KERR
for his fundamental contribution to Einstein's theory of general relativity: "The gravitational field of a spinning mass as an example of algebraically special metrics."

GEORGE COYNE
for his committed support for the international development of relativistic astrophysics and for his dedication to fostering an enlightened relationship between science and religion.

JOACHIM TRUMPER
for his outstanding scientific contributions to the physics of compact astrophysical objects and for leading the highly successful ROSAT mission which discovered more then 200,000 galactic and extragalactic X-ray sources: a major step in the observational capabilities of X-ray astronomy and in the knowledge of our universe.

10th Marcel Grossmann Meeting
July 2003, Rio di Janiero, Brazil

Institutional Award
CBPF (Brazilian Center for Research in Physics)
for its role as a teaching and research institution and as a place originating fundamental physics ideas in the exploration of the universe.
- presented to its founders Cesar Lattes, Josè Leite Lopez and Jayme Tiomno

Individual Awards
YVONNE CHOQUET-BRUHAT AND JAMES W. YORK, JR.
for separate as well as joint work in establishing the mathematical framework for proving the existence and uniqueness of solutions to Einstein's gravitational field equations.

YUVAL NE'EMAN
for his contributions to science, epistimology, mathematics and physics from subnuclear to space sciences.

9th Marcel Grossmann Meeting
July 2000, Rome, Italy

Institutional Award
SOLVAY INSTITUTES
for identifying and recording in discussions by the protagonists the crucial developments of physics and astrophysics in the twentieth century.
- presented to Jacques Solvay

Individual Awards
CECILLE AND BRYCE DEWITT
for promoting General Relativity and Mathematics research and inventing the "summer school" concept.

RICCARDO GIACCONI
for opening, five successive times, new highways for exploring the Universe.

ROGER PENROSE
for extending the mathematical and geometrical foundations of General Relativity.

8th Marcel Grossmann Meeting
June 1997, Jerusalem

Institutional Award
HEBREW UNIVERSITY
for its role as a cradle of Science and Humanities and for hosting the manuscripts of Albert Einstein.
- presented to M. Magidor, President of the Hebrew University of Jerusalem

Individual Awards
TULLIO REGGE
for his contributions to the interface between mathematics and physics leading to new fields of research of paramount importance in relativisic astrophysics and particle physics.

FRANCIS EVERITT
for leading the development of extremely precise space experiments utilizing superconducting technology to test General Relativity and the Equivalence Principle.

7th Marcel Grossmann Meeting
June 1994, Stanford, USA

Institutional Award
SPACE TELESCOPE SCIENCE INSTITUTE
for its critical role in the direction and operation of the Hubble Space Telescope, a truly unique international laboratory for the investigation and testing of general relativity in the context of modern astrophysics and cosmology.
- presented to Peter Stockman

Individual Awards
SUBRAHMANYAN CHANDRASEKHAR
for his contributions to the analysis of gravitational phenomena from Newton to Einstein and especially for leading the way to relativistic astrophysics with the concept of critical mass for gravitational collapse.

JIM WILSON
for having built on his experience in nuclear physics, thermonuclear reactions, and extensive numerical simulation to create a new testing ground for the novel concepts of relativistic astrophysics.

6th Marcel Grossmann Meeting
June 1991, Kyoto, Japan

Institutional Award
RITP
for keeping alive first in Hiroshima and them in Kyoto research in relativity, cosmology, and relativistic field theory and the development of a school of international acclaim.
- presented to Professor K. Tomita

Individual Awards
MINORU ODA
for participating in the pioneering work of the early sixties in X-ray astronomy and for his subsequent molding of an agile and diversified Japanese scientific space program investigating the deepest aspects of relativistic astrophysics.

STEPHEN HAWKING
for his contributions to the understanding of spacetime singularities and of the large scale structure of the Universe and of its quantum origins.

5th Marcel Grossmann Meeting
August 1988, Perth, Australia

Institutional Award
THE UNIVERSITY OF WESTERN AUSTRALIA
for its contributions to relativistic astrophysics.
- presented to the Vice Chancellor, Professor Robert Smith

Individual Awards
SATIO HAYAKAWA
for his contributions to research in gamma, X-ray and infrared radiation as well as cosmic rays.

JOHN ARCHIBALD WHEELER
for his contributions to geometrodynamics and Einstein’s visions.

4th Marcel Grossmann Meeting
July 1985, Rome, Italy

Institutional Award
THE VATICAN OBSERVATORY
for its contributions to the origin and development of astrophysics.
- presented to His Holiness Pope John Paul II

Individual Awards
WILLIAM FAIRBANK
for his work in gravitation and low temperature physics.

ABDUS SALAM
for his work in unifying fundamental interactions.

