

## **Enclosure 7**

### **International Meetings**





## ORGANIZATION

ICRANet Seats  
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## MEETINGS

Upcoming Meetings  
Marcel Grossmann  
Galileo - Xu Guangqi  
Italian-Korean  
C. Lattes Meeting  
Bego Scientific Rencontre  
Zeldovich Meetings  
Meetings in Armenia  
Past meeting series  
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ICRANet Workshops  
Other Meetings  
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## RESEARCH

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## PUBLICATIONS

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## OUTREACH

Newsletter  
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Recorded talks  
Public Events

**Visitors:** 181497766  
We have 1 guest online

## Niccolò Copernico e Gregorio XIII

24 Febbraio 2023 - 10:00-12:00

Aula Magna (2° piano), Ateneo Pontificio Regina Apostolorum, Roma  
Meeting online

Ateneo Pontificio Regina Apostolorum, Istituto Scienza e Fede  
in collaborazione con ICRANet di Pescara e Osservatorio Astrofisico di Asiago

## Scientific Rationale

[ITA] - [ENG]



Copernico a colloquio con Dio, del pittore Jan Matejko (1873), preparato per il quarto centenario della nascita dell'Astronomo polacco.

Comitato Organizzatore: Cesare Barbieri Università di Padova, Giuseppe Giudice Università di Napoli Federico II, Paolo Ochner Osservatorio Astrofisico di Asiago e Università di Padova, Cosimo Palagiano Accademia dei Lincei, Rafael Pascual APRA/ISF, Elena Piccoli Liceo Antonio Scarpa Motta di Livenza, Tiziana Pompa Liceo Galilei Pescara, Remo Ruffini ICRANet, Costantino Sigismondi APRA/ICRANet.

L'incontro ha avuto luogo nell'Aula Magna dell'Ateneo Pontificio Regina Apostolorum, Roma.

Il meeting online si è tenuto sulla piattaforma Zoom. [Link di accesso alla stanza.](#)

Lo stesso è stato trasmesso in streaming sul canale YouTube [Scienza e Fede](#) presso i seguenti link: [prima parte](#), [seconda parte](#).



## Link referenze

- Conferenza Copernicana, S. Maria degli Angeli 18 febbraio 2023: [youtu.be/N5283ov9D9o](https://youtu.be/N5283ov9D9o)
- L'ingresso nei Pesci alla Meridiana di piazza S. Pietro 18 febbraio 2023: [youtu.be/Maiojbl3oTE](https://youtu.be/Maiojbl3oTE)
- Il transito di Sirio alla Meridiana di piazza San Pietro 18 febbraio 2023: [youtu.be/mQPbeULS9gQ](https://youtu.be/mQPbeULS9gQ)
- Il passaggio del Sole alla Meridiana Clementina domenica 19 febbraio 2023: [youtu.be/GplFPBBpnFI](https://youtu.be/GplFPBBpnFI)
- Bolla Inter Gravissimas tradotta in Italiano: [http://dpgi.unina.it/giudice/calendar/Inter\\_Gravissimas.html](http://dpgi.unina.it/giudice/calendar/Inter_Gravissimas.html)
- L'Astronomo Copernico di Jan Matejko (1873): [en.wikipedia.org/wiki/Astronomer\\_Copernicus\\_or\\_Conversations\\_with\\_God](https://en.wikipedia.org/wiki/Astronomer_Copernicus_or_Conversations_with_God)
- Algoritmo lunare del calendario gregoriano: [Testo \(PDF\)](#), [Presentazione \(PPT\)](#), [Audio \(MP3\)](#)
- Presentazione del prof. Sigismondi: [Powerpoint \(PPT\)](#)

**Programma della giornata**

- 10:00 Accoglienza dei partecipanti e saluto del Direttore dell'ISF prof. Rafael Pascual, LC
- 10:10 Copernico, l'Astronomo e le Rivoluzioni
- 10:30 Copernico, il telescopio di Cima Ekar
- 10:50 pausa caffè
- 11:00 la bolla Inter Gravissimas di Gregorio XIII
- 11:20 il Sole nei Pesci con Sirio
- 11:40 Parco di meridiano e Cassini
- 12:00 Conclusioni e saluti

**Positional data of the solar image on the Clementine meridian line on 18 and 19 february 2023 and linear interpolation for the ingress in Pisces**

18 febbraio centro del Sole a 5035.75 mm dal 160 alle 12:24:12

centro riquadro Pesci a 5198 mm dal 160

19 febbraio centro del Sole a 5385 mm dal 160 alle 12:24:05

incremento in 24 ore 349.25 mm,

distanza tra il punto raggiunto il 18 feb al meridiano e i Pesci 162.25 mm,

ossia 11.15 ore = 11 ore 09 minuti

sommati alle 12:24 danno le 23:33 del 18 febbraio,

in ottimo accordo con le effemeridi che danno le 23:34 per l'ingresso geocentrico.



For suggestions&comments write to the [Webmaster](#).



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## Misurare il Sole con la Luna: l'eclissi solare anulare totale dal 1567 a oggi

Giornate Gerbertiane 2023

20 Aprile 2023 - 13:00-14:00 (YouTube)  
04 Maggio 2023 - 13:00-14:00 (YouTube)  
11 Maggio 2023 - 13:00-14:00 (YouTube)  
17 Maggio 2023 - 13:00-14:00 (YouTube)



Busto-Mira di Angelo Secchi sul Pincio; Eclissi di Sole del 20 aprile 2023 a Com (Timor Leste, courtesy of Institut Teknologi Sumatra; Macchia solare al lembo AR 3262 foto 23 aprile 2023 rifrattore 80 mm f/7.5 a Roma @540±10 nm. Papa Silvestro II (Torino, Lit. Giordana, Grandidier e Salussoia, 1854).

L'uno ha un diametro di un milione e mezzo di km, l'altra 3480 km, l'uno sta a 150 milioni di km dalla Terra, l'altra a 384 mila km... eppure giovedì 20 alle 3 di notte, a Timor Est, Oceano Indiano meridionale e Nord Ovest dell'Australia ci sarà una rara eclissi di Sole *ibrida*, cioè anulare verso gli estremi e totale al centro della *fascia*.

Noi usiamo la Luna, che non cambia il suo diametro da quando è solidificata, per misurare il Sole, conoscendo bene le distanze tra noi, la Luna e il Sole, e il profilo della Luna con un metro di accuratezza.

Per ottenere dati, questa volta, invece dei telescopi, ho proposto il telefonino in Telegramma degli Astronomi a tutta la comunità scientifica internazionale.

ATel #15991: [Videorecording Baily beads of the hybrid eclipse of 20 April 2023](#)

In questo ATel ho riassunto le molte lezioni che abbiamo fatto insieme per scoprire la ghost image del Sole. Ora ciò che abbiamo elaborato insieme nelle nostre aule è in giro per il Mondo. Provate a fare anche voi un video del Sole da 5 minuti, come uno dei tre video che ho messo nell'ATel. Avete anche altri due articoli da consultare: uno in [Inglese](#) per questo tipo di esperimento, e un altro in [Italiano](#) che include ed espande le spiegazioni su questo esperimento, con l'aggiunta di una introduzione storica e autobiografica

Già nel 2012 all'ICRANet a Pescara abbiamo tenuto il [Convegno internazionale in occasione dei 400 anni dalla morte di Clavio](#); giovedì 20 Aprile 2023 la giornata di studi è dedicata al tema dell'eclissi con un evento online sulle orme di Cristoforo Clavio, che la osservò e descrisse per primo, a Roma nel 1567. Giovedì 4 maggio è stato dedicato a preparare l'osservazione dell'eclissi di Luna di penombra del 5 maggio "gemellata" con quella di Sole del 20 aprile, e Giovedì 11 maggio con l'inaugurazione del volume 20 di Gerbertus con "Il Sole" di Angelo Secchi (Edizione Italiana del 1884, ora digitalizzata) e con una biografia di Gerberto d'Aurillac - papa Silvestro II, nel 1020° anniversario della sua morte.

Filmato dell'eclissi anulare-totale dall'Australia Occidentale.

### L'esperimento di Archimede per misurare il diametro solare

A Siracusa Archimede aveva escogitato di osservare il sorgere e il tramontare del Sole sul mare ponendo un cilindro su un righello. Da un capo del righello metteva l'occhio, e ad una distanza da misurare poneva il cilindro affinché il Sole fosse appena appena occultato. Abbiamo ripetuto l'esperimento con il banco ottico in laboratorio, in vista dell'eclissi anulare del 20 aprile, per entrare meglio nello spirito di questo evento astronomico con la scienza ad esso collegata.

Il testo di Archimede si chiama **Arenario** ed è uno dei primi testi classici che ho conosciuto quando ho iniziato a studiare il diametro solare.

[Video in laboratorio - Video analisi dati lavagna e con excel](#)  
[File excel con cui ho capito il problema dell'esperimento](#)  
[Playlist completa dei video dell'esperimento](#)

In pratica se avessimo considerato il "Sole" un po' più piccolo le frazioni si sarebbero eguagliate perfettamente; di fatto ho fermato il cilindro quando non vedevo più il disco rosso dietro di esso, ma se fosse stato il Sole avrei avuto ancora della luce abbagliante a destra e a sinistra del cilindro, che mi avrebbe costretto ad avvicinarlo all'occhio (o alla telecamera). È interessante farci notare come a questa conclusione ci siamo arrivati usando l'analisi dati e giocando con i parametri su Excel, come vi avevo predetto. Praticamente questo file Excel è un simulatore dell'esperimento di Archimede.

Date un'occhiata al [testo originale](#) di Archimede...

Link alla presentazione del prof. Virginio Oldani: [PDF](#) - [PowerPoint](#)

Lezione del 20 aprile 2023: [YouTube](#)

Lezione del 04 maggio 2023: [YouTube](#)

Lezione del 11 maggio 2023: [YouTube](#)

Eclissi di Luna di penombra del 5 maggio: [playlist](#) - [analisi dati \(PDF\)](#)

Vulcan and the solar oblateness (R9)<sup>2</sup> special meeting: [YouTube](#) - [PDF](#) - [audio \(M4A\)](#)

### Inaugurazione di Gerbertus 20

Il giornale dedicato alla storia e didattica della scienza, è arrivato al Volume 20!

Dal 2010: [www.icra.it/gerbertus](http://www.icra.it/gerbertus)

Tutti gli argomenti trattati fino ad ora sono a questo link:

[bibstem:Gerb - NASA/ADS \(harvard.edu\)](#)

Per l'anniversario gerbertiano 12 maggio 2023 numero 1020 (mori infatti il 12 maggio 1003) abbiamo pronto il numero 20 monografico, edizione digitale del Sole di Angelo Secchi. È un testo poco o niente conosciuto, perché ha avuto più fortuna l'edizione francese del 1877.

Il Sole uscì nel 1884 postumo, in Italiano, e resta un validissimo testo per capire cosa si vede osservando il Sole con uno strumento pregevole come il telescopio Merz da 25 cm di diametro e 2.5 metri di focale.

Questo telescopio bruciò nel luglio del 1958 quando si trovava nella cupola centrale di Monte Mario. Giuseppe Armellini, che era il direttore, morì di crepacuore qualche giorno dopo...

### Featuring

- [Annular-total eclipse 2023](#)
- [Solar diameter](#)
- [Solar oblateness](#)
- [Solar limb LDF](#)
- [Solar limb faculae](#)
- [Solar limb Wilson effect](#)
- [Archimedes](#)
- [Clavius](#)
- [J. A. Eddy](#)
- [GERBERTVS vol. 19 2023](#)

### Guests

- [Paolo Ochner, Osservatorio Astrofisico di Asiago e Università di Padova](#)
- [Virginio Oldani, SAS - Stazione Astronomica di Sozzago, Novara - \[presentazione \\(PDF\\)\]\(#\)](#)
- [Francesco Berrilli, Università di Roma Tor Vergata e Accademia dei Lincei](#)
- [Remo Ruffini, ICRA Net Pescara](#)

### Chair

- [Costantino Sigismondi](#)



Archimede, eclissi ibrida del 1966, J.A. Eddy e Clavio: personaggi della storia dell'astronomia legati a questo tipo di eclissi per lo studio del diametro solare

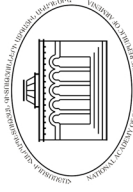
For suggestions&comments write to the [Webmaster](#)

# The Fifth Zeldovich Meeting

Yerevan, Armenia, 12 - 17 June 2023

Website: [www.icranet.org/zeldovich5](http://www.icranet.org/zeldovich5)

Contacts: [zeld5@icranet.org](mailto:zeld5@icranet.org)



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Rashid Sunyaev (Germany, Russia),  
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Igor Novikov, Askol'd Perelomov,

Vladimir Popov, Nikolai Shakura, Aleksei Starobinsky,  
Vladimir Surdin, **Slovakia:** Vladimir Balek,

**Slovenia:** Andreja Gomboc, **Kazakhstan:** Yerlan Aimuratov,  
Kuantay Boshkayev, Daniele Malafarina

**Ukraine:** Oleg Zaslavsky, **United Kingdom:** Alexander Pol-  
narev, **USA:** David Arnett, John Mester,  
**Vatican State:** Guy J. Consolmagno

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Mher Khachatryan, Manvel Manvelyan

**TOPICS**

- multimessenger astrophysics;
- early universe, large scale structure,
- cosmic microwave background;
- neutron stars, black holes, gamma-ray
- bursts, supernovae, hypernovae;
- gravitational waves;
- quantum and gravity.

The series of Zeldovich meetings started with the celebration of the International Year of Astronomy 2009 in Belarus. These international meetings are organized in honor of Yakov Borisovich Zeldovich, a brilliant Soviet physicist and the father of the Russian scientific school on Relativistic Astrophysics, born in Minsk. The Zeldovich meetings are organized by ICRAA.

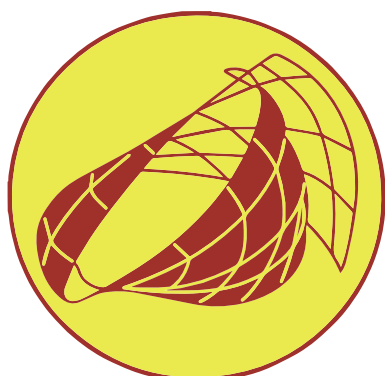




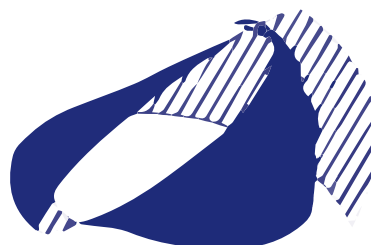
# The Fifth Zeldovich Meeting

12-16 June, 2023

## Booklet of abstracts and conference program



*ICRANet*



*ICRA*

**Venue and dates**

**Nairi Hall**

**Ani Plaza Hotel, 19 Sayat-Nova Ave, Yerevan,  
Armenia**

**12-16 of June, 2023**

# Monday, 12 June 2023

## Opening ceremony with honored guests (09:30 - 10:00)

-Conveners: Narek Sahakyan

## Coffee break (10:00 - 10:30)

## Monday morning session (10:30 - 13:00)

-Conveners: Remo Ruffini

time	[id] title	presenter
10:30	[18] SRG/eROSITA all-sky survey: from solar flares and neutrino sources to cosmology	GILFANOV, Marat
11:00	[53] Relativistic Jets from Tidal Disruption Events	PIRAN, Tsvi
11:30	[13] The Imaging X-ray Polarimetry Explorer (IXPE) results from the first 1.5 years of observation	SOFFITTA, Paolo
12:00	[32] Polarized light from accreting low mass X-ray binaries	CAPITANIO, Fiamma
12:30	[70] X-Ray Polarimetry: a new breakthrough in Relativistic Astrophysics (online talk)	COSTA, Enrico

## Monday afternoon session (15:00 - 18:00)

-Conveners: Hansjoerg Dittus

time	[id] title	presenter
15:00	[54] X-Ray and microwave cosmology: synergy and competition. What do we expect from the next generation X-ray and microwave telescopes? (online talk)	SUNYAEV, Rashid
15:30	[41] Breathing Fire: High-speed Ejecta from a Gamma-ray Binary	PAVLOV, George
16:00	[31] Three arguable concepts	SOBOUTI, Yousef
16:30	Coffee break	
17:00	[49] 25 years of GRB/SNe: an overview	MAZZALI, Paolo
17:30	[17] A new channel for supermassive black hole formation (online talk)	ARGÜELLES, Carlos Raúl

# Tuesday, 13 June 2023

## **Tuesday morning session (09:00 - 13:00)**

-Conveners: **Jorge Armando Rueda Hernandez**

time	[id] title	presenter
09:00	[5] Discoveries from FAST	LI, Di
09:30	[6] Black hole induced star formation in the early universe	MIRABEL, Felix
10:00	[19] Selected Studies of Cosmic and Gamma Rays with the MAGIC telescopes	MIRZOYAN, Razmik
10:30	Coffee break	
11:00	[48] Extreme Universe through the eyes of MASTER Robots	LIPUNOV, Vladimir
11:30	[74] The Cerenkov Telescope Array in a multi-wavelength context	PIAN, Elena
12:00	[28] Neutrino astronomy: IceCube results and the future of multimessenger searches	LINCETTO, Massimiliano
12:30	[24] Neutrino Telescope Baikal-GVD: Status and Nearest Future	DZHILKIBAEV, Zhan-Arys

