Enclosure 9

The 2018 ICRANet Newsletters

ICRANet Newsletter

December 2017– January 2018 – February 2018

SUMMARY

1. New scientific result from ICRANet collaboration with Brazil

The group of authors led by prof. Jorge Rueda from ICRANet has just published a new paper "*Neutrino Oscillations within the Induced Gravitational Collapse Paradigm of Long Gamma-Ray Bursts*" in the prestigious Astrophysical Journal with Impact Factor 5.533.

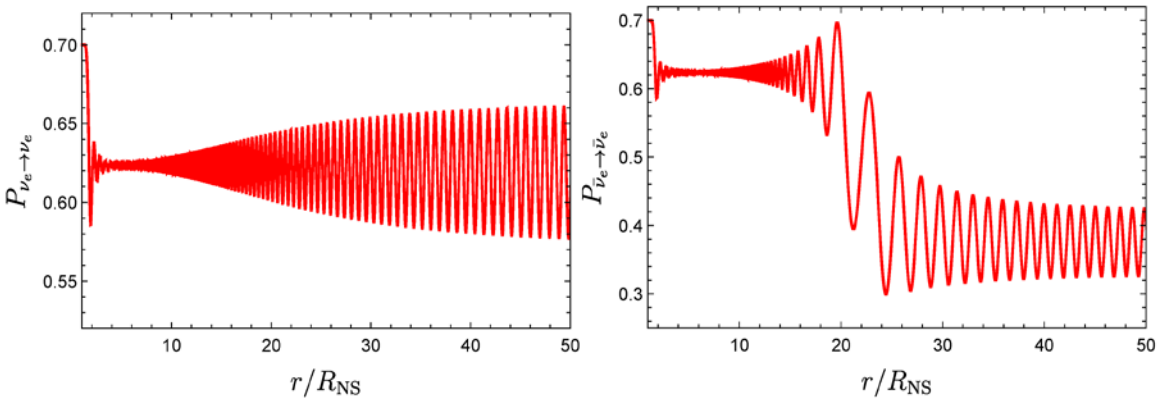


Fig. 1. Electron neutrino and antineutrino flavor evolution for inverted hierarchy and dM/dt = 10^{-6} solar masses. The survival probability is shown as a function of distance from the NS surface.

The induced gravitational collapse paradigm of long gamma-ray bursts associated with supernovae (SNe) predicts a copious neutrino–antineutrino emission owing to the hypercritical accretion process of SN ejecta onto a neutron star (NS) binary companion. The neutrino emission can reach luminosities of up to 10^{57} MeV s^{-1}, mean neutrino energies of 20 MeV, and neutrino densities of 10^{31} cm^{-3}. Along their path from the vicinity of the NS surface outward, such neutrinos experience flavor transformations dictated by the neutrino-to-electron-density ratio, see Fig. 1. The evolution of neutrino and electron on the accretion zone are determined and used to compute the neutrino flavor evolution. For normal and inverted neutrino mass hierarchies and within the two-flavor formalism $\nu_e\nu_x$), the final electronic and nonelectronic neutrino content after two oscillation processes is estimated: (1) neutrino collective effects due to neutrino self-interactions where the neutrino density dominates, and (2) the Mikheyev–Smirnov–Wolfenstein effect, where the electron density dominates. The final neutrino content is composed by ~55% (~62%) of electronic neutrinos, for the normal (inverted) neutrino mass hierarchy. The results of this work are the first step toward the characterization of a novel source of astrophysical MeV neutrinos in addition to core-collapse SNe and, as such, deserve further attention.