TEST: **T**raction of **E**vents in **S**pace-**T**ime

Anna Imponente
National Gallery of Modern Art, Rome

The TEST sculpture provides an innovative example of interaction between science and art, not abstractly interpreted as a result of a subsequent critical analysis but indeed an active and creative collaboration between an astrophysicist and a sculptor.

In order to comprehend the meaning of collaboration between scientists and artists and to retrace its historical origin, we must go back to the Renaissance. There we find the so-called *Weltanschaung* and the idea of unitary art as a continuous and inseparable process of recognition of the structure of reality. This underlies the experience of Leonardo Da Vinci's talent, expressed in his drawings, of not separating scientific enquiry from artistic research.

In the seventeenth century, the "climb to the stars" of the stage machinery in baroque scenography, nourished by imagination, had loosened this link. It had coincided, on the one hand, with experimental Galilean sciences pursuing exact research towards a rational comprehension of the universe, and on the other hand, with the flourishing of the poetics of subjectivity, taste and feeling, the *beaux arts*, and a stratification of painting into specialistic genres.

In the nineteenth century, however, a new reversal of this trend can be observed: the scientific achievements of H.L. Helmholtz in the field of optics and of E. Chevreul in that of chemistry helps *pointillistes* painters in the separation of color. Furthermore, at the beginning of the twentieth century (1907) the Cubist revolution, which changes the concepts of space and time towards a simultaneity of vision, is synchronized with Einstein's theory of special relativity (1905).

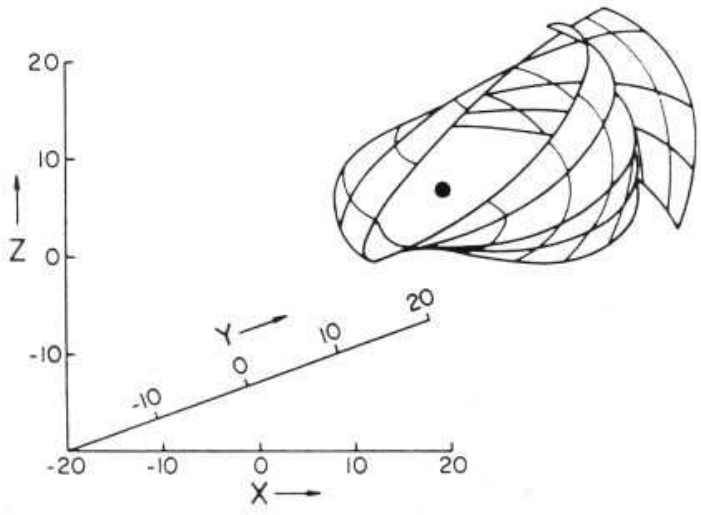
$$\dot{r} = \rho^{-2}\{[E(r^2+a^2) - a\Phi]^2 - \Delta(\mu^2 r^2 + K)\}^{1/2}$$

$$\dot{\theta} = \rho^{-2}\{K - (\Phi - aE)^2 - \cos^2\theta[a^2(\mu^2 - E^2) + \Phi^2 \sin^{-2}\theta]\}^{1/2}$$

$$\dot{t} = -a\rho^{-2}(aE\sin^2\theta - \Phi) + \rho^{-2}(r^2+a^2)\Delta^{-1}P$$

$$\dot{\phi} = -\rho^{-2}(aE - \Phi\sin^{-2}\theta) + a\rho^{-2}\Delta^{-1}P$$

$$E = .968\ ,\ \Phi = 2\ ,\ Q = 10\ ,\ a = e = 1/\sqrt{2}$$



Equations for a family of geodesics in a Kerr black hole and their graphical representation (*M. Johnston and R. Ruffini, 1974*).

The relationship between Remo Ruffini and Attilio Pierelli was not one of director/implementer nor could it exactly be defined as a four-handed performance. It has instead been a line of work suggested to the artist by a graphic design which had already been scientifically tested and computerized by M. Johnston and Ruffini at Princeton University in 1974.

This scientific investigation concerned the calculation of the geometric motion of five particles moving in space-time according to the application of a solution of Einstein's equations; the *in vitro* materialization and the visible replica of the discovery of a phenomenon existing in our own galaxy, namely the *black hole*, consisting of a stellar mass which is sucked into itself by gravitational collapse under the effect of its own self-gravity.

The encounter between Ruffini and Pierelli was not just a coincidence. On the one hand, there is the scientist, who in investigating astrophysical laws has always matched the exactness of results with the acknowledgement of a natural elegance of formulas, approaching an aesthetic outline of the detailed calculations. On the other hand, there is the sculptor, who appeases his eagerness for geometry by the contemplation of intricate reflecting symmetries and by perspective-illusive visions based on proportionate sizes, with the intention of proving the poetry of pure science before it becomes a technological adventure. In the theoretical formulation of his research on space, Pierelli has surveyed the history of mathematical thought and non-Euclidean geometries, deriving his hyperspatial shapes from the investigations of Gerolamo Saccheri, a Jesuit philosopher and mathematician of the seventeenth century.