## **Tuesday afternoon session (15:00 - 18:00)**

-Conveners: **Artur Hakobyan**

time	[id] title	presenter
15:00	[72] Are we prepared to observe the next Galactic Supernova? (online talk)	DELLA VALLE, Massimo
15:30	[21] Hubble Tension challenge in the modern cosmology: possible solutions	BISNOVATYI-KOGAN, Gennady
16:00	[14] Pair-balance model for relativistic shocks and its application to astrophysical sources	DERISHEV, Evgeny
16:30	Coffee break	
17:00	[52] The James Webb Space Telescope: status and science results (online talk)	STIAVELLI, Massimo
17:30	[38] The Science Promise Now Being Realized After JWST's Decades of Challenges (online talk)	ILLINGWORTH, Garth

# Wednesday, 14 June 2023

## Wednesday morning session (09:00 - 13:00)

-Conveners: Gregory Vereshchagin

time	[id] title	presenter
09:00	[15] Highlights of the Insight-HXMT X-ray Astronomy Satellite	ZHANG, Shuang-Nan
09:30	[33] The observation of GRB221009A from LHAASO	ZHA, Min
10:00	[75] GRB220101A the most powerful GRB ever with seven BdHN Episodes observed	RUFFINI, Remo
10:30	Coffee break	
11:00	[16] An electrodynamic process to extract the rotational energy of a Kerr black hole	RUEDA HERNANDEZ, Jorge Armando
11:30	[78] Gaining understanding of gravitational wave emission in the earliest phases of long GRBs: sweeping frequencies and energetics (online talk)	BIANCO, Carlo Luciano
12:00	[79] Exploring the Progenitor of the Crab Nebula and Crab Pulsar: Insights from Binary-Driven Hypernovae	MORADI, Rahim
12:30	[73] Newborn Neutron Star Activities in Gamma-ray Burst	WANG, Yu

## Wednesday afternoon session (15:00 - 18:00)

-Conveners: Gennady Bisnovatyi-Kogan

time	[id] title	presenter
15:00	[67] Gamma-ray burst observations with the GRB IKI Follow up Network	POZANENKO, Alexei
15:15	[11] Relativistic Jets from all angles	BENIAMINI, Paz
15:30	[81] Limitations on the emitting particles spatial distribution and heating mechanism in relativistic jets	FROLOVA, Valeriya
15:45	[84] Constraining Supernova Ia progenitors by their locations in host galactic disc	HAKOBYAN, Artur
16:00	[63] Radiative Penrose process: energy gain by a single radiating charged particle in ergosphere of rotating black hole	KOLOŠ, Martin
16:15	[66] Supermassive PeVatron at the Galactic centre	TURSUNOV, Arman
16:30	Coffee break	
16:45	[86] On direct and inverse Schwinger process in pair plasma	VERESHCHAGIN, Gregory
17:00	[91] Analyses of QPOs in the background of deformed compact object	TROVA, Audrey
17:15	[92] WIMP phenomenology in Dilatonic Einstein Gauss-Bonnet Cosmology	SCOPEL, Stefano

# Thursday, 15 June 2023

## Thursday morning session (09:00 - 13:00)

-Conveners: Yu Wang

time	[id] title	presenter
09:00	[87] Compact Star Merger as Progenitor of Low Redshift GRBs and the Occurrence Rates of Gravitational Sources and Kilonovae (online talk)	PETROSIAN, Vahe
09:30	[23] New quantum technologies and gravity	LAEMMERZAHN, Claus
10:00	[25] Quantum sensing – the key technology for further gravitational experiments in space	DITTUS, Hansjoerg
10:30	Coffee break	
11:00	[20] Influence of a plasma on the shadow of black holes	PERLICK, Volker
11:30	[46] Black holes in alternative theories of gravity	KUNZ, Jutta
12:00	[3] Near field cosmology with constrained simulations: an overview	GOTTLOEBER, Stefan
12:30	[82] Physics on the event horizon scale with millimetre and submillimetre interferometry	LOBANOV, Andrei

## Thursday afternoon session (15:00 - 18:00)

-Conveners: Jutta Kunz

time	[id] title	presenter
15:00	[59] Vacuum polarization around cosmic strings in anti-de Sitter spacetime	SAHARIAN, Aram
15:15	[50] Exploring second-order gravitational effects and the possibility for dark matter detection with the next generation of space-borne atomic standards of frequency and time	LITVINOV, Dmitry
15:30	[65] Gravity assist as a test of relativistic gravity	BOLOKHOV, Sergei
15:45	[68] Wormholes in a Friedmann universe	BRONNIKOV, Kirill
16:00	[37] Quantum-gravitational corrections to the power spectrum for a closed universe	VARDANYAN, Tatevik
16:15	[30] Electromagnetic field of a charged particle, asymptotically approaching Schwarzschild black hole	KOMAROV, Stanislav
16:30	Coffee break	
16:45	[89] Physics of quadrupolar compact astrophysical objects	FARAJI, Shokoufe
17:00	[45] Exploring massive neutron stars towards mass gap: Constraining the high-density nuclear equation of state	ZURAIQ, Zenia
17:15	[69] General radially moving reference frames in the black hole background	TOPORENSKY, Alexey
17:30	[62] On quasinormal modes in 4D black hole solutions in the model with anisotropic fluid	IVASHCHUK, Vladimir
17:45	[39] Symmetric periodic trajectories of charged particles in Gutsunaev--Manko spacetime	TEGAI, Sergey

# Friday, 16 June 2023

## Friday morning session (09:00 - 13:00)

-Conveners: Claus Laemmerzahl

time	[id] title	presenter
09:00	[55] New developments in the inflationary scenario	STAROBINSKY, Alexei
09:30	[12] Cosmology with Gamma-Ray Bursts (online talk)	AMATI, Lorenzo
10:00	[35] Astrophysical searches for primordial black holes	POSTNOV, Konstantin
10:30	Coffee break	
11:00	[22] The spectral signatures of BHs versus NS	TITARCHUK, Lev
11:30	[27] Neutron Stars as Strong Field QED Laboratory	KIM, Sang Pyo
12:00	[1] Black-hole bomb and confined Penrose process	ZASLAVSKII, Oleg
12:15	[83] The transformation of the rotational energy of a Kerr BH	ZHANG, Shurui
12:30	[36] Black entropy, Weyl curvature, and Christodoulou-Ruffini irreducible mass	GREGORIS, Daniele
12:45	[88] Probing episodes of phenomena associated with naturally produced GRB using X-ray free electron lasers	UKA, Arban

## Friday afternoon session (15:00 - 17:45)

-Conveners: Konstantin Postnov

time	[id] title	presenter
15:00	[26] Development of semi-implicit numerical method on a moving grid for differentially rotating astrophysical MHD flows with self-gravity.	MOISEENKO, Sergey
15:15	[42] Magnetized advective accretion disks and their stability at higher accretion rate: Theory and simulation	MUKHOPADHYAY, Banibrata
15:30	[64] Black hole extended thermodynamics	QUEVEDO, Hernando
15:45	[10] An improved Zeldovich formula for the Cosmological Constant from Precanonical Quantum Gravity	KANATCHIKOV, Igor
16:00	[51] Astrophysical scenarios leading to gravitational wave modification	NAIDOO, Monos
16:15	[60] Plausible detection of rotating magnetized neutron stars by their continuous gravitational waves	DAS, Mayusree
16:30	Coffee break	
16:45	[90] Revival of Descartes-Leibniz debate as a guide for a unification theory by removing singularities	UKA, Arban
17:00	[2] Warm Inflation using Irreversible Thermodynamical Approach	SALEEM, Rabia
17:15	[9] Anisotropic Strange Stars through Complexity Factor	SADIQ, Sobia
17:30	[61] A New Approach to Quantizing the General Relativity	TAWFIK, Abdel Nasser

## Concluding remarks (17:45 - 18:00)

-Conveners: Remo Ruffini

**Opening ceremony, 09:30-10:00, 12 of June 2023**

**Nairi Hall**

**Official opening ceremony with invited guests**

**Presentation of the Marcel Grossmann (MG16)  
Awards' sculpture to Marat Gilfanov on behalf of the  
Space Research Institute IKI of the Russian Academy  
of Sciences.**



## Monday morning session, 10:30-13:00, 12 of June 2023

Contribution ID: 18

### SRG/eROSITA all-sky survey: from solar flares and neutrino sources to cosmology

Monday, 12 June 2023 10:30 (30 minutes)

After more than two years of scanning the sky the eROSITA X-ray telescope aboard SRG orbital observatory produced the best ever X-ray maps of the sky and discovered more than three million X-ray sources, of which about 20% are stars with active coronas in the Milky Way, and most of the rest are galaxies with active nuclei, quasars and clusters of galaxies. eROSITA detected over  $10^3$  sources that changed their luminosity by more than an order of magnitude, including about a hundred tidal disruption events. Two tidal disruption events are associated with IceCube neutrinos. SRG/eROSITA samples of quasars and galaxy clusters will make it possible to study the large-scale structure of the Universe at  $z \sim 1$  and measure its cosmological parameters. I will review some of the SRG/eROSITA results in the Eastern Galactic hemisphere.

**Presenter:** GILFANOV, Marat (IKI, Moscow & MPA, Garching)

Contribution ID: 53

### Relativistic Jets from Tidal Disruption Events

Monday, 12 June 2023 11:00 (30 minutes)

Sw 1644 was one of the most surprising tidal disruption events (TDEs). Its prompt emission in soft gamma-rays triggered Swift. Later this was followed by X-ray and Radio afterglows. The energy implied by the radio afterglow increased by a factor of 10 over a period of a few hundred days, reaching an ultimate value of a few times  $10^{52}$  erg. This is much higher than in other TDEs. Recently several TDEs have shown a delayed radio emission that began a few years after the event. I show that both events can be explained as relativistic jets viewed off-axis. This requires an initially relativistic jet with  $10^{53}$  erg, making those events among the most energetic transient events. I will speculate on the origin of these events, as compared with regular TDEs that are significantly weaker, and on implications to other phenomena and in particular to the origin of Ultra High Energy Cosmic Rays.

**Presenter:** PIRAN, Tsvi (The Hebrew University)

Contribution ID: 13

### The Imaging X-ray Polarimetry Explorer (IXPE) results from the first 1.5 years of observation

Monday, 12 June 2023 11:30 (30 minutes)

The Imaging X-ray Polarimetry Explorer (IXPE) is a NASA-ASI Small Explorer mission selected on January 2017 and launched on 9<sup>th</sup> December 2021. Three X-ray mirrors are coupled to three De-

tector Units clocked at  $120^\circ$  each one hosting a Gas Pixel Detector, sensitive to X-ray polarization designed, built tested, and calibrated by INAF and INFN institutes. Some dozens of celestial X-ray sources, from almost all the classes, were observed so far, and for more than a half IXPE detected significant polarization. Some unexpected results were found by IXPE and in this talk after an introduction to the mission I will describe the main Astrophysical achievements reached so far

**Presenter:** SOFFITTA, Paolo (INAF-IAPS)

Contribution ID: 32

## Polarized light from accreting low mass X-ray binaries

Monday, 12 June 2023 12:00 (30 minutes)

The polarized X-ray radiation emitted from an accreting low mass X-ray binary (LMXB) is expected to give information about the geometry of the region where the Comptonization occurs and about the spin of the accreting BH. Actually, first results obtained from IXPE seem to reveal that the scenario for LMXBs is more complicated than expected: the polarization properties seem to differ from what current models have predicted. Moreover, while there are hints that winds and the reflection component could have a role in the detected polarised light, the most interesting result reported until now is that the polarization angle of both BH and NS LMXB seems to be aligned with the radio jets.

I will summarize the principal characteristics of LMXBs in the light of the new IXPE results on polarization.

**Presenter:** CAPITANIO, Fiamma (INAF/IAPS)

Contribution ID: 70

## X-Ray Polarimetry: a new breakthrough in Relativistic Astrophysics

Monday, 12 June 2023 12:30 (30 minutes)

At the beginning of X-Ray Astronomy Vitali Ginzburg stated that polarimetry would play a major role as a diagnostic in this domain. Experiments of Polarimetry were trailing after a few years the progresses of the discipline. But when Giacconi performed the revolution of the optics, polarimetry, totally mismatched in sensitivity, was kept aside for almost 35 years. The situation totally changed with the invention of detectors based on the photoelectric effect in gas. The Imaging X-Ray Polarimetry Explorer, based on this technique, allowed to extend to polarimetry the breakthrough in sensitivity performed with the Einstein Satellite. Data from IXPE, by introducing two new observational parameters are challenging many established views in Relativistic Astrophysics.

**Presenter:** COSTA, Enrico (INAF)

## Monday afternoon session, 15:00-18:00, 12 of June 2023

Contribution ID: 54

### **X-Ray and microwave cosmology: synergy and competition. What do we expect from the next generation X-ray and microwave telescopes?**

Monday, 12 June 2023 15:00 (30 minutes)

Our Universe is filled with cosmic microwave background radiation (CMB) which is isotropic and has the black body spectrum with temperature 2.7 Kelvin. No spectral deviations from a black body have been detected in the CMB monopole until now. However, the physics of the interaction of CMB photons with hot electrons predicted the presence of "shadows" in the angular distribution of CMB in the directions where clouds of very hot electrons  $T_e$  106-108 K exist in our Universe. Today we know that such objects exist and they are clusters of galaxies containing thousands of galaxies each, a lot of dark matter, and hot gas filling the huge potential well. The "shadows" with very peculiar frequency spectrum arise due to the Thomson scattering interaction of the CMB photons with the hot electrons. Today this method has permitted us to discover more than 8 thousand of clusters and even a protocluster of galaxies at relatively high redshifts  $0 < z < 2$ . Behind many newly discovered rich clusters of galaxies, we see the extremely distant galaxies with their shapes distorted and brightness increased due to gravitational lensing by the huge gravitational potential of the invisible "dark matter" present in a cluster. The amplitude of the CMB brightness shadow corresponds only to a few tens to hundreds of microKelvin. There is another way to observe the same hot gas. On June 13th of 2019, Russia launched the SRG spacecraft with Russian ART-XC and German eRosita X-Ray telescopes aboard into the second Lagrangian Point of the Sun-Earth system. These telescopes are sensitive correspondingly to the hard and soft X-Ray photons. eRosita created the best map of the entire sky in X-Rays and was expected to discover more than 100,000 clusters of galaxies (i.e. all rich clusters of galaxies in the observable Universe) during the 4 years of surveying the full sky. At the same time, ground-based millimeter wavelength telescopes on the South Pole of the Earth and in the Atacama desert at 5 km altitude, equipped with tens of thousands of cryogenic bolometers in their focal planes, promise to detect the majority of these clusters due to their "shadows" in the CMB. These two data sets will be very complimentary and there will be a lot of synergy. At the same time, there is competition: who will be the first to discover the most interesting (massive, high  $z$ , etc) clusters of galaxies? Ensemble of 105 clusters, their distribution in space, mass, and redshift will provide a unique sample of data for testing cosmological models. The interaction of CMB photons with free electrons opens a unique way to measure the peculiar velocity of a cluster of galaxies relative to the unique system of coordinates in which the CMB is isotropic. Observers dream to measure peculiar velocities and even bulk and turbulent velocities inside the clusters of galaxies at any distance from us because both SZ effects (thermal and kinematic) do not depend on the redshift of the object. I will try to present the results of a search for the clusters obtained by eRosita and ground-based SPT and ACT microwave telescopes. In addition, I will try to mention a few new observational effects which might be discovered in addition to new clusters of galaxies using the methods of CMB cosmology.

**Presenter:** Prof. SUNYAEV, Rashid (Space Research Institute (IKI) of the Russian Academy of Sciences, Max Planck Institute for Astrophysics and Institute for Advanced Study, Princeton)

Contribution ID: 41

## Breathing Fire: High-speed Ejecta from a Gamma-ray Binary

Monday, 12 June 2023 15:30 (30 minutes)

If a rotation-powered (non-accreting) pulsar is in a binary with a high-mass star, then the collision of the relativistic pulsar wind with the stellar wind creates an intrabinary shock, generating high-energy radiation. In addition, the shocked pulsar and stellar winds can leave the binary and form a nebula whose properties should vary with the orbital phase. To search for such a nebula, we carried out multiple observations of the well known gamma-ray and X-ray high-mass binary LS 2883 with the Chandra X-ray observatory. In this eccentric binary ( $e = 0.87$ ,  $P_{\text{orb}} = 3.4$  yr) a middle-aged pulsar B1259-63 orbits a fast-rotating Be star with an equatorial excretion disk. Our observations have unexpectedly shown X-ray emitting clumps, moving away from the binary in about the same direction and changing their shape and brightness. Presumably ejected near periastron passages, they reached projected velocities of about  $0.1 c$ . I will discuss possible explanations of this remarkable phenomenon whose nature has not been fully understood yet.