See more: L. Becerra, M. M. Guzzo, F. Rossi-Torres, J. A. Rueda, R. Ruffini and J. D. Uribe, "*Neutrino Oscillations within the Induced Gravitational Collapse Paradigm of Long Gamma-Ray Bursts*", The Astrophysical Journal, Volume 852, Issue 2, article id. 120, 19 pp. (2018)

Link: http://iopscience.iop.org/article/10.3847/1538-4357/aaa296/meta

2. Presentation of the 2017 ICRANet Scientific Report

The 2017 ICRANet Scientific Report was presented to the Scientific Committee by Professor Remo Ruffini, Director of ICRANet. The aim of this 2017 report, organized as every year in 3 volumes, is to review the traditional fields of research and present the most recent scientific results obtained in the ICRANet Centers in Italy, Armenia, Brazil, France as well as report on the status of international collaboration coordinated by ICRANet. These 3 volumes also present all ICRANet scientific activities including the international meetings organized by ICRANet, all the scientific agreements confirmed and/or extended with Universities and research centres within the year, and indicate the composition of the Faculty, of the Administrative Staff,

of the Lecturers, of the Students. The Curricula of the ICRANet Staff are given in the Accompanying Document "*The ICRANet Staff, Visiting Scientists and Graduate Students at the Pescara Center*".

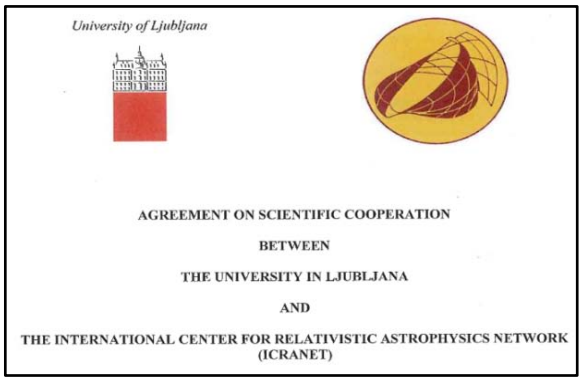
To read and download Volume 1, see: http://www.icranet.org/report2017/Volume1.pdf
To read and download Volume 2, see: http://www.icranet.org/report2017/Volume2.pdf
To read and download Volume 3, see: http://www.icranet.org/report2017/Volume3.pdf
To read and download the Accompanying document, see:
http://www.icranet.org/report2017/Staff_VisitingScientists_GraduateStudents_2017.pdf

3. Congratulations to Professor Narek Sahakyan, Director of ICRANet-Yerevan, for receiving the national prize for the best scientific achievements

Fig. 2: Professor Narek Sahakyan, Director of ICRANet-Yerevan, receiving the prize.

It is a pleasure to announce that Professor Narek Sahakyan, Director of ICRANet-Yerevan, has received the prize for the "*Best Youth Scientific Achievement*" on the 28 February 2018 in the occasion of the Haykyan-2017 awards ceremony. The event took place at the National Academic Opera and Ballet Theater in Armenia, at the presence of the Armenian President Serzh Sargsyan and of several representatives from Armenian government. Successful young people, youth groups and organizations that had excelled and come up with innovative undertakings in 2017 were awarded

4. New scientific agreements


University of Ljubljana

AGREEMENT ON SCIENTIFIC COOPERATION

BETWEEN

THE UNIVERSITY IN LJUBLJANA

AND

THE INTERNATIONAL CENTER FOR RELATIVISTIC ASTROPHYSICS NETWORK (ICRANET)

On the 2nd of February 2018, ICRANet signed a cooperation agreement with the University of Ljubljana – Slovenia. The document was signed by Prof. Igor Papic, Rector of the University, and Prof. Ruffini, Director of ICRANet and will be valid for 5 years.

The main joint activities to be developed under the framework of this agreement include: the promotion of theoretical and observational activities within the fiel of Relativistic Astrophysics; the institutional exchange of faculty members, researchers, post-doctorat fellows and students; the promotion of technological developments; the development of Data Centersfor Astrophysical data in all wavebands; the organisation of seminars, conferences, workshops, training and research courses, and the development of inter-institutional research areas associated to local graduate programs; and joint publications.