The intuition of the aesthetic potential of this new form derived from the integration of Einstein's equations and describing the geodesics or trajectories of bodies around a black hole is compared by Ruffini to the "Greeks' discovery of π and the circle, which led to Hellenic architecture and the column" (interview with R. Ruffini by F. Bellonzi, Rome, 1985). Initially in 1981 the structural novelty of this form was understood by the architect Maurizio Sacripanti when he considered it as a space one can enter with one's own body and perceive directly with one's senses (M. Sacripanti in *Catalogo Roma*, Palazzo delle Esposizioni, 1981).

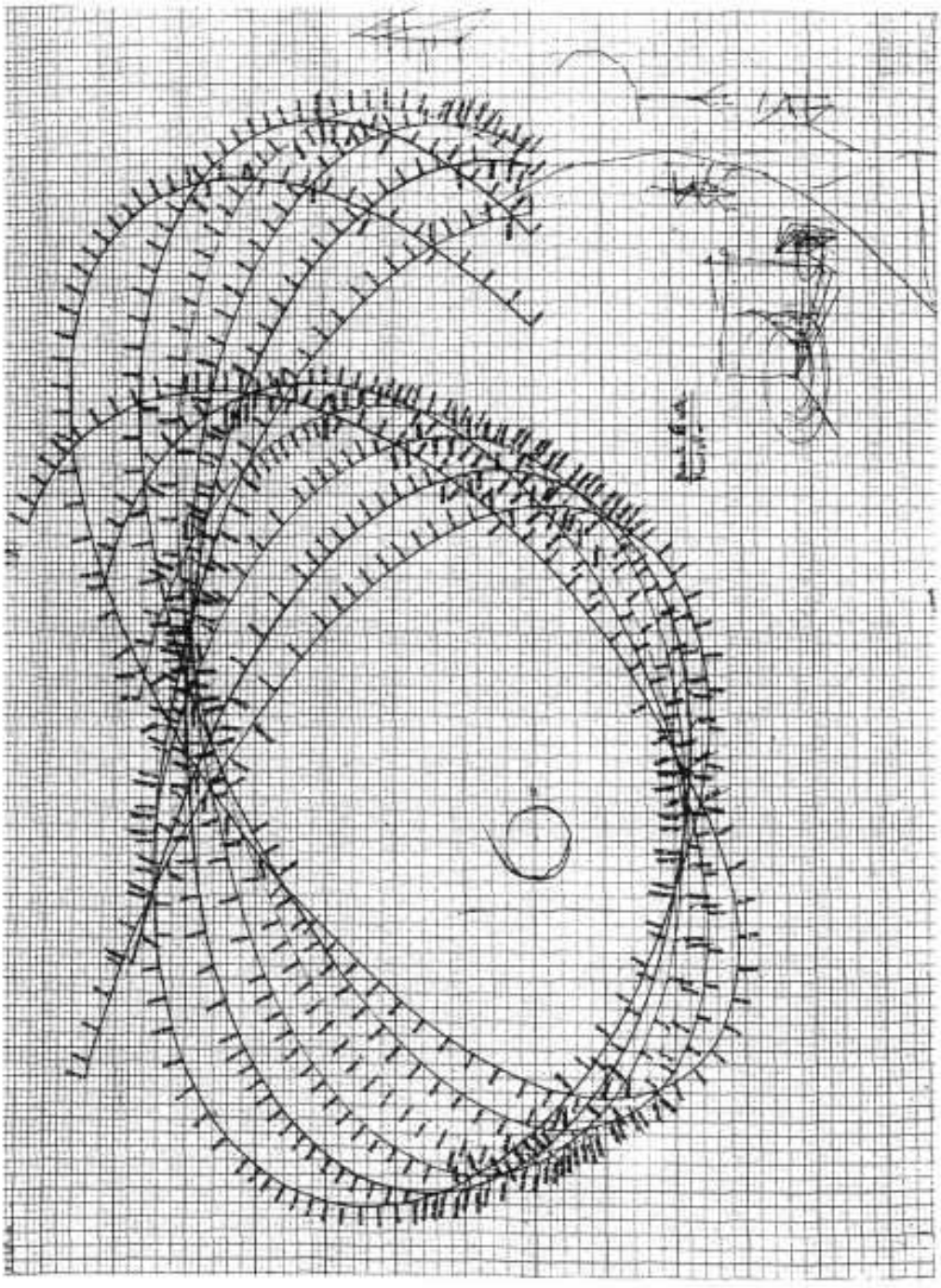
The initiation of this new work has the flavor of a challenge that the sculptor makes to himself, namely to represent the trajectories in a plastic form given their spatial co-ordinates—height, width and length—and to reinterpret them as an aesthetic object, using his own judgement to verify its artistic coherence.