**Presenter:** PAVLOV, George (Pennsylvania State University)

Contribution ID: 31

## Three arguable concepts

Monday, 12 June 2023 16:00 (30 minutes)

We address i) the point-particle assumption inherent to non-quantum physics. It is singular and entails divergences. ii) In quantum mechanics (QM) EM plays an asymmetric role. It acts on QM fields, but the latter does not react back. We suggest a mutual action-reaction partnership between the two. By so doing, QM fields share their analyticity with EM fields and remove the singularities. iii) The conventional U1 symmetry leaves QM and EM invariant under a 'general' Lorentz gauge and causes the standard minimal coupling of QM to the EM 4-vector potential. One may, however, ask for invariance under the 'restricted' Lorentz gauge. This invites in the coupling to the derivatives of the vector potential and enlarges U1. We examine the Dirac electron in the context just described. Without recourse to QED, we find that electron develops non-singular and distributed charge and current densities. The enlarged symmetry has its own constant of motion. The anomalous g-factor of the so designed electron emerges, up to order  $(\hbar/c)^2$ , as the constant of motion in agreement with the QED theorized and the laboratory measured values.

**Presenter:** Prof. SOBOUTI, Yousef (Institute for Advanced Studies in Basic Sciences)

## Coffee break 16:30-17:00

Contribution ID: 49

## 25 years of GRB/SNe: an overview

Monday, 12 June 2023 17:00 (30 minutes)

25 years after the discovery of the first GRB/SN, SN1998bw remains the best observed example of this extraordinary class of events. Several other GRB/SNe have been discovered, allowing progress in determining their overall properties.

I will review some of the advances and outline the outstanding problems in this field.

**Presenter:** Prof. MAZZALI, Paolo (Astrophysics Research Institute, Liverpool John Moores University, United Kingdom)

Contribution ID: 17

## A new channel for supermassive black hole formation

Monday, 12 June 2023 17:30 (30 minutes)

Observations support the idea that supermassive black holes (SMBHs) power the emission at the center of active galaxies. However, contrary to stellar-mass BHs, there is a poor understanding of their origin and physical formation channel. In this article, we propose a new process of SMBH formation in the early Universe that is not associated with baryonic matter (massive stars) or primordial cosmology. In this novel approach, SMBH seeds originate from the gravitational collapse of fermionic dense dark matter (DM) cores that arise at the center of DM halos as they form. We show that such a DM formation channel can occur before star formation, leading to heavier BH seeds than standard baryonic channels. The SMBH seeds subsequently grow by accretion. We compute the evolution of the mass and angular momentum of the BH using a geodesic general relativistic disk accretion model. We show that these SMBH seeds grow to  $10^9 - 10^{10}$  Msun in the first Gyr of the lifetime of the Universe without invoking unrealistic (or fine-tuned) accretion rates.

**Presenter:** Prof. ARGÜELLES, Carlos Raúl (Universidad Nacional de La Plata)

## Tuesday morning session, 09:00-13:00, 13 of June 2023

Contribution ID: 5

## Discoveries from FAST

Tuesday, 13 June 2023 09:00 (30 minutes)

The Five-hundred-meter Aperture Spherical radio Telescope (FAST) has been in operation since early 2020. Largely motivated by the great Arecibo observatory, FAST now perches on the apex of sensitivity among centimeter-band radio instruments and will stay there until the advent of SKA. In a little three years, FAST data has facilitated more than 150 journal papers, including at least 7 on Nature, 2 on Science, 1 on Science Bulletin, and a few more on high-impact astronomy journals, such as Nature Astronomy. I will present a brief overview of FAST's discoveries so far,

with particular emphasis on those that better reflects the unique advantages of this observatory. For example, the precise Zeeman measurement based on our novel HI Narrow Self-Absorption (HINSA) technique, the high quality HI images ( $\sim 1\%$  flux uncertainty), the world's first persistently active fast radio bursts (FRBs), etc. With these discoveries, I will also ponder upon the potential progresses to be made in terms of the better understanding the fundamental physical principles of the cosmos.

**Presenter:** LI, Di (National Astronomical Observatories, China)

Contribution ID: 6

## Black hole induced star formation in the early universe

Tuesday, 13 June 2023 09:30 (30 minutes)

In the local universe have been observed enhancements of star formation due to relativistic jets from accreting black holes (BHs). These BH “positive feedbacks” take place by the interaction of BH-jets with high-density molecular clouds, which leads to compression of the gas and subsequent enhancement of star formation. This BH-jet triggering mechanism of star formation must have been more important in the early universe, for two reasons. First, the global gas density in the universe evolves with redshift  $z$  as  $(1+z)^3$ , and at  $z = 30$  the global gas density would be more than  $10^4$  times the global gas density in the local universe. Second, recently have been increasing indications that in the galaxies of the early universe massive BHs came first and grow faster than the stellar populations. In this context, I propose that the rapidly growing BH seeds of the SMBHs of  $10^9 M_\odot$  in quasars at  $z = 7$  may have induced the formation of the first massive stars of Pop III.

**Presenter:** Dr MIRABEL, Felix (IAFE-Argentina)

Contribution ID: 19

## Selected Studies of Cosmic and Gamma Rays with the MAGIC telescopes

Tuesday, 13 June 2023 10:00 (30 minutes)

MAGIC is a ground-based Imaging Atmospheric Cherenkov Telescope (IACT) for very high energy gamma-ray measurements that has pioneered high-sensitivity measurements down to a few tens of GeV. It includes a system of double telescopes with a diameter of 17 m, separated by a distance of 85 m, operating in coincidence mode (stereo). The telescopes are located at an altitude of 2200 m above sea level in the European Northern Observatory *El Roque de los Muchachos* on the Canary Island of La Palma. In recent years, the MAGIC collaboration has developed innovative techniques that have increased the dynamic range and sensitivity of the telescopes to around 20 GeV and up to 100 TeV. These have expanded and greatly improved the capabilities of the instrument. In this report we want to focus on some selected observations of cosmic and gamma rays of galactic and extragalactic origin.

**Presenter:** MIRZOYAN, Razmik (Max-Planck-Institute for Physics)

## **Coffee break 10:30-11:00**

Contribution ID: 48

### **Extreme Universe through the eyes of MASTER Robots**

Tuesday, 13 June 2023 11:00 (30 minutes)

The Extreme Universe is the most powerful and fastest explosions in the Universe associated with the formation and transformation of relativistic stars.

For localization of gravitational-wave, neutrino and gamma-ray events, first of all, optical instruments of the 21st century are needed, which have outstanding technical characteristics: fast response, full robotization and high angular resolution. For example, the optical localization of these objects reduces the error box of neutrino, gamma and gravitational wave events by billion of times.

The latest results of the MASTER Global Robotic Network of Optical Robotic Telescopes are presented.

**Presenter:** LIPUNOV, Vladimir (Lomonosov Moscow State University, SAI, Physics Department)

Contribution ID: 74

### **The Cerenkov Telescope Array in a multi-wavelength context**

Tuesday, 13 June 2023 11:30 (30 minutes)

The advent of the Cerenkov Telescope Array (CTA) will increase dramatically the number of detected very-high energy transients and will improve the accuracy of their variability timescale sampling. A number of facilities at lower energies are being designed and developed to guarantee accurate follow-up, identification, and monitoring of the counterparts to the TeV emitters. Within this framework, I will present a project for dedicated observational support of the CTA at radio, infrared and optical wavelengths, to be implemented as part of the "CTA Plus" program funded by the Italian Research Ministry under the EU PNRR aegis.

**Presenter:** Dr PIAN, Elena (INAF OAS, Bologna)

Contribution ID: 28

### **Neutrino astronomy: IceCube results and the future of multimessenger searches**

Tuesday, 13 June 2023 12:00 (30 minutes)

In the course of the last decade, the IceCube Neutrino Observatory has marked the first milestones of neutrino astronomy, starting with the discovery and characterisation of the astrophysical neutrino flux. Astrophysical neutrinos are unique tracers of hadronic particle acceleration and could be the key to unveil the origin of high-energy cosmic rays. IceCube has been hunting for the sources of astrophysical neutrinos with a wide range of methods. Its realtime program which sends prompt alerts to the multimessenger community following the detection of interesting IceCube events, led in 2017 to the association of a high-energy neutrino and the flaring blazar TXS 0506+056. Subsequent archival searches found a burst of neutrinos from the same location five years earlier. More recently, improved searches for steady point-sources have produced evidence of neutrino emission from the nearby active galaxy NGC 1068. In this talk, I will focus on these and other IceCube neutrino astronomy results and outline the perspective for its near-future multimessenger searches.

**Presenter:** LINCETTO, Massimiliano (Astronomisches Institut, Ruhr-University Bochum)

Contribution ID: 24

## **Neutrino Telescope Baikal-GVD: Status and Nearest Future**

Tuesday, 13 June 2023 12:30 (30 minutes)

The progress in the construction and operation of the Baikal Gigaton Volume Detector in Lake Baikal is reported. The detector is designed for search for high energy neutrinos whose sources are not yet reliably identified. It currently includes over 3500 optical modules arranged on 98 strings, providing an effective volume of 0.6 km<sup>3</sup> for cascades with energy above 1 PeV. We review the scientific case for Baikal-GVD, the construction plan, and first results from the partially built experiment, which is currently the largest neutrino telescope in the Northern Hemisphere and still growing up.

**Presenter:** DZHILKIBAEV, Zhan-Arys (Institute for nuclear research)

## **Tuesday afternoon session, 15:00-18:00, 13 of June 2023**

Contribution ID: 72

## **Are we prepared to observe the next Galactic Supernova?**

Tuesday, 13 June 2023 15:00 (30 minutes)

I will briefly review some of the observational facts of Supernovae from the perspective of multimessenger astronomy, such as future optical and neutrino observations. Based on the current estimates of the supernova rate, some predictions are presented and discussed.



**Presenter:** DELLA VALLE, Massimo (INAF)

Contribution ID: 21

## Hubble Tension challenge in the modern cosmology: possible solutions

Tuesday, 13 June 2023 15:30 (30 minutes)

One of the problems in the modern cosmology is a so-called Hubble tension (HT), which is the difference between values of the present Hubble constant  $H_0$ , measured by observation of the universe at redshift  $z \leq 1$ , and the same value measured by observations of a distant universe by observations of CMB fluctuations corresponding to  $z \approx 1100$ . We suggest that this Tension may be explained by deviation of the cosmological expansion from a standard  $\Lambda$ CDM model of a flat universe, due to the action of an additional variable component DEV during the post-recombination stage.

In order to maintain the almost constant DEV/DM energy density ratio during the whole time interval at  $z < 1100$ , it is necessary to allow the existence of a wide mass DM particle distribution.

**Presenter:** BISNOVATYI-KOGAN, Gennady (Space Research Institute Rus. Acad. Sci., Moscow, Russia)

Contribution ID: 14

## Pair-balance model for relativistic shocks and its application to astrophysical sources

Tuesday, 13 June 2023 16:00 (30 minutes)

Among astrophysical objects whose emission originates from relativistic shocks are active galactic nuclei, gamma-ray bursts, and pulsar winds. Their exceptionally broad spectra are due to synchrotron and inverse Compton emission of accelerated leptons. Although these radiation processes are common in space, the relativistic shocks and shear flows possess an efficient feedback mechanism that sets them apart from other particle acceleration sites.

The feedback operates through inelastic collisions of high-energy inverse Compton photons with low-energy synchrotron photons, that create electron-positron pairs in a region where the flow's velocity is relativistic with respect to the photons' source. The pairs gain energy from the difference in flow's velocity. This constitutes the converter acceleration mechanism.

Whenever it is efficient, the converter acceleration reaches nonlinear saturation regime, where momentum transfer by high-energy photons keeps flow's velocity gradient at minimum necessary for converter acceleration to operate. The balance occurs when photons from the inverse Compton peak in the spectrum have barely enough energy to produce pairs with photons from the synchrotron peak. This balance condition predicts the positions of both synchrotron and inverse Compton peaks, and the ratio of their heights. The predictions are in line with recent observations of TeV emission from gamma-ray burst afterglows.

**Presenter:** DERISHEV, Evgeny (Institute of Applied Physics, Nizhny Novgorod, Russia)

## **Coffee break 16:30-17:00**

Contribution ID: 52

### **The James Webb Space Telescope: status and science results**

Tuesday, 13 June 2023 17:00 (30 minutes)

I will briefly describe the James Webb Space Telescope and its status. I will provide an overview of its major science results, or planned observations, in areas that will impact cosmology and fundamental physics.

**Presenter:** Prof. STIAVELLI, Massimo (Space Telescope Science Institute, USA)

Contribution ID: 38

### **The Science Promise Now Being Realized After JWST's Decades of Challenges**

Tuesday, 13 June 2023 17:30 (30 minutes)

The James Webb Space Telescope is an astronomy mission that exceeds all others in capability. The first science results from JWST have already rewritten the science history books. JWST is astonishingly complex, yet it exceeds its requirements in essentially all areas. Its flawless launch and deployments are a testament to the engineering and management commitment of thousands of people in the US and in our partner nations, the European ESA and Canadian CSA, and of the support of policy-makers who funded this extraordinary mission through all its trials and tribulations. I will give a broad overview of the multi-faceted challenges that JWST faced and overcame, from birth 35 years ago, and of the early science results that challenge our understanding, particularly of the growth of galaxies in the early universe.

**Presenter:** ILLINGWORTH, Garth (UCSC)

## **Wednesday morning session, 09:00-13:00, 14 of June 2023**

Contribution ID: 15

### **Highlights of the Insight-HXMT X-ray Astronomy Satellite**

Wednesday, 14 June 2023 09:00 (30 minutes)

Insight-HXMT (hxmt.cn) is China's first X-ray astronomy satellite and was successfully launched on June 15th, 2017. It carries three sets of collimated X-ray instruments with large effective areas, covering energy ranges of 1-15 keV, 5-30 keV, and 20-250 keV, respectively. In addition, it can also serve as an all-sky monitor for high energy sources between 0.2 to 3 MeV, such as bright pulsars and gamma-ray bursts. This talk will review some highlights of the scientific results of Insight-HXMT, including discoveries of the highest energy fundamental frequency of neutron star's cyclotron absorption feature from an accretion neutron star, the highest energy low frequency quasi-periodic oscillations from an accretion black hole which is evidence for a relativistic jet near the black hole, the first non-thermal X-ray burst associated with a fast radio burst and its identification with a magnetar, the brightest gamma-ray burst GRB 221009A, etc. Insight-HXMT has been performing well in orbit and is expected to operate for several more years. The observational program of Insight-HXMT is open world-wide.

**Presenter:** Prof. ZHANG, Shuang-Nan (Center for Particle Astrophysics, Institute of High Energy Physics, CAS)

Contribution ID: 33

## The observation of GRB221009A from LHAASO

Wednesday, 14 June 2023 09:30 (30 minutes)

LHAASO is a multi-purpose ground-based array of gamma-ray and cosmic-ray detectors in China, consisting of three detector arrays, the Water Cherenkov Detector Array (WCDA), the Kilo-meter square Array (KM2A) and the Wide Field of view Cherenkov Telescope Array (WFCTA). In this talk the observations of the brightest GRB 221009A by LHAASO including SEDs and light curves are to be presented.

**Presenter:** ZHA, Min (Institute of High Energy Physics, CAS, China)

Contribution ID: 75

## GRB220101A the most powerful GRB ever with seven BdHN Episodes observed

Wednesday, 14 June 2023 10:00 (30 minutes)

A long GRB that occurred at 2022-01-01 05:11:13 (UT), was triggered by multiple satellites, including Swift (Tohuvavohu et al. 2022), Fermi (Arimoto et al. 2022), AGILE (Ursi et al. 2022), and Konus-Wind (Tsvetkova et al. 2022). The optical observation by Xinglong-2.16m telescope (Fu et al. 2022) revealed a broad absorption feature in the spectrum indicating the presence of Lyman alpha absorption, as well as from the absorption lines, the redshift was determined to be  $z = 4.61$ , which was confirmed by the Liverpool telescope (Perley 2022) and NOT (Fynbo et al. 2022). The burst exhibited a bright, complex multi-peaked time profile within the first  $\sim 150$  s. An estimated isotropic equivalent energy is of  $E_{iso} \sim 4 \times 10^{54}$  erg, and a peak luminosity is of  $L_p \sim 9 \times 10^{53}$  erg  $s^{-1}$ , making GRB 220101A as one of the most luminous GRBs ever observed. The fact that it occurs at  $z = 4.6$  gives a great opportunity to exploit new perspectives of observations as presented in Bianco et al. 2023. The discovery of a radio source with a mean frequency of 6.0 GHz was re-

ported in Laskar (2022a). This finding aligns with the X-ray position noted in Osborne et al. (2022), as well as the optical positions reported by Tohuvavohu et al. (2022) and Hentunen et al. (2022), along with the mm-band position mentioned in Laskar (2022b). All seven episodes characterizing a BdHN I, as predicted in Ruffini et al. (2022a,b), have been identified, details are presented in Ruffini et al., (submitted). Our attention in this article is to identify the earliest XRT observations made possible by the use of the cosmological redshift of  $z = 4.61$  and to obtain an unprecedented accurate description of the rising part and the power-law decay part of the X-ray emission evidencing the transition from a Jacobi ellipsoid into a Mac Laurin spheroid in the description of the newNS originating the afterglow.