For the text of the agreement, see: http://www.icranet.org/documents/agreementICRANet-UNILJ.pdf

5. Exhibition at Besso Foundation, 12 December 2017-12 January 2018

From 12 December 2017 to 12 January 2018, ICRANet, in collaboration with the Besso Foundation, organized two exhibitions in the heart of Rome. In the framework of the project supported by the Italian Ministry of Education, University and Research (MIUR) "*Del Talento e della curiosità. Quando l'aquila e il passero volano insieme*" ("*Of Talent and Curiosity. When the eagle and the sparrow fly together*"), the two organizations together with ICRA and ECIPA, arranged the exhibitions on "Einstein, Fermi and Heisenberg and the birth of Relativistic Astrophysics" and on "ICRANet and China", that were contemporary opened to the public in the opening hours of the Besso Foundation
(see: http://www.fondazionemarcobesso.it/3362/inaugurazione-mostre-einstein-fermi-e-heisenberg-e-la-nascita-della-astrofisica-relativistica-e-icranet-e-cina-2/) .

Fig. 2. Prof. Ruffini commenting on pictures of the Exhibition to the students.

Fig. 3. Prof. Ruffini commenting on pictures of the Exhibition to the students.

In addition to the material relevant to the topics of the two exhibitions, important historical documents by ICRA and ICRANet, several videos of plenary talks at the MG14 – Marcel Grossmann Meeting (held in Rome in 2015), and photographic evidence of important events held in different seats of ICRANet worldwide, were presented to the public.

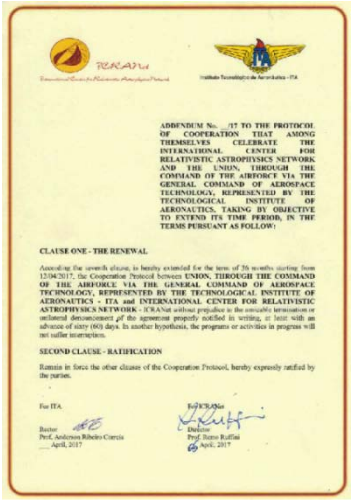
Fig. 4. From right to left: Prof. Remo Ruffini (Dicrector of ICRANet) with Prof. Paolo de Bernardis Sapienza University of Rome) and Prof. Roberto Battiston (President of the Italian Space Agency) during the joint seminar held on 12th January 2018 in Besso Foundation, Rome.

Fig. 5. Organizers of the Exhibition and speakers at the Besso Foundation.

In parallel with the exhibitions, ICRANet organized three seminars on December 12, 2017, January 8 and 12, 2018, attended by more than 50 students from "Liceo scientific Galileo Galilei" of Pescara, "I.I.S. Federico Caffé" of Rome, and "I.I.S. Guglielmo Marconi" of Civitavecchia (Rome). During these events, some new important scientific results were presented by prominent researchers and scientists to both the students and the public. Key speakers took the floor in these three days seminar; among them, the Crafoord Prize recipient

Prof. Roy Patrick Kerr (Yevgeny Mikhajlovic Lifshitz - ICRANet Chair), Prof. Remo Ruffini (Director of ICRANet), Prof. Roberto Battiston (President of the Italian Space Agency), Prof. Paolo de Bernardis (Sapienza University of Rome), Prof. Paolo Giommi (Italian Space Agency), Prof. Fulvio Ricci (Sapienza University of Rome), Prof. Massimo Della Valle (former Director of the Astronomical Observatory of Capodimonte in Naples), Prof. Marco Tavani (National Institute for Astrophysics), Prof. Carlo Luciano Bianco (Sapienza University of Rome), Prof. Costantino Sigismondi ("I.I.S. Federico Caffé" of Rome, "I.I.S. Guglielmo Marconi" of Civitavecchia- Rome, Adjunct Professor of ICRANet), Prof. Jorge Armando Rueda Hernández (ICRANet Faculty) and some IRAP PhD students from Pescara.
For video of presentations and a virtual tour of the exhibitions with the explanations of Prof. Remo Ruffini (in Italian), please see:
https://www.youtube.com/playlist?list=PLr5RLbSWSons08aRIX8vY_5kMdTgNyO32