TEST, sculpture by A. Pierelli, photo by S. Takahashi.

The realization of this project seems to be conceptually complex and revolutionary. It is meant to describe a motion, but not a terrestrial one, as the futurists and Boccioni had already done in 1913 with the famous sculpture *Unique forms in space continuity*. Nor should it be the motion of a body set free in the earth's gravitational field, which would fall either vertically or with elliptical or hyperbolic motions. Instead it should resemble a Möbius strip without being so simple, since it would be differentially dragged by the rotational field of the black hole in the geometry of space-time. Hence the acronym TEST which stands for "Traction of Events in Space-Time." Thus the sculpture has no priviledged interpretational directions and no supporting pedestal which might associate it with a central perspective view: no "top" or "bottom," no "right-side" or "left-side." Any orientation gives a complete and faithful realization.

Rather one should imagine it in rotation, with its surface being independent of any relation with the source of natural light ("ambientation" is the fundamental issue of sculpture), ignoring any possible atmospheric effect; in other words, the opposite of a "Mobile" of Calder which awaits a gust of wind to reanimate itself and come alive. Here, the metal light alone outlines and designs the vision of the rotating black hole. The transformation of this sequence of events into a solid form is portrayed by abstracting their properties and reducing everything to a direct perception of its essence, a *Wesenschau*. This representation does not lend itself to psychological or science-fictional interpretation and suggestion; the collective imagination can perceive and attain an emotional projection and exemplification of the universe, of egoism, since it involves a prehensile shape which absorbs and sucks in matter. Moreover, the title TEST, only by pure chance, includes the monogram "ET" which recalls the mythical encounter of a human being with the extraterrestrial of Steven Spielberg's fairy-tale film. There the emblematic image of the finger contact between the two had been borrowed from Michelangelo's *Creation of Man* in the Sistine Chapel while the return to space resembled a mythical ascension on the trail of the Christmas comet.

From a scientific point of view, the clear and lucid form of this sculpture might remind one of the application of mathematical logic to ideographic instantaneity that Giuseppe Peano carried out towards the end of the last century (G.C. Argan, 1985). And from a properly artistic perspective, it can be related to the philosophy of Russian Constructivism around 1920, and to the first clear perception, by Naum Gabo, of the unity of all visible forms and of the existence of aesthetic ones only in accordance with physical and



Three-dimensional trajectories of particles near a Kerr black hole
(*Calculations by V. Bellezza and V. Ferrari, drawing by M. Sacripanti*).

mathematical laws.

In the more recent context, characterized towards the late seventies by strong neo-expressionist and subjectivistic artistic movements, or neo-manner-ist re-evaluation of art from the past, interaction with science has meant above all the adoption and use of advanced technologies, the so-called "computer art." However, the use of media totally different from the traditional ones can change only the visual perception of the image and produce only a technical updating of the communication without necessarily yielding a new artistic message. On the other hand a "snapshot" which is new in concept and ichonography can also be expressed through the use of traditional and experimented techniques. Its very novelty may be expressed through the use of modules of different sizes and composition: namely in the form of a 20cm silver object, as in 1985, or in that of a 50cm bronze one, or in steel tubes, like the $340\times470\times260\text{cm}^3$ structure which was shown at the Venice Biennial Exhibition of 1986.

In the silence of his studio the artist finds his knowing craftsmanship, in making the moulds to be forged into metal and in his attempts to achieve the right shape of the torsions which express the intuition of their artistic value, with the light and opacity of the metal. With his mind, he tries not to betray the accuracy promised to the measurements of the curvatures and strives to make them coincide with his own geometric dream.

The discovery of a form which is not an invention, but bears the simple beauty and the perfection of an archetype existing in nature, leads one to re-experience aesthetically the same emotion that must have been felt by whoever discovered it first.

—English translation by Susanna Hirsch

TEST, sculpture by A. Pierelli, photo by S. Takahashi.

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ICRANET promotes international scientific cooperation and undertakes research in the field of Relativistic Astrophysics. Its activities are:

- development of scientific research
- teaching at doctorate and post-doctorate level
- long-term and short-term scientific training
- organization of workshops and scientific meetings
- arrangement of exchange programs for scientists and associates
- development of new standards of electronic communication among the Research Centers
- establishment of integrated data banks for all celestial bodies in all observable wave bands
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