**Presenter:** RUFFINI, Remo (ICRANet, ICRA, INAF)

## Coffee break 10:30-11:00

Contribution ID: 16

### An electrodynamic process to extract the rotational energy of a Kerr black hole

Wednesday, 14 June 2023 11:00 (30 minutes)

It has been thought for decades that rotating black holes (BHs) power the energetic gamma-ray bursts (GRBs) and active galactic nuclei (AGNs), but the mechanism that extracts the BH energy has remained elusive. This problem might be solved when the BH is immersed in an external magnetic field and ionized low-density matter. For a magnetic field parallel to the BH spin, the induced electric field accelerates electrons outward and protons inward in polar regions and vice versa in equatorial regions. For an antiparallel magnetic field, protons and electrons exchange their roles. The particles that are accelerated outward radiate off energy and angular momentum to infinity. The BH powers the process by reducing its energy and angular momentum by capturing polar protons and equatorial electrons that lead to net negative energy and angular momentum. The electric potential allows for negative energy states outside the BH ergosphere, so the latter does not play any role in this electrodynamical BH energy extraction process.

**Presenter:** RUEDA HERNANDEZ, Jorge Armando (ICRANet)

Contribution ID: 78

### Gaining understanding of gravitational wave emission in the earliest phases of long GRBs: sweeping frequencies and energetics

Wednesday, 14 June 2023 11:30 (30 minutes)

Due to the technical time delay, greater than  $\sim 40$  s, of the XRT instrument on board the Neil Gehrels Swift Observatory satellite, we are not able to observe the x-ray emission occurring less than  $\sim 40$  s after a gamma-ray burst (GRB) trigger time. A new strategy is indicated here of using the cosmological dilatation of time in the observer rest frame measured in high redshift GRBs

to observe in the GRB cosmological rest-frame their earliest X-ray emission by Swift/XRT even less than 10 s after the trigger. We illustrate this procedure using 353 GRBs with well-defined cosmological redshift, based on the \textit{NASA-Swift GRB Table}. We compare and contrast the time delay between the trigger of the source and the first observation by Swift/XRT as measured in the observer frame (OTD) and the corresponding delay measured in GRBs' cosmological rest-frame (RTD). We consider as specific prototypes GRB 090423 at  $z = 8.2$  with an RTD of 8.2-s, GRB 090429B at  $z \sim 9.4$  with an RTD of 10.1-s, as well as the GRB 220101A at  $z = 4.6$  with an RTD of 14.2-s. This opens a new possibility for probing the first episode of the binary-driven hypernova (BdHN) model linked to the origin and early appearance of the newborn neutron star ( $\nu$ NS) and the first clear manifestation of a transition from a Jacobi to a Maclaurin sequence prior to the onset of the GRB afterglow.

**Presenters:** BIANCO, Carlo Luciano (ICRANet)

Contribution ID: 79

Type: **not specified**

## Exploring the Progenitor of the Crab Nebula and Crab Pulsar: Insights from Binary-Driven Hypernovae

Wednesday, 14 June 2023 12:00 (30 minutes)

We propose that the progenitor of the Crab Nebula and the Crab pulsar shares similarities with binary-driven hypernovae. The understanding of binary-driven hypernovae has revealed the crucial role played by the explosion of the supernova, as well as the hypercritical accretion of the supernova ejecta onto the binary companion neutron star (NS) and the newborn NS ( $\nu$ NS) in determining the dynamics of gamma-ray bursts (GRBs). The synchrotron emission resulting from the  $\nu$ NS-pulsar emission and the accreted supernova ejecta onto the  $\nu$ NS gives rise to X-ray afterglows. Notably, we find evidence that the X-ray afterglow luminosity of GRB 190114C, selected as a prototype binary-driven hypernova, when extrapolated to 1000 years, coincides with the presently observed emission of the Crab Nebula. To model the  $\nu$ NS, we employ the equilibrium sequence of Maclaurin spheroids. By ensuring that the  $\nu$ NS period extrapolated to 1000 years matches that of PSR B0531+21 (the Crab pulsar), we determine the initial spin of the  $\nu$ NS to be 0.9 ms. Subsequently, we track the evolution of the eccentricity, which manifests itself through the release of rotational and gravitational energy of the  $\nu$ NS-pulsar.

**Presenter:** MORADI, Rahim (ICRANet and ICRA-Sapienza)

Contribution ID: 73

## Newborn Neutron Star Activities in Gamma-ray Burst

Wednesday, 14 June 2023 12:30 (30 minutes)

The collapse of the CO star forms a newborn neutron star ( $\nu$ NS) and triggers a supernova (SN) explosion. Mass and angular momentum are transferred to the  $\nu$ NS through fallback accretion. The

energy from this accretion powers the gamma-ray burst prompt emission, while the synchrotron radiation fueled by the spinning vNS, explains the afterglow. Taking GRB 171205A as an example, we calculate the vNS's mass, angular momentum, and rotational evolution, fit the afterglow lightcurve, and determine that the SN explosion occurred within at most 7.36 hours before the GRB trigger.

**Presenter:** WANG, Yu (ICRA, ICRANet, INAF)

## Wednesday afternoon session, 15:00-18:00, 14 of June 2023

Contribution ID: 67

### Gamma-ray burst observations with the GRB IKI Follow up Network

Wednesday, 14 June 2023 15:00 (15 minutes)

We present recent observations of gamma-ray bursts using the GRB IKI Follow up Network. In particular, we are discussing observations of the long duration GRB 221009A. The burst is the brightest one which registered almost all space-born gamma-ray detectors and saturated most of them. Besides of brightness it is usual GRB at low redshift of  $z=0.151$  and due to its near vicinity both highest energy gamma photons ever detected and statistically significant multicolor optical afterglow as well as late SN was detected. We present optical multicolor observations and evidence of SN. We discuss properties of the source and SN/GRB 221009A. of the source and SN/GRB 221009A.

**Presenter:** POZANENKO, Alexei (Space Research Insitute (IKI))

Contribution ID: 11

### Relativistic Jets from all angles

Wednesday, 14 June 2023 15:15 (15 minutes)

Due to their strong beaming, relativistic jets are overwhelmingly more likely to be detected from viewing angles close to their jet axis. This makes the angular structure of the jets (and in particular the under-energetic 'wings' of the jet) difficult to explore in the majority of jet powered transient events. Nonetheless, jets viewed mildly off-axis should be commonly detected and the resulting multiwavelength light-curves have unique features. I will show how these considerations can (i) explain peculiar behaviors seen in TDE jet light-curves, (ii) re-frame our understanding of commonly observed phenomena in GRB afterglows, such as X-ray plateaus and flares, (iii) puts strong constraints on GRB prompt emission, and (iv) sets tests and expectations for future observations. For jets viewed far off-axis I will show that there are different types of light-curves that could be observed (single or double peaked) and outline how the underlying jet structure can be robustly recovered from their observations. I will also discuss the connection with the recently discov-

ered GRB 221009A, the brightest detected GRB to date by some margin, which has exhibited an intriguing and highly constraining afterglow evolution.

**Presenter:** Dr BENIAMINI, Paz (Open University of Israel)

Contribution ID: 81

## **Limitations on the emitting particles spatial distribution and heating mechanism in relativistic jets**

Wednesday, 14 June 2023 15:30 (15 minutes)

Recent VLBI observations have revealed the AGNs with double- and triple-peaked transverse intensity profiles, particularly, M87 (Hada 2017, Walker et al. 2018) and 3C 273 (Bruni et al. 2021). There can be several reasons for such intensity profiles: (i) boosting and de-boosting of the emission from different parts of the jet; (ii) a spatial distribution of non-thermal electrons, which can be produced due to developing instabilities (e.g., McKinney 2006, Chatterjee 2019, Hardee & Eilek 2011, Nikonov et al. submitted), shear acceleration (Ostrowski 1990, 1998), Ohmic heating or equipartition (Lyutikov et al. 2005); (iii) a non-uniform structure of the jet; (iv) opacity effects (e.g., Zakamska et al. 2008). Many of these effects can contribute simultaneously (e.g. Gabuzda et al. 2021).

In presented work, we use magnetohydrodynamic semi-analytical models by Lyubarsky 2009 and Beskin et al. 2017 to explore the effect of stratified jet structure on the total intensity profiles. We show that double-peaked profiles appear either in the models with high maximal Lorentz factors or in optically thick conditions, and triple-peaked profiles in radio galaxies constrain the fraction of the emitting particles in a jet. The preferred models are the localization of non-thermal electrons at the jet edges and Ohmic heating.

**Presenter:** FROLOVA, Valeriya (MIPT)

Contribution ID: 84

## **Constraining Supernova Ia progenitors by their locations in host galactic disc**

Wednesday, 14 June 2023 15:45 (15 minutes)

Over the past decade, substantial evidence has emerged supporting the presence of diverse progenitor channels leading to Type Ia Supernovae (SNe Ia). Among these channels, there are SNe Ia originating from carbon-oxygen white dwarfs with sub-Chandrasekhar masses. These white dwarfs undergo detonation and explosion triggered by primary detonation in the helium shell, which has been accreted from a companion star. This double-detonation model predicts a correlation between the age of the progenitor system and the near peak brightness: the younger the exploding progenitors, the brighter the supernovae. Here, we present our recent achievements, demonstrating the validity of the anticipated correlation. To accomplish this, we studied the spatial distribution of nearby SNe Ia within host galactic discs and estimate the ages of their progenitor populations using various approaches, including the analysis of SNe light curve decline rates versus the vertical age gradients in discs, the distances from host spiral arms, and versus the stellar

population properties in the star formation desert phenomenon and beyond.

**Presenter:** HAKOBYAN, Artur (Alikhanian National Science Laboratory, Center for Cosmology and Astrophysics)

Contribution ID: 63

## Radiative Penrose process: energy gain by a single radiating charged particle in ergosphere of rotating black hole

Wednesday, 14 June 2023 16:00 (15 minutes)

We demonstrate an extraordinary effect of energy gain by a single radiating charged particle inside the ergosphere of a Kerr black hole in presence of magnetic field. We solve numerically the covariant form of the Lorentz-Dirac equation reduced from the DeWitt-Brehme equation and analyze energy evolution of the radiating charged particle inside the ergosphere, where the energy of emitted radiation can be negative with respect to a distant observer in dependence on the relative orientation of the magnetic field, black hole spin and the direction of the charged particle motion. Consequently, the charged particle can leave the ergosphere with energy greater than initial in expense of black hole's rotational energy. In contrast to the original Penrose process and its various modification, the new process does not require the interactions (collisions or decay) with other particles and consequent restrictions on the relative velocities between fragments. We show that such a Radiative Penrose effect is potentially observable and discuss its possible relevance in formation of relativistic jets and in similar high-energy astrophysical settings.

**Presenter:** KOLOŠ, Martin (Institute of Physics, Silesian University in Opava)

Contribution ID: 66

## Supermassive PeVatron at the Galactic centre

Wednesday, 14 June 2023 16:15 (15 minutes)

*A compact supermassive source SgrA located at the center of our Galaxy has been observed at different wavelengths across the electromagnetic spectrum. It is the closest and largest in projection supermassive black hole candidate. At the same time, its particle acceleration capability related to the cosmic ray and neutrino messengers were not yet experimentally probed despite indirect indications of the existence of a PeVatron at the Galactic centre. In this talk, I will present a novel scenario of particle acceleration at the Galactic centre involving electromagnetic extraction of rotational energy from the central black hole. Modeling the black hole magnetosphere with the multiwavelength flaring activity of SgrA, I will show that the maximum energy of accelerated protons may reach a few PeV at the source, contributing thus to the knee of the observed cosmic ray spectrum at the Earth's surface.*

**Presenter:** Dr TURSUNOV, Arman (Silesian University in Opava and Max Planck Institute for Radio Astronomy)



## Coffee break 16:30-16:45

Contribution ID: 86

### On direct and inverse Schwinger process in pair plasma

Wednesday, 14 June 2023 16:45 (15 minutes)

We consider interaction between strong uniform electric field and electron-positron plasma. Depending on initial pair distribution in momentum space pairs are either created or annihilated in external field. Accounting for back reaction of pairs on the electric field leads in the former case to damped plasma oscillations, while in the latter case to energy transfer from rest mass into internal energy of pairs.

**Presenter:** VERESHCHAGIN, Gregory (ICRANet)

Contribution ID: 91

### Analyses of QPOs in the background of deformed compact object

Wednesday, 14 June 2023 17:00 (15 minutes)

Many Galactic black holes and neutron stars sources in Low-Mass X-Ray Binaries (LMXBs) exhibit quasi-periodic oscillations (QPOs) in the observed X-ray fluxes in their peaks. There are models of high frequency QPOs (HF QPOs) that relate this oscillatory motion to the properties of accretion disk formed in the vicinity of a compact object. Our interest is the study this phenomena in the black holes systems, since this HF QPO peaks are usually detected for a given source at constant frequencies ratio of small natural numbers, typically in a 3 : 2 ratio. In this work, we are considering a static and axially symmetric spacetime parametrized by a quadrupole and analyses the interplay between different parameters in this setup considering various HF QPO models.

**Presenter:** TROVA, Audrey (ZARM, University of Bremen)

Contribution ID: 92

### WIMP phenomenology in Dilatonic Einstein Gauss-Bonnet Cosmology

Wednesday, 14 June 2023 17:15 (15 minutes)

We use the Weakly Interacting Massive Particle (WIMP) thermal decoupling scenario to probe Cosmologies in dilatonic Einstein Gauss-Bonnet (dEGB) gravity, where the Gauss-Bonnet term is non-minimally coupled to a scalar field with vanishing potential. We show that when the WIMP relic density is constrained to match the observed DM abundance in the Universe the ensuing modified cosmological scenario can drive the required WIMP annihilation cross section to Standard Model particles beyond the present bounds from DM indirect detection searches, allowing to

constrain the model parameters. The bounds from WIMP indirect detection are nicely complementary to late-time constraints from compact binary mergers, suggesting that it could be interesting to use other Early Cosmology processes to probe the dEGB scenario.

**Presenter:** SCOPEL, Stefano (Sogang University)

**Thursday morning session, 09:00-13:00, 15 of June 2023**

Contribution ID: 87

## **Compact Star Merger as Progenitor of Low Redshift GRBs and the Occurrence Rates of Gravitational Sources and Kilonovae**

Thursday, 15 June 2023 09:00 (30 minutes)

Bimodal distribution of duration of gamma-ray bursts (GRBs) has led to two progenitors; compact star mergers (two neutron stars, NSs or a NS and a black hole), for short GRBs (SGRBs), and collapsars for long GRBs (LGRBs). It is expected that formation rate (FR) of LGRBs should be similar to the cosmic SFR, while that of SGRBs to be delayed relative to the SFR. The localization of some LGRBs in star forming galaxies and some SGRBs away from such regions support this expectation. Also SGRBs are associated with gravitational wave (GW) sources and kilonovae.

However, several independent investigations of the FRs of LGRBs, using the Efron-Petrosian non-parametric method show a that is significantly larger than SFR at low redshifts.

I will review these results, present a new result on the FR of SGRBs, and show that decomposition of the FR of LGRBs into a SFR and low redshift components leads a low redshift

FR similar to that of SGRBs and delayed SFR. These suggest that low redshift LGRBs also have compact star mergers as progenitor increasing rate of the GW sources and kilonovae.

Recent discovery of association of a low redshift LGRB with a kilonova complements our findings.

**Presenter:** Prof. PETROSIAN, Vahe (Stanford University)

Contribution ID: 23

## **New quantum technologies and gravity**

Thursday, 15 June 2023 09:30 (30 minutes)

As has been emphasized in the talk of Hansjoerg Dittus, the second quantum revolution enables new technologies which are not accessible through classical physics. These technologies are characterized by the engineering and manipulating of quantum states. In this talk the interface between these new technologies and the gravitational interaction is highlighted by considering a few top-

ics: (i) a metrological triangle for gravity, (ii) two gravitational constants, (iii) Hong-Ou-Mandel interferometry in gravitational fields, and (iv) quantum imaging of the gravitational field.

**Presenter:** LAEMMERZAHN, Claus (University of Bremen)

Contribution ID: 25

## Quantum sensing – the key technology for further gravitational experiments in space

Thursday, 15 June 2023 10:00 (30 minutes)

Progress in physics always has been stimulated by unexplained observations or experiments. Expressions like “dark matter” or “dark energy” might help to apply the present standard physical theories, but cannot explain their origin sufficiently. The situation of fundamental physics today still causes a lot of open questions, e.g. the theoretical inconsistency of quantum mechanics and General Relativity. Furthermore, there are observations which at least until now and after many years of studies, have not yet found any convincing explanation.