6. Prof. Ruffini visit to Brazil, 18-23 January 2018



ADDENDUM No. /17 TO THE PROTOCOL OF COOPERATION THAT AMONG THEMSELVES CELEBRATE THE INTERNATIONAL CENTER FOR RELATIVISTIC ASTROPHYSICS NETWORK AND THE UNION, THROUGH THE COMMAND OF THE AIRFORCE VIA THE GENERAL COMMAND OF AEROSPACE TECHNOLOGY, REPRESENTED BY THE TECHNOLOGICAL INSTITUTE OF AERONAUTICS, TAKING BY OBJECTIVE TO EXTEND ITS TIME PERIOD, IN THE TERMS PURSUANT AS FOLLOW:

CLAUSE ONE - THE RENEWAL

SECOND CLAUSE - RATIFICATION

On January 18-23 2018, Prof. Remo Ruffini, Director of ICRANet, visited Brazil and formulated the new proposal for the Brazilian Science Data Center (BSDC), which has been launched with participation of ICRANet, ITA, INPE, CBPF. The collaboration agreement with ITA has been renewed.
A high point of the visit has been the meeting at São Jose dos Campos with the Rector of ITA, Prof. Dr. Anderson Ribeiro Correia, and with the Diretor of INPE, Prof. Dr. Ricardo Magnus Osório Galvão.
Then Prof. Ruffini moved to Brasilia, where he met representatives from the Brazilian Ministry of Science, Technology, Innovation and Communication (MCTIC), and from the Brazilian Ministry of Foreign Affairs (MRE). In the capital, Professor Ruffini also had a fruitful meeting with H.E. Antonio Bernardini, Ambassador of Italy to Brazil.
The last day, Professor Ruffini moved to Rio De Janeiro, to meet the Director of CBPF, Prof. Ronald Cintra Shellard and Ulisses Barres de Almeida, Professor at CBPF as well as ICRANet Faculty Staff member.
The visit of Professor Ruffini to Brazil was a good occasion to have fruitful discussions and exchanges with relevant personalities in the field of astrophysics, and represented also the possibility to present them the new scientific results obtained by ICRANet scientists in the last months.

7. Prof. Ruffini visit to Denmark, 23 February 2018

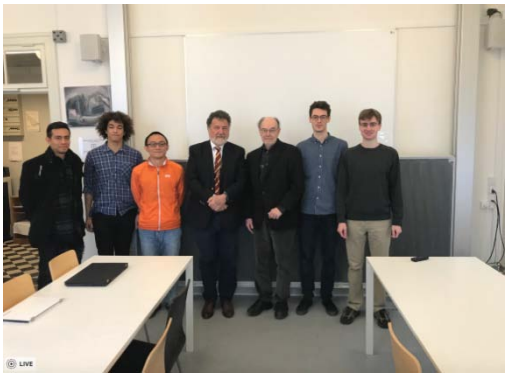


Fig. 6 and 7: Prof. Remo Ruffini during his visit at the Niels Bohr Institute in Copenhagen, Denmark on 23 February 2018, together with Professor Andrew D. Jackson and Professor Pawel Naselsky, the IRAP PhD student Jose Fernando Rodriguez Ruiz and some researchers from the Danish Institute.

Prof. Remo Ruffini, Director of ICRANet, together with the IRAP PhD student Jose Fernando Rodriguez Ruiz, visited the Niels Bohr Institute in Copenhagen, Denmark on 23 February 2018. This visit was the opportunity for them to discuss with Professor Andrew D. Jackson and Professor Pawel Naselsky, both from The Niels Bohr Institute & Discovery Center in Copenhagen, about the latest results obtained in the ICRANet on gravitational waves. These results are presented in a series of publications, including the paper recently published in JCAP, see http://adsabs.harvard.edu/abs/2018JCAP...02..030R.

8. Conference of Prof. Ruffini at Cosmos Club, Washington, 5 February 2018

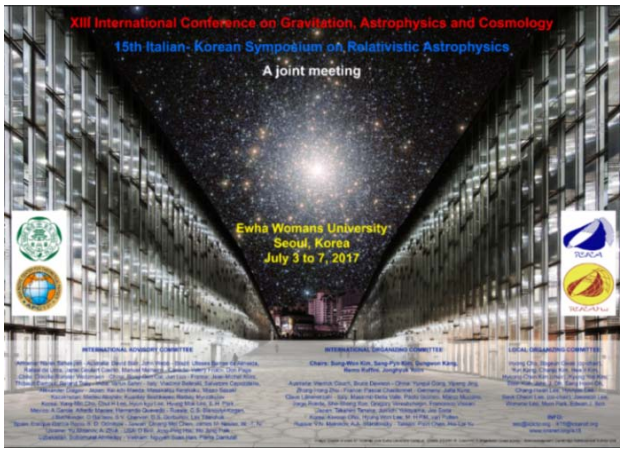
On the 5 February 2018, Prof. Remo Ruffini, Director of ICRANet, gave an important conference at Cosmos Club in Washington (U.S.A.) on "The Moment of formation of a Black Hole in Gamma-Ray Burst".

He was very happy and honored to had this opportunity for the second time, since he already delivered the Joseph Henry Lecture of the Philosophical Society of Washington at the Cosmos Club, on 12 May 1972 on "Neutron stars and black holes in our galaxy".

During the conference, he also presented the recent ICRANet research topics and the ongoing scientific activities.

9. Publication of the proceedings of IK15

It is our pleasure to announce the publication on the 29 January 2018 of the Proceedings of the "*Joint International Conference of ICGAC-XIII and the 15th Italian-Korean Symposium (IK-15) on Gravitation, Astrophysics and Cosmology*" held in Seoul, Korea, on July 3-7, 2017.



The proceedings have been edited by B. Gwak, G. Kang, C. Kim, H.-C. Kim, C.-H. Lee, J. Lee, S. Lee and W. Lee and are available online for free and downloadable at the following link: https://www.epj-conferences.org/articles/epjconf/abs/2018/03/contents/contents.html

The collection is organized in nine main sections and subjects, namely the Plenary Talks, Classical Gravity, Quantum Gravity, Astrophysics, Gravitational Waves, Inflation and Dark Matter, Gravity in String Theory, Cosmology and Black Holes.

The Italian-Korean symposium started in 1987, and then continued every two years alternatively in Korea and Italy with the support of Korea Science and Engineering Foundation (KOSEF), Consiglio Nazionale delle Ricerche (CNR), International Center for Relativistic Astrophysics Network (ICRANet) and hosting institutes. Main purpose of this symposium is to accelerate the exchange between scientists of Italy and Korea, especially young researchers.

10. Upcoming meetings

- **The XV Marcel Grossmann meeting**

It gives us great pleasure to announce the opening of the on-line registration for the 15th Marcel Grossmann Meeting (see: http://www.icra.it/mg/mg15/registration.htm) to be held from 1 to 7 July 2018 at "La Sapienza" University in Rome.

The early registration fee is 400 EUR through May 25, after which the fee will be 450 EUR. The student fee is 150 EUR through May 25, after which the fee will be 200 EUR (with certification of "Student Status"). On line fee payments will be accepted until June 25th, 2018. After this deadline, registration fees can only be paid on site by credit card.

The poster can be downloaded from: http://www.icra.it/mg/mg15/MG15_poster.pdf

Abstracts for parallel session presentations must be submitted **by April 30, 2018**, but preferably at the time of registration.