Therefore, we need better, i.e. more and more accurate measurement technology in order to detect even the most tiny effects acting on spacecraft which are our probes in deep space. It seems that those emerging technology must be based mainly on quantum optics able to explore the structure of spacetime in a new and unique way.

The presentation will report on the possibilities for future missions and space experiments in gravitational and quantum physics.

**Presenter:** DITTUS, Hansjoerg (University of Bremen)

## Coffee break 10:30-11:00

Contribution ID: 20

## Influence of a plasma on the shadow of black holes

Thursday, 15 June 2023 11:00 (30 minutes)

If a black hole is seen against a backdrop of bright light sources, it forms a dark disc on the observer’s sky, known as the “shadow” of the black hole. If one assumes that light rays are not influenced by a medium, i.e., if one assumes that they are lightlike geodesics of the spacetime metric, the boundary curve of the shadow can be analytically determined, provided that the spacetime is stationary and axisymmetric and that the Hamilton-Jacobi equation for lightlike geodesics separates. In this talk it is discussed under which conditions such an analytical determination of the shadow is possible if the light rays are influenced by a non-magnetised pressure-less electron-ion plasma. Several examples are worked out, not only for black holes but also, for the sake of comparison, for some “black-hole impostors” such as wormholes. In particular, it is discussed if the boundary curve of the shadow can form “fishtails”.

The talk is partly based on joint papers with Oleg Tsupko, Gennady Bisnovatyi-Kogan, Barbora Bezděková and Jiří Bičák.

**Presenter:** PERLICK, Volker

Contribution ID: 46

## **Black holes in alternative theories of gravity**

Thursday, 15 June 2023 11:30 (30 minutes)

Black holes represent ideal laboratories to test Einstein's theory of general relativity and alternative theories of gravity. Alternative theories of gravity typically introduce additional degrees of freedom, among them most prominently a scalar field. Depending on the theory, the resulting black holes may then differ significantly from their counterparts in General Relativity. Possessing hair, such black holes might, for instance, be distinguished by their shadows or by their gravitational wave spectra.

**Presenter:** Prof. KUNZ, Jutta (University of Oldenburg)

Contribution ID: 3

## **Near field cosmology with constrained simulations: an overview**

Thursday, 15 June 2023 12:00 (30 minutes)

Numerical simulations are the driving force behind much of the theoretical progress in our understanding of the formation of structure in the universe. Cosmological simulations must cover a large dynamical and mass range. A representative volume of the universe should be large, but this comes at the expense of the resolution. To overcome this problem we developed a new approach over the last two decades which consists of using observations of the nearby universe as constraints imposed on the initial conditions of the simulations.

The resulting constrained simulations successfully reproduce the observed structure within a few tens of megaparsecs around the Milky Way including the nearby well known clusters of galaxies. We have performed first constrained simulations within the CLUES project (Constrained Local UniversE simulations). More recently zoomed high resolution gasdynamical simulations allowed to study the formation of the Local Group in the right large scale environment, the HESTIA (High-resolution Environmental Simulations of The Immediate Area) project.

**Presenter:** GOTTLOEBER, Stefan (AIP Potsdam)

Contribution ID: 82

## **Physics on the event horizon scale with millimetre and submillimetre interferometry**

Thursday, 15 June 2023 12:30 (30 minutes)

Impressive progress has been achieved recently in studies addressing fundamental physical processes near the event horizon scale of putative cosmic black holes. The detection of gravitational waves, the near infrared interferometry measurements of relativistic stellar orbits and accretion disk hot spot motion in the Galactic Centre, and the millimetre interferometry imaging of the strong gravitational lensing on scales down to several Schwarzschild radii are presently the best evidence for the existence of black holes. These areas of study will continue to draw substantial attention in the coming years, as the results obtained until now still admit several alternative explanations featuring, for example, such exotic entities as wormholes and gravastars. In millimetre and submillimetre bands, significant advances in the sensitivity and resolution of interferometric measurements should enable the most stringent tests for discerning between black holes and their alternatives. These tests will include improved direct imaging of the event horizon scale at 86, 230, and 345 GHz, accurate polarimetric and Faraday rotation measurements, precise astrometric observations of the hot spot motion in the Galactic Centre, and detailed studies of the photon rings in a number of AGN. Current status and future prospects of these measurements will be discussed in this presentation.

**Presenter:** Dr LOBANOV, Andrei (Max-Planck-Institut für Radioastronomie)

## **Thursday afternoon session, 15:00-18:00, 15 of June 2023**

Contribution ID: 59

### **Vacuum polarization around cosmic strings in anti-de Sitter spacetime**

Thursday, 15 June 2023 15:00 (15 minutes)

Local properties of scalar, fermionic and electromagnetic vacua are discussed in the presence of cosmic string type topological defects. As important characteristics of the vacuum state we consider the expectation values of the squared fields, of the energy-momentum tensor and of the current density in the case of charged fields. The topological contributions are extracted from the vacuum expectation values and their asymptotic behavior is studied near the core of the defect and at large distances. The effects of the presence of branes are discussed and applications are described in braneworld models of the Randall-Sundrum type.

**Presenter:** Prof. SAHARIAN, Aram (Professor, Head of the Chair of Theoretical Physics, Yerevan State University)

Contribution ID: 50

### **Exploring second-order gravitational effects and the possibility for dark matter detection with the next generation of space-borne atomic standards of**

## frequency and time

Thursday, 15 June 2023 15:15 (15 minutes)

General relativity (GR) and quantum theory form the basis of the modern physical picture of the universe. However, attempts to unify them inevitably lead to violations of the Einstein Equivalence Principle (EEP) which is the basis of GR. A promising kind of experiments to test the domain of validity of EEP is based on measuring the gravitational redshift. Recent progress in the stability and accuracy of atomic clocks, including those qualified for operation in space, provides for significant improvements of the accuracy of these measurements in the next 10 years, and also enables new kinds of experiments.

To assess the accuracy of such experiments and process their data, the current models of frequency and time transfer between two spacecraft in the Solar system, or a spacecraft and a ground station, need to be refined. We present such an improved model, which includes terms to order  $c^{-4}$  and accounts for nonrelativistic Doppler compensation schemes, and use it to analyze the accuracy of EEP tests and PPN parameter measurements which can be performed in near-future space experiments in the Solar system. We also formulate the constraints on EEP violations predicted by fuzzy dark matter theories which can be achieved in such experiments.

**Presenter:** Dr LITVINOV, Dmitry (Lebedev Physical Institute)

Contribution ID: 65

## Gravity assist as a test of relativistic gravity

Thursday, 15 June 2023 15:30 (15 minutes)

We consider the gravity assist maneuver, that is, a correction of spacecraft motion at its passing near a planet, as a tool for evaluating the Eddington post-Newtonian parameters  $\beta$  and  $\gamma$ , characterizing vacuum spherically symmetric gravitation fields in metric theories of gravity. We estimate the effect of variation in  $\beta$  and  $\gamma$  on a particular trajectory of a probe launched from the Earth's orbit and passing closely near Venus, where relativistic corrections slightly change the impact parameter of probe scattering in Venus's gravitational field. It is shown, in particular, that a change of  $10^{-4}$  in  $\beta$  or  $\gamma$  leads to a shift of about 50 km in the probe's aphelion position.

**Presenter:** Dr BOLOKHOV, Sergei (RUDN University, Moscow, Russia)

Contribution ID: 68

## Wormholes in a Friedmann universe

Thursday, 15 June 2023 15:45 (15 minutes)

We consider the generalized Tolman solution of general relativity, describing the evolution of a spherical dust cloud in the presence of an external electric or magnetic field. In such models, we study the possible existence of wormhole throats defined as spheres of minimum radius at a fixed time instant, and prove the existence of throats in the elliptic branch under certain conditions imposed on the arbitrary functions that are present in the solution. It is further shown that such dust clouds with throats can be inscribed into closed isotropic cosmological models filled with dust

to form wormholes which exist for a finite period of time and experience expansion and contraction together with the corresponding cosmology. Explicit examples and numerical estimates are presented.

**Presenter:** BRONNIKOV, Kirill (RUDN University, Moscow, Russia)

Contribution ID: 37

## Quantum-gravitational corrections to the power spectrum for a closed universe

Thursday, 15 June 2023 16:00 (15 minutes)

We study the quantum-gravitational corrections to the power spectrum of a gauge-invariant inflationary scalar perturbations in a closed model of a universe. We consider canonical quantum gravity as an approach to quantizing gravity. This leads to the Wheeler-DeWitt equation, which has been studied by applying a semiclassical Born–Oppenheimer type of approximation. At the corresponding orders of approximation, we recover both the uncorrected and quantum-gravitationally corrected Schrödinger equations for the perturbation modes from which we calculate the quantum-gravitational corrections to the power spectrum in the slow-roll regime. The results are compared to the power spectra for the flat model of the universe.

**Presenter:** Ms VARDANYAN, Tatevik (Institute for Theoretical Physics, University of Cologne)

Contribution ID: 30

## Electromagnetic field of a charged particle, asymptotically approaching Schwarzschild black hole

Thursday, 15 June 2023 16:15 (15 minutes)

The knowledge of electromagnetic field of charged particles in the vicinity of a black hole is important for the study of many astrophysical phenomena, in particular of gamma-ray bursts and jets of supermassive black holes. In the present work we determine multipole coefficients of electromagnetic field for charged particle, radially falling into Schwarzschild black hole and consider the limit of approaching to the event horizon.

**Presenter:** KOMAROV, Stanislav (Belarusian State University)

## Coffee break 16:30-16:45

Contribution ID: 89

## Physics of quadrupolar compact astrophysical objects

Thursday, 15 June 2023 16:45 (15 minutes)

Theoretical and observational efforts are being pursued to understand and test general relativity. The ideal regime for such surveying involves the strong gravitational fields in the vicinity of the astrophysical black holes and compact objects, which are not directly accessible. Large international collaborations like the Event Horizon Telescope, and LISA, among many others, make access to a wide range of observational data. Mostly, it is assumed that astrophysical black holes are described by Kerr solution. However, others can also imitate a blackhole's properties, making it challenging when one tries to link the models to the observation. The black hole mimickers are currently of significant interest in the astrophysics communities. It appears essential to explore departures due to exercising relatively small parameters that can be taken as the additional physical degrees of freedom to the set-up and facilitate the link to the observational data with analytical and numerical approaches. This talk will present the construction of such an alternative background and be followed up by a recap on the physics and astrophysical properties that one expects to observe, using analytical and numerical methods and testing them with observational data.

**Presenter:** FARAJI, Shokoufe (ZARM)

Contribution ID: 45

## Exploring massive neutron stars towards mass gap: Constraining the high-density nuclear equation of state

Thursday, 15 June 2023 17:00 (15 minutes)

Due to the high-density nuclear matter equation of state (EOS) being as yet unknown, neutron stars (NSs) do not have a confirmed limiting "Chandrasekhar" type maximum mass. However, observations of NSs (PSR J1614-2230, PSR J0348+0432, PSR J0740+6620, PSR J0952-0607) indicate that NS's limiting mass, if there is any, could be well over  $2M_{\odot}$ . On the other hand, there exists an observational mass gap between  $2.5M_{\odot}$  and  $5M_{\odot}$ , and the "massive NSs" are prime candidates to fill that gap. Several NS EOSs have been proposed using both microscopic and phenomenological approaches. In this project, we look at a class of phenomenological nuclear matter EOSs – relativistic mean field models – and see what kind of NS is formed from them. We compute the maximum mass supported by each model EOS to observe if the mass of the NS is indeed in the "massive" NS ( $> 2M_{\odot}$ ) regime. Using tidal deformability constraints from gravitational wave observations, we place a further check on how physical the EOS used is. We also observe the effects of including exotic particles (hyperons, deltas) in the NS EOS and how that affects the NS mass. Finally, we look at how the NS's magnetic field affects its mass.

**Presenter:** ZURAIQ, Zenia (Indian Institute of Science, Bangalore)

Contribution ID: 69



## General radially moving references frames in the black hole background

Thursday, 15 June 2023 17:15 (15 minutes)

We consider general radially moving frames realized in the background of nonextremal black holes having causal structure similar to that of the Schwarzschild metric. In doing so, we generalize the Lemaître approach, constructing free-falling frames which are built from the reference particles with an arbitrary specific energy  $e_0$  including  $e_0 < 0$  and a special case  $e_0 = 0$ . The general formula of 3-velocity of a freely falling particle with the specific energy  $e$  with respect to a frame with is presented. Using our radially moving frames, we consider also nonradial motion of test particles including the regions near the horizon and singularity. We also point out the properties of the Lemaître time at horizons depending on the frame and sign of particle energy.

**Presenter:** TOPORENSKY, Alexey (Sternberg Astronomical Institute)

Contribution ID: 62

## On quasinormal modes in 4D black hole solutions in the model with anisotropic fluid

Thursday, 15 June 2023 17:30 (15 minutes)

We consider a family of 4-dimensional black hole solutions governed by natural number  $q = 1, 2, 3, \dots$ , which appear in the model with anisotropic fluid and the equations of state:  $p_r = -\rho(2q - 1)^{-1}$ ,  $p_t = -p_r$ , where  $p_r$  and  $p_t$  are pressures in radial and transverse directions, respectively, and  $\rho > 0$  is the density. These equations of state obey weak, strong and dominant energy conditions. For  $q = 1$  the metric of the solution coincides with that of the Reissner-Nordström one. The global structure of solutions is outlined, giving rise to Carter-Penrose diagram of Reissner-Nordström or Schwarzschild types for odd  $q = 2k + 1$  or even  $q = 2k$ , respectively. Certain physical parameters corresponding to BH solutions (gravitational mass, PPN parameters, Hawking temperature and entropy) are calculated. We obtain and analyse the quasinormal modes for a test massless scalar field in the eikonal approximation. For limiting case  $q = +\infty$ , they coincide with the well-known results for the Schwarzschild solution. We show that the Hod conjecture which connect the Hawking temperature and the damping rate is obeyed for all  $q \geq 2$  and all (allowed) values of parameters.

**Presenter:** IVASHCHUK, Vladimir (RUDN/VNIIMS)

Contribution ID: 39

## Symmetric periodic trajectories of charged particles in Gutsunaev–Manko spacetime

Thursday, 15 June 2023 17:45 (15 minutes)

We consider the motion of charged particles in Gutsunaev–Manko spacetime, which is the exact solution of the Einstein–Maxwell field equations for a massive dipole. In the present work we

study periodic orbits symmetric with respect to the equatorial plane. The spacetime is static and axially symmetric, therefore the problem is reduced to the motion in two-dimensional effective potential. We show that the Gutsunaev–Manko solution admits the same types of symmetric periodic trajectories as the classical magnetic dipole problem and study the stability of those trajectories.

**Presenter:** TEGAI, Sergey (Siberian Federal University)

## Friday morning session, 09:00-13:00, 16 of June 2023

Contribution ID: 55

### New developments in the inflationary scenario

Friday, 16 June 2023 09:00 (30 minutes)

The present upper limit on the amount of tensor perturbations (primordial gravitational waves) generated during inflation, the tensor-to-scalar ratio  $r < 0.03$ , excludes many inflationary models popular in the past, like those with a power-law inflaton potential ('chaotic inflation'). However, a number of viable inflationary models still remain including the three one-parametric models: the pioneer  $R^2$  one, the Higgs and the mixed  $R^2$ -Higgs models whose unambiguous target prediction is  $r = 3(1 - n_s)^2 = 0.004$ . New developments in these models are mostly related to their behaviour after inflation including creation and heating of usual matter. I consider one possibility of relating the purely geometrical  $R^2$  model to realistic baryogenesis after inflation by adding three families of right-handed Majorana neutrinos with a large mass to the matter sector of the Standard Model. Another trend in the inflationary scenario is to think what was before inflation. This is natural since duration of the inflationary epoch was finite inside our past light-cone. I discuss different possibilities proposed historically with the main emphasis on isotropic bounce due to positive spatial curvature, or even in its absence, or alternatively, generic anisotropic singularity with curvature much exceeding that during the observable part of inflation.

**Presenter:** STAROBINSKY, Alexei (Landau Institute for Theoretical Physics RAS)

Contribution ID: 12

### Cosmology with Gamma-Ray Bursts

Friday, 16 June 2023 09:30 (30 minutes)

The huge luminosity, the redshift distribution extending at least up to  $z \sim 10$  and the association with the explosive death of very massive stars make long GRBs (i.e., those lasting up to a few minutes) potentially extremely powerful probes for shedding light on main open issues in our understanding of the early Universe: star formation rate evolution up to the first generation of stars (pop-III), cosmic reionization, luminosity function and metallicity evolution of primordial galaxies up to the "cosmic dawn". At the same time, the correlation between radiated energy and spectral photon peak energy ("Amati relation" is under intensive investigations for "standardizing" GRBs

and using them for measuring cosmological parameters, investigating the nature and evolution of "dark energy" and testing non-standard cosmological models. I will also report on the status, concepts and expected performances of space mission projects (e.g., THESEUS) aiming at fully exploiting these potentialities of the GRB phenomenon, also in synergy with the large e.m. facilities of the future like LSST, ELT, TMT, SKA, CTA, ATHENA.

**Presenter:** AMATI, Lorenzo (INAF - OAS Bologna)

Contribution ID: 35

## Astrophysical searches for primordial black holes

Friday, 16 June 2023 10:00 (30 minutes)

Interest to astrophysical evidence for primordial black holes formed in the early Universe from initial cosmological perturbation has increased after the discovery of coalescing binary black holes with masses more than dozen solar ones by gravitational-wave observatories. I will discuss the formation channels of merging binary black holes with a special focus on the possibility that some fraction of the observed binary black hole mergings can have the primordial origin.

**Presenter:** POSTNOV, Konstantin (Sternberg Astronomical Institute)

## Coffee break 10:30-11:00

Contribution ID: 22

## The spectral signatures of BHs versus NS

Friday, 16 June 2023 11:00 (30 minutes)

Titarchuk, Lev (University of Ferrara, Italy and Seifina, Elena (GAISH, MSU, Russia)

In 2017 the work on the Comptonization (Sunyaev-Titarchuk) seen in the X-ray spectra of astrophysical sources was a candidate for the Nobel Prize in Physics. In this talk I provide all the details of the exciting prehistory of this topic and precise details of this discovery. The solution of this problem and its subsequent development and application to the spectra of accreting neutron star (NS) and black hole (BH) binaries reveals a lot of information on these objects. In particular, now we can unambiguously distinguish between a NS and a BH (Galactic or extragalactic) using correlations of their spectral indices vs mass accretion rate (or QPO frequency). I further demonstrate how we can determine a BH mass using this correlation

**Presenter:** Prof. TITARCHUK, Lev (University of Ferrara, Ferrara, Italy)

Contribution ID: 27

## Neutron Stars as Strong Field QED Laboratory

Friday, 16 June 2023 11:30 (30 minutes)

Strong electromagnetic fields polarize the vacuum and electric fields produce charged pairs, the so-called Schwinger effect. The critical strength of electromagnetic fields, whose energy density equals to the rest mass of the charge, cannot be achieved in present laboratories. The critical electric fields enormously produce electron-positron pairs and the critical magnetic field has the lowest Landau level whose energy equals the rest mass of the charge and gives a measurable effect on the photon propagation.

I will address the physics in strong electromagnetic fields of neutron stars and advance methods to observe the vacuum polarization effects. Magnetars, the highly magnetized neutron stars, have magnetic fields stronger than the critical field and lead to measurable vacuum polarization effects such as the birefringence. A supercritical magnetic field in the Goldreich-Julian pulsar model induces a subcritical electric fields due to high spinning of neutron star, and hence the wrench effect of both electric and magnetic fields becomes significant in the propagation of light modes. The vacuum birefringence will be formulated to include the wrench effect and the X-ray polarimetry will be studied which can be measured in the future space telescopes, such as IXPE, e-XTP and Compton Telescope.

**Presenter:** KIM, Sang Pyo (Kunsan National University)

Contribution ID: 1

## Black-hole bomb and confined Penrose process

Friday, 16 June 2023 12:00 (15 minutes)

We consider the decay of a particle with some energy  $E_0 > 0$  inside the ergosphere of a black hole. After the first decay, one of particles with the energy  $E_1 < 0$  falls towards a black hole while the second one with  $E_2 > E_0$  moves in the outward direction. It bounces back from a reflecting shell and, afterwards, the process repeats. For radial motion of charged particles in the Reissner-Nordstrom metric, the result depends strongly on a concrete scenario. In particular, an indefinitely large growth of energy inside a shell is possible that gives rise to a black-hole bomb. We also consider a similar multiple process with neutral particles in the background of a rotating axially symmetric stationary black hole. We demonstrate that, if particle decay occurs in the turning point, a black-hole bomb in this case is impossible at all. For a generic point inside the ergoregion, there is a condition for a black-hole bomb to exist. It relates the ratio of masses before and after decay and the velocity of a fragment in the center of mass frame.

**Presenter:** ZASLAVSKII, Oleg (Kharkov V. N. Karazin National University)

Contribution ID: 83

## The transformation of the rotational energy of a Kerr BH

Friday, 16 June 2023 12:15 (15 minutes)

We analyze the “ballistic method” of rotational energy extraction from an Kerr black hole (BH)

by massive particle decay in the BH ergosphere pioneered by Roger Penrose. We focus on the negative energy counterrotating particles in-going to the horizon and evaluate the feedback on the BH irreducible mass ( $\Delta M_{\text{irr}} > |E_1|$ ). The change in irreducible mass is a function of the ratio of the particle mass  $\mu_1$  to the mass of BH. In the limit  $\mu_1/M \rightarrow 0$ ,  $\Delta M_{\text{irr}}/|E_1| \rightarrow \infty$ , all the reduced extractable energy goes into the irreducible mass, resulting in high irreversibility.

**Presenter:** ZHANG, Shurui (USTC & ICRANet)

Contribution ID: 36

## **Black entropy, Weyl curvature, and Christodoulou-Ruffini irreducible mass**

Friday, 16 June 2023 12:30 (15 minutes)

In the context of reversible vs. irreversible transformations of a black hole, Christodoulou and Ruffini introduced the notion of irreducible mass, which is related to the event horizon area. The area of the event horizon was subsequently interpreted as the black hole entropy by Hawking and Bekenstein. Furthermore, Penrose conjectured the Weyl curvature hypothesis: the Weyl curvature is a density of gravitational entropy. However, implementing this idea is not so trivial with some drawbacks in the proposal of taking the square of the Weyl curvature as an entropy density being identified. In my talk, I will propose a solution to this issue through an appropriate combination of curvature quantities based only on the Weyl curvature (which therefore is not sensitive to the matter content of the spacetime and really constitutes a measure of the pure gravitational field), which exhibits a general applicability for all static and spherically symmetric black holes in general relativity independently on the matter field on their exterior. Our new formula for the gravitational entropy density allows us to provide some physical insights about the nature of black hole entropy, and of the Christodoulou-Ruffini irreducible mass, also putting our results in the perspective of modified gravity theories.

**Presenter:** GREGORIS, Daniele (Jiangsu University of Science and Technology)

Contribution ID: 88

## **Probing episodes of phenomena associated with naturally produced GRB using X-ray free electron lasers**

Friday, 16 June 2023 12:45 (15 minutes)

Gamma-ray bursts (GRB) are the most energetic explosions that occur naturally in distant galaxies [1]. Their analysis facilitates the probing of early Universe and its expansion, the understanding of stellar evolution, the analysis of high energy phenomena and of the matter under extreme conditions [2, 3, 4]. GRBs constitute excellent natural laboratory settings to test the fundamental physics theories the properties of matter at data on matter-radiation interaction. This analysis enabled by the data acquisition Earth orbiting satellites may be complemented by experiments that can be conducted in a controlled manner in laboratories. The constant improvement of the X-ray

free electron lasers facilities [5, 6] allow the realization of highly integrated projects [7, 8]. Experiments that would mimic the conditions in the outer galactic region and that can be conducted are: i) study of matter at extreme conditions, ii) analysis of matter dynamics at the atomic and molecular level employing pump-probe experiments on pulsed molecular supersonic beams, iii) study of electronic structure of matter under high magnetic fields, and iv) study the DNA mutations to test the hypothesis that GRB associated radiation with optimal intensities at the sea level could lead to bio-diversification [9].

**Presenter:** Dr UKA, Arban (Epoka University)

## Friday afternoon session, 15:00-18:00, 16 of June 2023

Contribution ID: 26

### Development of semi-implicit numerical method on a moving grid for differentially rotating astrophysical MHD flows with self-gravity.

Friday, 16 June 2023 15:00 (15 minutes)

We represent a numerical method for the simulation of 3D differentially rotating astrophysical MHD flows in cylindrical and spherical geometries. This approach belongs to the class of mixed Euler-Lagrange methods. The grid consists of rings which are rotating in a quasi-Lagrangian manner together with the background (differential and solid state) large-scale rotation, significantly reducing the numerical diffusion of the method associated with advection in the azimuthal direction. We use explicit Godunov-type scheme, while acoustic waves are treated in a semi-implicit way. This approach makes it possible to solve the equations of gas dynamics uniformly for wide range of Mach. The stability condition for the scheme does not depend on the speed of sound. This approach allows to simulate MHD differentially rotating flows like core collapse supernovae or accretion problems.

**Presenter:** MOISEENKO, Sergey (Space Research Institute, Moscow, Russia)

Contribution ID: 42

### Magnetized advective accretion disks and their stability at higher accretion rate: Theory and simulation

Friday, 16 June 2023 15:15 (15 minutes)

An optically thin advective accretion disk appears to be indispensable to explain hard-state of black hole sources. Any transport of matter therein is assumed to be led by (modified)  $\alpha$ -viscosity when the magnetic field is weak. We explore how large scale stronger magnetic

field helps in transporting angular momentum, over  $\alpha$ -viscosity based transport, depending on the field geometry. Interestingly, while above a critical accretion rate the accretion disk turns out to be thermally unstable, in the presence of stronger magnetic fields the disk regains its stability. We first establish this by theory and then explore the same by numerical simulation based on HARMPI. This increases the upper limit of accretion rate in optically thin flows, which has far reaching implications including explanation of ultra-luminous X-ray sources.

**Presenter:** MUKHOPADHYAY, Banibrata (Indian Institute of Science)

Contribution ID: 64

## Black hole extended thermodynamics

Friday, 16 June 2023 15:30 (15 minutes)

We use certain compatibility conditions in the formalism of geometrothermodynamics and the non-extensivity property of black holes to argue that the corresponding fundamental equations should be given in terms of quasi-homogeneous functions. As a result, coupling constants in alternative theories of gravity, such as the cosmological constant, the Born-Infeld constant, etc., turn out to be thermodynamic variables, leading to extensions of classical black hole thermodynamics.

**Presenter:** QUEVEDO, Hernando (National Autonomous University of Mexico)

Contribution ID: 10

## An improved Zeldovich formula for the Cosmological Constant from Precanonical Quantum Gravity

Friday, 16 June 2023 15:45 (15 minutes)

Within the precanonical quantization, which we will outline, the dynamics of quantum fields is controlled by the operator of the De Donder-Weyl Hamiltonian (DWH) whose classical version is derived from the Lagrangian. The operator ordering in the DWH operators of GR and its teleparallel equivalent, which is consistent with the diffeomorphism-invariant measure in the scalar product and the required (pseudo-)Hermiticity, produces an exactly calculable constant addition, which is identified with the cosmological constant  $\Lambda$ . Its value corresponds to the Zeldovich-1968 formula in which the 6th degree of the proton mass is replaced by the square of the ultraviolet (inverse volume) scale  $\aleph$  introduced by the precanonical quantization. This scale can be related to the scale of the mass gap of the quantum pure gauge theories of the Standard Model (IK-2017). This identification yields the observable value of  $\Lambda$  up to approximately  $3^2$  orders of magnitude error which is due to an error in the estimation of  $\aleph$  from its relation to the mass gap. We also discuss how this error can be improved and how our approach leads to the “minimal acceleration” and derives its relation with  $\sqrt{\Lambda}$  as anticipated in Milgrom’s MOND.

**Presenter:** KANATCHIKOV, Igor (Natl Quantum Information Center)

Contribution ID: 51

## Astrophysical scenarios leading to gravitational wave modification

Friday, 16 June 2023 16:00 (15 minutes)

Calculations of gravitational waves (GWs), both analytical and numerical, assume that they propagate from source to a detector on Earth in a vacuum spacetime. Whilst the average cosmological density of baryonic plus dark matter is small, a detected GW event may be a considerable distance away from its source, up to order 1 Gpc, and the quantity of intervening matter may not be negligible. Furthermore, there is the possibility that the astrophysical environment of a source event may be such that the source is surrounded by a substantial amount of matter. As we enter into an era of precision GW measurements, it is important to quantify any effects due to the propagation of GWs through a non-vacuum spacetime

**Presenter:** Dr NAIDOO, Monos (Rhodes University)

Contribution ID: 60

## Plausible detection of rotating magnetized neutron stars by their continuous gravitational waves

Friday, 16 June 2023 16:15 (15 minutes)

In the past decades, several neutron stars (NSs), particularly pulsars, with mass  $M > 2M_{\odot}$ , have been observed. Hence, there is a generic question of the origin of massive compact objects. Here we explore the existence of massive, magnetized, rotating NSs by solving axisymmetric stationary stellar equilibria in general relativity using the Einstein equation solver for stellar structure XNS code. Such rotating NSs with magnetic field and rotation axes misaligned, hence with non-zero obliquity angle, can emit continuous gravitational waves (GW). We discuss the decay of the magnetic field due to Ohmic, Hall and Ambipolar diffusion, and decay of angular velocity, and obliquity angle with time due to angular momentum extraction by GW and dipole radiation, which determine the timescales related to the GW emission. Further, in the Alfvén timescale, a differentially rotating, massive proto-NS rapidly settles into a uniformly rotating, less massive NS due to magnetic braking and viscosity. These explorations suggest that detecting massive NSs is challenging and sets a timescale for detection. We calculate the signal-to-noise ratio of GW emission, which confirms that any detector cannot detect them immediately, but detectable by Einstein Telescope and Cosmic Explorer over months of integration time, leading to direct detection of NSs.

**Presenter:** DAS, Mayusree (Indian institute of science)

## Coffee break 16:30-16:45

Contribution ID: 90



## Revival of Descartes-Leibniz debate as a guide for a unification theory by removing singularities

Friday, 16 June 2023 16:45 (15 minutes)

This paper revives the Descartes-Leibniz debate on the constant quantity of motion. This idea is based on keeping the total energy  $E=mc^2$  as a constant where the energy and the mass are independent of the form and speed even when the latter converges to the speed of light. With the increase of the speed, the object transforms the rest energy denoted here as the unexposed energy. The energy transformation process ends when the unexposed energy is completely transformed to an energy with a kinetic character denoted as exposed energy. This is used in the Lagrangian to derive the equations of motion. The exposed energy expresses the intensity of the field and is represented by another inherent characteristic: the energy state. At rest it is associated with the Schwarzschild radius for masses larger than Planck's mass. For smaller masses it is associated with the classical radius. The maximum energy state corresponds to the Planck length. The radii associated with different energy states are found using  $mcr=ah$ . The new model drops the elementary charge, the gravitational constant and unifies gravitation with electromagnetism. It leads to a new gravitation law with quantum character whose applicability limit is up to the Planck length.

**Presenter:** UKA, Arban (Epoka University)

Contribution ID: 2

## Warm Inflation using Irreversible Thermodynamical Approach

Friday, 16 June 2023 17:00 (15 minutes)

We aim to study warm inflation via irreversible thermodynamics of open systems with matter creation/decay within Rastall theory of gravity. Interacting scalar field and radiation are assumed to be the components of cosmological fluid in a spatially flat FRW universe model. Considering the early universe as an open system and implementing the thermodynamics on the interacting cosmological fluid leads to modifying the standard formalism of the warm inflationary model, including the creation(decay) pressure, which is considered part of the energy-momentum tensor explicitly. Under slow-roll approximation, numerical solutions of the thermodynamical equations are obtained and represented graphically. By constraining the free model parameters, the theoretical predictions of the underlying model are compared with the Planck-2018 data.

**Presenter:** Dr SALEEM, Rabia (COMSATS UNIVERSITY ISLAMABAD, LAHORE CAMPUS)

Contribution ID: 9

## Anisotropic Strange Stars through Complexity Factor

Friday, 16 June 2023 17:15 (15 minutes)

By using the gravitational decoupling method to create an exact solution to the field equations, this

talk discusses the formulation of a charged anisotropic spherically symmetric strange star model. The initial decoupled system is split into Einstein-Maxwell and quasi-Einstein systems using minimal geometric modification. By employing the complexity factor to solve quasi-Einstein field equations, a well-known model for the isotropic spherical matter distribution is adopted with MIT bag equation of state incorporating electromagnetic field and generalize it to an anisotropic model. By visualizing metric functions, density, pressure, anisotropy parameter, energy requirements, and stability criterion for various strange star candidates, the physical viability of the resulting charged anisotropic solution is investigated. The generated model's physical acceptability is ensured by the fact that all physical aspects behave properly.

**Presenter:** SADIQ, Sobia (University of Education, Lahore)

Contribution ID: 61

## A New Approach to Quantizing the General Relativity

Friday, 16 June 2023 17:30 (15 minutes)

General theory and quantum mechanics are fundamentally very different theories with distinct formulations. Nevertheless, both of them claim to predict how Nature works! The everlasting battle for exploring and understanding the Universe and for privileging a consistent perception of reality is therefore awaiting a consolidator rather than a conqueror. This should be capable of either unifying those two different benchmarks or at least bringing one closer to the other! The latter describes the consolidating approach we are introducing here. We are not suggesting alternatives to GR. Also, we are not aiming at replacing QM by another theory. The present approach preserves the current versions of both theories. The applicability of GR and QM are solely enlarged so that sensical predictions become feasible at all scales. This was only possible, when finite gravitational fields are integrated in QM and quantum-mechanical aspects are then properly imposed on GR. We find that the additional curvatures that emerged with the quantization are associated with a maximal proper force, which is apparently related to the quantum-mechanical jumps characterizing the quantized metric tensor.

**Presenter:** TAWFIK, Abdel Nasser (Egyptian Center for Theoretical Physics, Future University in Egypt)



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**Founded by:** Republic of Armenia, ICRA, Republic of Italy, University of Arizona, Stanford University, Vatican City State

**Date of foundation:** February 10, 2005

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;
- cooperation and affiliation with international scientific organizations and technology transfer with industry.

Scientific areas covered include cosmology, high-energy astrophysics, theoretical and mathematical physics. ICRANET coordinates the research activities of Member Universities and Research Centers operating in different geographical areas. A series of new seats for the activities are being developed in order to achieve these goals. The first has been completed and is fully operative in Pescara. New centers have been established in Nice, Yerevan, Minsk, Isfahan and Mazandaran. Projects for additional Centers in Stanford (USA), Central Asia, China, Australasia, Germany and Pakistan are considered. ICRANET encourages the mobility of scientists among the Centers and offers fellowships to young students at graduate, post-graduate and post-doctoral levels within the framework of special training programs. ICRANET is at the service of the scientific institutions and the Member States that wish to cooperate in the field of Relativistic Astrophysics.

# 18th Italian-Korean Symposium on Relativistic Astrophysics

June 19-23, 2023  
ICRANet Pescara  
Italy

The Italian-Korean Symposia on Relativistic Astrophysics is a series of biannual meetings, alternatively organized in Italy and in Korea since 1987. The symposia discussions cover topics in astrophysics and cosmology, such as gamma-ray bursts and compact stars, high energy cosmic rays, dark energy and dark matter, general relativity, black holes, and new physics related to cosmology.



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# **18th Italian-Korean Symposium on Relativistic Astrophysics**

**Monday, June 19, 2023 - Friday, June 23, 2023**

**ICRANet, Pescara  
Program**

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# Monday, June 19, 2023

**GRB220101A the most powerful GRB with seven BdHN Episodes observed (9:00 AM - 9:45 AM)**

- Presenter: RUFFINI, Remo

**Light from a quasar interacting with gravitational waves: a geometrical-optics analysis (9:45 AM - 10:30 AM)**

- Presenter: KIM, Dong-Hoon

**Coffee break (10:30 AM - 11:00 AM)**

**Probing electromagnetic-gravitational wave emission coincidence in type I binary-driven hypernova family of long GRBs at very-high redshift (online talk) (11:00 AM - 11:45 AM)**

- Presenter: BIANCO, Carlo Luciano

**Discussions (11:45 AM - 12:15 PM)**

**Coffee break (3:30 PM - 4:00 PM)**

**Properties of a rotating black hole with anisotropic matter fields (4:00 PM - 4:45 PM)**

- Presenter: LEE, Wonwoo

**The transformation of the rotational energy of a Kerr BH (4:45 PM - 5:30 PM)**

- Presenter: ZHANG, Shurui

**Discussion (5:30 PM - 6:00 PM)**

## **Tuesday, June 20, 2023**

### **Emission from Magnetized Black Holes and KN Black Holes (9:00 AM - 9:45 AM)**

- Presenter: KIM, Sang Pyo

### **Schwinger pair production in relativistic plasma (9:45 AM - 10:05 AM)**

- Presenter: VERESHCHAGIN, Gregory

### **Asymptotic electromagnetic field of a charged particle, radially falling onto a Schwarzschild black hole (10:05 AM - 10:30 AM)**

- Presenter: VERESHCHAGIN, Gregory

### **Coffee break (10:30 AM - 11:00 AM)**

### **Are we prepared to observe the next Galactic Supernova? (online talk) (11:00 AM - 11:45 AM)**

- Presenter: DELLA VALLE, Massimo

### **Discussion (11:45 AM - 12:15 PM)**

### **coffee break (3:30 PM - 4:00 PM)**

### **Detection of gravitational waves by electromagnetic cavity: a review (4:00 PM - 4:45 PM)**

- Presenter: PARK, Chan

### **Constraining the neutron star critical mass with long gamma-ray bursts (4:45 PM - 5:30 PM)**

- Presenter: RUEDA HERNANDEZ, Jorge Armando

### **Discussion (5:30 PM - 6:00 PM)**

# Wednesday, June 21, 2023

## Searching for Dark Matter with White Dwarves (9:00 AM - 9:45 AM)

- Presenter: SCOPEL, Stefano

## Cosmology with Gamma-Ray Bursts (online talk) (9:45 AM - 10:30 AM)

- Presenter: AMATI, Lorenzo

## Coffee break (10:30 AM - 11:00 AM)

## Constraining the neutron star critical mass with long gamma-ray bursts (11:00 AM - 11:45 AM)

- Presenter: RUEDA HERNANDEZ, Jorge Armando

## Exploring the Progenitor of the Crab Nebula and Crab Pulsar: Insights from Binary-Driven Hypernovae (online talk) (11:45 AM - 12:30 PM)

- Presenter: MORADI, Rahim

## Discussion and beach (3:30 PM - 6:00 PM)

# Thursday, June 22, 2023

**Introduction to Space Science Activities in Korea (9:00 AM - 9:45 AM)**

- Presenter: LEE, Dong-hun

**Examples of Machine Learning in Astrophysics (9:45 AM - 10:30 AM)**

- Presenter: WANG, Yu

**Coffee break (10:30 AM - 11:00 AM)**

**The mirage of luminal modified gravitational-wave propagation (11:00 AM - 11:45 AM)**

- Presenter: ROMANO, Antonio Enea

**Discussion (11:45 AM - 12:15 PM)**

**coffee break (3:30 PM - 4:00 PM)**

**Some Modified Gravity Models and Cosmological Implications (4:00 PM - 4:45 PM)**

- Presenter: LEE, Bum-Hoon

**Transition from a Riemann ellipsoid to a Mclaurin spheroid: gravitational wave emission and some astrophysical implications (online talk) (4:45 PM - 5:30 PM)**

- Presenter: RODRIGUEZ RUIZ, Jose Fernando

**Discussion (5:30 PM - 6:00 PM)**

## **Friday, June 23, 2023**

**Entanglement entropy in expanding universes (9:00 AM - 9:45 AM)**

- Presenter: PARK, Chanyong

**TBD (9:45 AM - 10:30 AM)**

- Presenter: RUFFINI, Remo

**Coffee break (10:30 AM - 11:00 AM)**

**Study of Decoupled Cosmological Solutions in  $f(R,T)$  Theory (online talk) (11:00 AM - 11:20 AM)**

- Presenter: SHARIF, Muhammad

**Discretized Finsler-Hamilton Structure: a framework to quantize the general relativity (online talk) (11:20 AM - 11:40 AM)**

- Presenter: TAWFIK, Abdel Nasser

**Discussion (11:45 AM - 12:15 PM)**

**coffee break (3:30 PM - 4:00 PM)**

**Post-Newtonian approximation for a wormhole binary system (4:00 PM - 4:45 PM)**

- Presenter: KIM, Sung-Won

**Massive particle pair production and oscillation in Friedman Universe: its effect on inflation (4:45 PM - 5:30 PM)**

- Presenter: XUE, She-Sheng

**Discussion (5:30 PM - 6:00 PM)**

# **18th Italian-Korean Symposium on Relativistic Astrophysics**

Monday, June 19, 2023 - Friday, June 23, 2023

ICRANet, Pescara

## **Book of Abstracts**





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1

## Cosmology with Gamma-Ray Bursts (online talk)

**Author:** Lorenzo Amati<sup>1</sup>

<sup>1</sup> *INAF - OAS Bologna*

**Corresponding Author:** lorenzo.amati@inaf.it

The huge luminosity, the redshift distribution extending at least up to  $z \sim 10$  and the association with the explosive death of very massive stars make long GRBs (i.e., those lasting up to a few minutes) potentially extremely powerful probes for shedding light on main open issues in our understanding of the early Universe: star formation rate evolution up to the first generation of stars (pop-III), cosmic reionization, luminosity function and metallicity evolution of primordial galaxies up to the "cosmic dawn". At the same time, the correlation between radiated energy and spectral photon peak energy ("Amati relation" is under intensive investigations for "standardizing" GRBs and using them for measuring cosmological parameters, investigating the nature and evolution of "dark energy" and testing non-standard cosmological models. I will also report on the status, concepts and expected performances of space mission projects (e.g., THESEUS) aiming at fully exploiting these potentialities of the GRB phenomenon, also in synergy with the large e.m. facilities of the future like LSST, ELT, TMT, SKA, CTA, ATHENA

2

## Study of Decoupled Cosmological Solutions in $f(R,T)$ Theory (online talk)

**Author:** Muhammad Sharif<sup>None</sup>

**Corresponding Author:** msharif.math@pu.edu.pk

In this paper, we consider a non-static spherical geometry and formulate its extension for the case of anisotropic matter configuration through minimal gravitational decoupling in curvature-matter coupled gravity. We apply a particular transformation only on the radial metric function that divides the modified field equations into two distinct sectors corresponding to their parent (original and additional) sources. The unknowns in the first (isotropic) set are reduced by taking the Friedmann-Lemaître-Robertson-Walker cosmic model. We then obtain the isotropic solution by employing a linear equation of state and power-law form of the scale factor. The other set involves the decoupling function and components of an extra source, therefore we adopt a density-like constraint to close it. Finally, we analyze the role of this modified gravity and the decoupling parameter on three different eras of the cosmos by graphically observing the developed extended solution. It is concluded that the resulting solutions fulfill all the physical requirements only for the matter and radiation-dominated eras.

3

## Constraining the neutron star critical mass with long gamma-ray bursts

**Authors:** Chris Fryer<sup>1</sup>; Jorge Armando Rueda Hernandez<sup>2</sup>; Laura Becerra<sup>3</sup>; Remo Ruffini<sup>4</sup>

<sup>1</sup> *Los Alamos National Laboratory*

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The binary-driven hypernova (BdHN) model explains long GRBs associated with type Ic supernovae (SNe) with a binary composed of a carbon-oxygen (CO) star and a neutron star (NS) companion in close orbit. The CO core-collapse SN generates a newborn NS (new-NS) at its center and ejects the CO outer layers. This process triggers the GRB, starting from the accretion of ejecta onto the new-NS (via fallback) and the NS companion. We use a new, improved version of the numerical code for BdHN 3D simulations, which evolves the accreting NS in full general relativity for realistic nuclear equations of state (EOS). We shall catalog the outcome for different CO mass, NS mass, SN explosion energy and anisotropy, and orbital separations (periods) for various EOS to use GRB statistics to constrain the NS critical mass so the nuclear EOS. We also discuss additional astrophysical consequences of our calculations.

5

## Detection of gravitational waves by electromagnetic cavity: a review

**Author:** Chan Park<sup>1</sup>

<sup>1</sup> *Institute for Basic Science*

**Corresponding Author:** iamparkchan@gmail.com

Gravitational wave (GW) detection using electromagnetic (EM) cavities has garnered significant attention in recent years. With ongoing experiments on axion detection using highly sensitive electromagnetic cavity, there is potential to apply these existing facilities to GW detection, opening up a new channel of GW observation. In this review, we comprehensively examine the principles of GW detection using EM cavities within the framework of general relativity. We expect that it not only provides analysis of existing EM cavity experiments and but also offers insights for the design of new ones.

6

## Discretized Finsler-Hamilton Structure: a framework to quantize the general relativity (online talk)

**Author:** Abdel Nasser Tawfik<sup>1</sup>

<sup>1</sup> *Egyptian Center for Theoretical Physics, Future University in Egypt*

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To reconcile principles of general relativity (GR) and quantum mechanics (QM), differential and quantum geometry, duality-symmetry configurations of distance and momentum, the Born reciprocity principle (BRP), and noncommutative algebra, especially the relativistic generalized uncertainty principle (RGUP), are simultaneously applied on GR and QM. The latter integrates gravitational fields in the fundamental theory of QM. The earlier extends the four-dimensional Riemann to eight-dimensional Finsler-Hamilton geometry. The resulting structure is then characterized by coordinates and directions coupled to the momenta of a free particle,  $\hat{x}_0^\mu$  and  $\hat{p}_0^\nu$ , respectively. With RGUP, the momentum operator  $\hat{p}_0^\nu$  is modified to  $\phi\hat{p}_0^\nu$ , so that the resulting discretized Finsler-Hamilton structure  $F(\hat{x}_0^\mu, \phi\hat{p}_0^\nu)$  is also 1-homogeneous in  $\hat{p}_0^\nu$ . The quantity  $\phi = 1 + \beta\hat{p}_0^\rho\hat{p}_{0\rho}$ , which exclusively depends on  $\hat{p}_0^\nu$ , is 0-homogeneous. The corresponding metric tensor could be deduced from the Hessian of  $F^2(\hat{x}_0^\mu, \phi\hat{p}_0^\nu)$ .

7

## Searching for Dark Matter with White Dwarves

**Author:** Stefano Scopel<sup>1</sup>

<sup>1</sup> *Sogang University*

**Corresponding Author:** scopel@sogang.ac.kr

Weakly interacting massive particles (WIMPs) can be captured in compact stars such as white dwarves (WDs) if they are in a dark matter-rich environment, leading to an increase in the star luminosity through their annihilation process. I will show that if the WIMP interacts with nuclear targets through inelastic scattering the data on low-temperature large-mass WDs in the Messier 4 globular cluster can probe a part of the WIMP parameter space not accessible by terrestrial direct detection searches and from solar neutrino searches. I will discuss this new class bounds in the specific WIMP scenario of a self-conjugate bidoublet in the left-right symmetric model (LRSM), introduced to explain maximal parity violation in weak interactions, showing that it significantly reduces its cosmologically viable parameter space.

8

## Light from a quasar interacting with gravitational waves: a geometrical-optics analysis

**Author:** Dong-Hoon Kim<sup>1</sup>

<sup>1</sup> *Seoul National University*

**Corresponding Author:** ki13130@gmail.com

We consider a situation in which a quasar contains a source of gravitational waves (e.g. binary black holes) and electromagnetic waves from the quasar interact with gravitational waves from the source. The effect will be appreciable if the interaction initially takes place close to the source of gravitational waves where the strain amplitude can be large. This situation can be modeled effectively using spherical gravitational waves (rather than plane-fronted gravitational waves); i.e., transverse-traceless radially propagating waves, with the strain amplitude varying by the distance between the source and an observer. Our analysis employs geometrical-optics methods in curved spacetime and a particular focus is placed on the effect of gravitational Faraday rotation (or Skrotskii/Rytov effect) resulting from the interaction between light from a quasar and spherical gravitational waves from binary black holes within the quasar.

9

## Massive particle pair production and oscillation in Friedman Universe: its effect on inflation

**Author:** She-Sheng Xue<sup>1</sup>

<sup>1</sup> *ICRANet, Physics Department, Sapienza University of Rome*

**Corresponding Author:** xue@icra.it

We study the classical Friedman equations for the time-varying cosmological term  $\tilde{\Lambda}$  and Hubble function  $H$ , together with quantised field equations for the production of massive  $M \gg H$  particles, namely, the  $\tilde{\Lambda}$ CDM scenario of dark energy and matter interactions. Classical slow

components  $\mathcal{O}(H^{-1})$  are separated from quantum fast components  $\mathcal{O}(M^{-1})$ . The former obeys the Friedman equations, and the latter obeys a set of nonlinear differential equations. Numerically solving equations

for quantum fast components, we find the production and oscillation of massive particle-antiparticle pairs in microscopic time scale  $\mathcal{O}(M^{-1})$ . Their density and pressure averages over microscopic time do not vanish.

It implies the formation of a massive pair plasma state in macroscopic time scale  $\mathcal{O}(H^{-1})$ , whose effective density and pressure contribute to the Friedman equations. Considering the inflation driven by the time-varying cosmological term and slowed down by the massive pair plasma state, we obtain the relation of spectral index and tensor-to-scalar ratio in agreement with recent observations. We discuss the singularity-free pre-inflation, the CMB large-scale anomaly, and dark-matter density perturbations imprinting on power spectra.

10

## The mirage of luminal modified gravitational-wave propagation

**Author:** Antonio Enea Romano<sup>1</sup>

<sup>1</sup> *UDEA/CERN*

**Corresponding Author:** antonio.enea.romano@cern.ch

Using conformal invariance of gravitational waves, we show that for a luminal modified gravity theory, the gravitational-wave propagation and luminosity distance are the same as in general relativity. The relation between the gravitational-wave and electromagnetic-wave luminosity distance gets however modified for electromagnetism minimally coupled to the Jordan frame metric. Using effective field theory we show that the modified relation obtained for luminal theories is also valid for non-luminal theories with Jordan frame matter-gravity coupling. We generalise our analysis to a time-dependent speed of gravitational waves with matter minimally coupled to either the Jordan or Einstein frame metrics.

11

## Schwinger pair production in relativistic plasma

**Author:** Gregory Vereshchagin<sup>1</sup>

**Co-author:** Mikalai Prakapenia<sup>2</sup>

<sup>1</sup> *ICRANet*

<sup>2</sup> *ICRANet-Minsk*

**Corresponding Author:** veresh@icra.it

We consider pair production in uniform electric field in presence of electron-positron plasma. Depending on initial pair distribution in momentum space pairs are either created or annihilated in external field. Pairs are either created or annihilated depending on their initial distribution. We show that electric field cannot be enhanced by inverse Schwinger process.

12

## Asymptotic electromagnetic field of a charged particle, radially falling onto a Schwarzschild black hole

**Author:** Gregory Vereshchagin<sup>1</sup>

**Co-authors:** Alexander Gorbatsievich<sup>2</sup>; Stanislav Komarov<sup>3</sup>

<sup>1</sup> *ICRANet*

<sup>2</sup> *Belarusian State University*

<sup>3</sup> *ICRANet-Minsk*

**Corresponding Author:** veresh@icra.it

We determine multipole coefficients of electromagnetic field for charged particle, radially falling into Schwarzschild black hole by approximating the Regge-Wheeler potential by the Dirac delta-function. Considering the limit when the particle is approaching the event horizon of the black hole we show analytically that all multipoles except for the monopole vanish exponentially fast.

13

## Probing electromagnetic-gravitational wave emission coincidence in type I binary-driven hypernova family of long GRBs at very-high redshift (online talk)

**Authors:** Carlo Luciano Bianco<sup>1</sup>; F. Rastegarnia<sup>None</sup>; J.A. Rueda<sup>None</sup>; L. Li<sup>None</sup>; M. Della Valle<sup>None</sup>; M.T. Mirtorabi<sup>None</sup>; R. Moradi<sup>None</sup>; R. Ruffini<sup>None</sup>; S.R. Zhang<sup>None</sup>; Y. Wang<sup>None</sup>

<sup>1</sup> *ICRANet*

**Corresponding Author:** bianco@icra.it

Due to the technical time delay of the XRT instrument on board the Neil Gehrels Swift Observatory satellite, we cannot observe the X-ray emission occurring less than  $\sim 40$  s after a gamma-ray burst (GRB) trigger time. We here indicate a new strategy of using the cosmological time dilatation in high redshift GRBs to observe the earliest X-ray emission by Swift/XRT in the GRB cosmological rest-frame. We illustrate this procedure using 354 GRBs with a well-defined cosmological redshift selected from the Swift GRB catalog. We compare and contrast the time delay between the trigger of the source and the first observation by Swift/XRT as measured in the observer frame (OTD) and the corresponding delay measured in GRBs' cosmological rest-frame (RTD). We consider as specific prototypes three binary-driven hypernovae of type I (BdHNe I): GRB 090423 at  $z=8.2$  with an RTD of 8.2 s, GRB 090429B at  $z\sim 9.4$  with an RTD of 10.1 s, as well as the GRB 220101A at  $z=4.6$  with an RTD of 14.2 s. This opens a new possibility for probing Episode (1) of BdHNe, linked to the origin and early appearance of the newborn neutron star (vNS) and its transition from a Jacobi triaxial ellipsoid (JTE) to a Maclaurin spheroid configuration that originates the GRB afterglow onset. We also present the methodology to compute the sweeping frequencies and the energetics of the associated conspicuous gravitational wave emission.

14

## GRB220101A the most powerful GRB with seven BdHN Episodes observed

**Author:** Remo Ruffini<sup>1</sup>

<sup>1</sup> *ICRANet*

16

## Properties of a rotating black hole with anisotropic matter fields

**Author:** Wonwoo Lee<sup>None</sup>

We report the charged rotating black hole with an additional matter field. The geometry is obtained by adopting the Newman-Janis algorithm, and the solution of Maxwell fields is also obtained by that. We discuss the properties of that rotating black hole with the energetics, black hole shadow, and others.

18

## Are we prepared to observe the next Galactic Supernova? (online talk)

Optical surveys have been proven inefficient in detecting Supernovae events in our galaxy. In the face of 7 expected core-collapse SNe in the last 4 centuries, zero SNe have actually been observed. Present and future neutrino telescopes such as Super-Kam or Hyper-Kam have the capabilities to observe large numbers of neutrinos from SNe occurring inside the Milky Way and Local Group of Galaxies, respectively.

19

## Constraining the neutron star critical mass with long gamma-ray bursts

**Author:** Jorge Armando Rueda Hernandez<sup>1</sup>

<sup>1</sup> *ICRANet*

**Corresponding Author:** [jorge.rueda@icra.it](mailto:jorge.rueda@icra.it)

The binary-driven hypernova (BdHN) model explains long GRBs associated with type Ic supernovae (SNe) with a binary composed of a carbon-oxygen (CO) star and a neutron star (NS) companion in close orbit. The CO core-collapse SN generates a newborn NS (new-NS) at its center and ejects the CO outer layers. This process triggers the GRB, starting from the accretion of ejecta onto the new-NS (via fallback) and the NS companion. We use a new, improved version of the numerical code for BdHN 3D simulations, which evolves the accreting NS in full general relativity for realistic nuclear equations of state (EOS). We shall catalog the outcome for different CO mass, NS mass, SN explosion energy and anisotropy, and orbital separations (periods) for various EOS to use GRB statistics to constrain the NS critical mass so the nuclear EOS. We also discuss additional astrophysical consequences of our calculations.

20

## Introduction to Space Science Activities in Korea

**Author:** Dong-hun Lee<sup>None</sup>



23

## Some Modified Gravity Models and Cosmological Implications

**Author:** Bum-Hoon Lee<sup>None</sup>

Recent precise measurements suggest the needs beyond the standard lambda CDM cosmological model. We specifically consider gravity with the additional Gauss-Bonnet higher curvature term and study some astrophysical and cosmological implications.

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## Exploring the Progenitor of the Crab Nebula and Crab Pulsar: Insights from Binary-Driven Hypernovae (online talk)

**Author:** Rahim Moradi<sup>1</sup>

<sup>1</sup> *ICRANet and ICRA-Sapienza*

**Corresponding Author:** rahim.moradi@icranet.org

We propose that the progenitor of the Crab Nebula and the Crab pulsar shares similarities with binary-driven hypernovae. The understanding of binary-driven hypernovae has revealed the crucial role played by the explosion of the supernova, as well as the hypercritical accretion of the supernova ejecta onto the binary companion neutron star (NS) and the newborn NS (vNS) in determining the dynamics of gamma-ray bursts (GRBs). The synchrotron emission resulting from the vNS-pulsar emission and the accreted supernova ejecta onto the vNS gives rise to X-ray afterglows. Notably, we find evidence that the X-ray afterglow luminosity of GRB 190114C, selected as a prototype binary-driven hypernova, when extrapolated to 1000 years, coincides with the presently observed emission of the Crab Nebula. To model the vNS, we employ the equilibrium sequence of Maclaurin spheroids. By ensuring that the vNS period extrapolated to 1000 years matches that of PSR B0531+21 (the Crab pulsar), we determine the initial spin of the vNS to be 0.9 ms. Subsequently, we track the evolution of the eccentricity, which manifests itself through the release of rotational and gravitational energy of the vNS-pulsar.

26

## Entanglement entropy in expanding universes

**Author:** Chanyong Park<sup>None</sup>

We study the time evolution of entanglement entropy in expanding universes with various matters. To describe expanding universes holographically, we take into account a braneworld moving in an asymptotic AdS space involving a uniform p-brane gas. In the braneworld model, an observer living in the braneworld detects the bulk motion of the braneworld as an expanding universe. We show that the entanglement entropy of expanding universes increases by the volume law in the early time and by the area law in the late time. We further consider the cosmological horizon, which is the border of the visible and invisible universe, and then investigate the time-dependent quantum entanglement between them across the cosmological horizon.

28

## Post-Newtonian approximation for a wormhole binary system

**Author:** Sung-Won Kim<sup>None</sup>

We consider a binary system consisting of two traversable wormholes as one of the gravitational wave source candidates. If the two wormholes are far enough apart from each other, they can be treated as point masses, and the properties of gravitational waves generated by the system is very similar to those of a binary compact star system. However, when they approach each other and the system is at the late inspiral state, the finite-size effect becomes very important. When the Post-Newtonian approximation is applied to the wormhole binary system, we have to adopt the effective mass definition from gravitational potential of the wormhole. If the wormhole matters are distributed in delta-function type, wormhole can be considered as the point mass with the effective mass. If matters are distributed differently, such as the power-law, the finite-size effect can be seen using the effective one-body method.

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## Emission from Magnetized Black Holes and KN Black Holes

**Author:** Sang Pyo Kim<sup>1</sup>

<sup>1</sup> *Kunsan National University*

**Corresponding Author:** sangpyokim79@gmail.com

Charged black holes have been proposed as a central engine for GRBs. Damour and Ruffini proposed Schwinger mechanism of KN black holes as the central engine [Phys. Rev. Lett. 35, 332 (1975)] while Blandford and Znajek proposed that the magnetic fields surrounding rotating black holes supported by current of disks induce strong electric fields to produce electron-positron pairs for GRBs [Mon. Not. R. Astron. Soc. 179, 433 (1977)]. In this talk, strong field QED effects such as the Schwinger mechanism, vacuum polarization of magnetized black holes [Moss, Stasiak, arXiv:2303.01119, 2023] and KN black holes are studied and possible methods are discussed to probe underlying physical scenarios through observations by space telescopes in the future.

30

## The transformation of the rotational energy of a Kerr BH

**Authors:** Shurui Zhang<sup>1</sup>; Mikalai Prakapenia<sup>2</sup>; Jorge Rueda<sup>3</sup>; Remo Ruffini<sup>4</sup>

<sup>1</sup> *ICRANet & USTC*

<sup>2</sup> *Belarusian State University*

<sup>3</sup> *ICRANet & Unife*

<sup>4</sup> *ICRANet*

**Corresponding Authors:** zhangsr@mail.ustc.edu.cn, nikprokopenya@gmail.com, jorge.rueda@icra.it, ruffini@icra.it

We analyze the “ballistic method” of rotational energy extraction from an (extreme) Kerr black hole (BH) by massive particle decay in the BH ergosphere pioneered by Roger Penrose. We focus on the negative energy counterrotating particles in-going to the horizon and evaluate the feedback on the BH irreducible mass ( $\Delta M_{\text{irr}} > |E_1|$ ). The change in irreducible mass is a function of the ratio of the particle mass  $\mu_1$  to the mass of BH. In the limit  $\mu_1/M \rightarrow 0$ ,  $\Delta M_{\text{irr}}/|E_1| \rightarrow \infty$ , all the reduced extractable energy goes into the irreducible mass, resulting in high irreversibility.

31

## Examples of Machine Learning in Astrophysics

**Author:** Yu Wang<sup>1</sup>

**Co-authors:** Fatemeh Rastegarnia<sup>2</sup>; Rahim Moradi<sup>3</sup>

<sup>1</sup> *ICRANet, INAF*

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<sup>3</sup> *IHEP*

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I will provide two examples of machine learning applications in astrophysics. The first example is using deep neural networks to test the unification model of active galactic nucleus (AGN). The second example is a comparison between a simple specific neural network and a Fine-Tuned GPT model for the estimation of spectral redshift.

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## Transition from a Riemann ellipsoid to a Mclaurin spheroid: gravitational wave emission and some astrophysical implications (online talk)

**Authors:** Jorge Armando Rueda Hernandez<sup>1</sup>; Jose Fernando Rodriguez Ruiz<sup>2</sup>

<sup>1</sup> *ICRANet*

<sup>2</sup> *Universidad Industrial de Santander*

**Corresponding Authors:** joferoru@gmail.com, jorge.rueda@icra.it

Semi-analytical models of gravitational wave (GW) radiation are constructed following first principles. They are more than mere academic exercises and can be used to compute qualitative and quantitative results. We study a semi-analytical approach to gravitational radiation from rotating ellipsoids (Riemann ellipsoids), whose internal matter is described by a polytropic equation of state. It was found an early period when the GW has an increasing frequency and amplitude. This object is called a chirping ellipsoid (CEL), and its waveform when the polytropic index is close to 3, is almost identical to one of an inspiral binary. The almost perfect match occurs when the mass of the CEL is of the order of the chirp mass of the binary. These CELs are detectable by low-frequency detectors such LISA, Taiji or TianQin. The equivalent binary can be identified with an extreme-mass-ratio inspiral composed of an intermediate-mass black hole and planet-like object or with a double-detached white dwarf. On the other hand, these CELs can be also used to model the post-merger object of BNS merger or a DWD merger. It will be shown the transition from a Riemann ellipsoid to a Mclaurin spheroid. From the conservation of angular momentum and baryonic mass, some parameters of the initial state of the ellipsoid can be obtained. Also, the time it takes the CEL to make the transition can be used to constrain the initial ellipticity of the CEL.

33

## An Approach to Quantizing GR (online talk)

**Author:** Abdel Nasser Tawfik<sup>1</sup>

<sup>1</sup> *Egyptian Center for Theoretical Physics*

**Corresponding Author:** a.tawfik@eng.mti.edu.eg

General theory and quantum mechanics are fundamentally very different theories with distinct formulations. Nevertheless, both of them claim to predict how Nature works! The everlasting battle for exploring and understanding the Universe and for privileging a consistent perception of reality is therefore awaiting a consolidator rather than a conqueror. This should be capable of either unifying those two different benchmarks or at least bringing one closer to the other! The latter describes the consolidating approach we are introducing here. We are not suggesting alternatives to GR. Also, we are not aiming at replacing QM by another theory. The present approach preserves the current versions of both theories. The applicability of GR and QM are solely enlarged so that sensical predictions become feasible at all scales. This was only possible when finite gravitational fields are integrated in QM and quantum-mechanical aspects are then properly imposed on GR. We find that the additional curvatures that emerged with the quantization are associated with a maximal proper force, which is apparently related to the quantum-mechanical jumps characterizing the quantized metric tensor.

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**TBD**

**Corresponding Author:** ruffini@icra.it



# European Researchers' Night at ICRANet

Friday September 29, 2023

ICRANet HQ (Pescara), ICRANet Seat in Nice and online

## Program

**H 16:00 – 18:15**

ICRANet Seat at Villa Ratti, 1 Avenue Ratti, 06000, Nice (France) - <https://meet.goto.com/961416205>

**h 16:00 – 16:15: Welcoming addresses by local authorities (TBD)**

**h 16:15 – 16:50: “Black Holes in the Universe”**(Prof. Remo Ruffini, Director of ICRANet)

**h 16:50 – 17:25: “Les Rencontres de Villa Ratti ”**(Prof. Joseph Kouneiher, President Projet Archimedes E.C.A.)

**h 17:25 – 18:00: “The most recent GRB 230916 discovered at a redshift  $Z = 2.2$ ”**(Prof. Antonio De UgartePostigo, Observatoire de la Côte D'Azur)

**h 18:00 – 18:15: opening discussion**

**H 18:15 – 20:30**

ICRANet, Piazza della Repubblica 10, Pescara (Italy) - <https://meet.goto.com/961416205>

**h 18:15 – 18:30: Welcoming addresses by local authorities (TBD)**

**h 18:30 – 19:05: “Super-Moon, equinoctial tides and rogue waves”**(Prof. Costantino Sigismondi – ITIS Galileo Ferraris, Rome)

**h 19:05 – 19:40: “The energy source of GRB 230916”**(Dr Liang Li, ICRANet Pescara)

**h 19:40 – 20:15: “Electron-positron creation and Pauli blocking”**(Prof. Gregory Vereshchagin, ICRANet Pescara)

**h 20:15 – 20:30: open discussions**

**H 20:30 – 22:00**

Conference Room Valpolicella Benaco Banca BCC, Viadell'Artigianato 5, Marano di Valpolicella (Italy)

**h 20:30 – 20:45: Welcoming addresses by local authorities (TBD)**

**h 20:45 – 22:00: Conference “Invisible Universe” in the framework of the project “Universo a km0”**  
Prof. Jorge A. Rueda Hernandez, ICRANet and University of Ferrara

**H 22:00**

**Concluding remarks**

From h 18:00 to h 21:00, ICRANetHq center in Pescara will be open for guided visits, organized at the following times: h 18:00 (Prof. Xue She Sheng), h 19:00 (Dr Liang Li) and h 20:00- last entry (Prof. Gregory Vereshchagin). On that occasion, ICRANet Faculty members will reply to visitors' questions.

Contacts:

ICRANet Secretariat, [secretariat@icranet.org](mailto:secretariat@icranet.org), Tel: +39 085 23054200





# International Center for Relativistic Astrophysics Network

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**Visitors:** 181499541  
We have 2 guests online



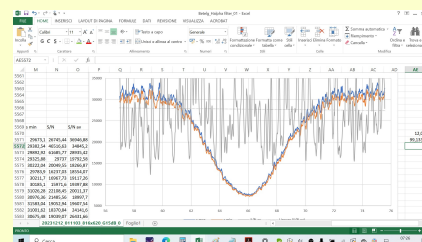
Preparation and preliminary results



field trip



experiments



data analysis

For suggestions&comments write to the [Webmaster](#)