The current preliminary list of parallel sessions and related chairpersons can be found at:

http://www.icra.it/mg/mg15/parallel_sessions.htm http://www.icra.it/mg/mg15/par_sessions_chairs_details.htm

All inquiries may be directed to the meeting mailbox: mg15[AT]icra.it

Conference website: http://www.icra.it/mg/mg15

- **The 3rd Zeldovich meeting**

The online registration for the 3rd Zeldovich meeting to be held in the National Academy of Sciences of Belarus in Minsk, Belarus on April 23-27, 2018 has been started.

Exceptionally wide research interests of Ya. B. Zeldovich ranging from chemical physics, elementary particle and nuclear physics to astrophysics and cosmology provide the topics to be covered at the conference: Early cosmology, large scale structure, cosmic microwave background; Neutron stars, black holes, gamma-ray bursts, supernovae, hypernovae; ultra high energy particles; gravitational waves.

The list of confirmed invited speakers with their talks includes:

- Gennady Bisnovatyi-Kogan - Strong shock in a uniformly expanding universe
- Valery Chechetkin - Asymmetric nucleosynthesis
- Artur Chernin - Dark energy in Zeldovich Local Pancake
- Evgeny Derishev - Radiation-mediated shocks
- Andrey Doroshkevich - TBD
- Gyula Fodor - Localized objects formed by self trapped gravitational waves (geons)
- Vladimir Fortov - Warm Dense Matter, Generated by the Intense Shock and Rarefaction Waves
- Sang Pyo Kim - Strong QED phenomena in astrophysics

- Noam Libeskind - TBD
- Vladimir Lipunov - The Discovery of gravitational waves: prediction and observation
- Manuel Malheiro - TBD
- Agnieszka Pollo - How luminous galaxies trace the dark Universe
- Alexei Pozanenko - Observations of GRB 1170817A associated with LIGO/Virgo GW170817 in gamma-rays, optic and radio, and the model of prompt gamma-ray emission
- István Rácz - TBD
- Jorge Rueda - Latest news on the induced gravitational collapse scenario of longgamma-ray bursts
- Remo Ruffini - Gamma-ray Bursts
- Narek Sahakyan - TBD
- Nikolai Shakura - Ya. B. Zeldovich and background of the accretion processes theory in the Universe
- Alexei Starobinsky - TBD
- Lev Titarchuk - Comptonization Problem and Its solution in Application to the Spectra of the Neutron Star and Black Hole Source
- Oleg Zaslavski - Ultra-high energy particle collisions near black holes and singularities and super-Penrose process

The conference website: http://www.icranet.org/zeldovich3

11.Scientific visits to ICRANet

- **Professor Roy Kerr, 2 - 11 January 2018**

Fig.8. The Crafoord Prize recipient prof. Roy Patrick Kerr, Prof. Remo Ruffini (Director of ICRANet), Prof. Massimo Della Valle, Prof. Marco Tavani, Prof. Carlo Luciano Bianco with some students during the joint seminar held on 8th January 2018 in Besso Foundation, Rome.

From 2 to 11 January 2018, Professor Roy Kerr, (Yevgeny Mikhajlovic Lifshitz - ICRANet Chair, 2016 Crafoord Prize in Astronomy), came to visit ICRANet center in Pescara. During his permanence, he had the opportunity to visit the two exhibitions (on "*Einstein, Fermi and Heisenberg and the birth of Relativistic Astrophysics*" and on "*ICRANet and China*") organized in Rome by ICRANet, in collaboration with the Besso Foundation, ICRA and ECIPA from 12 December to 12 January 2018, and to give an talk in the framework of this event on Rotating Black Holes.
Professor Roy Kerr also congratulated Professor Ruffini and other ICRANet researchers, for the publication on 1st January 2018 of their article "Early X-Ray Flares in GRBs" on the first page of The Astrophysical Journal (ApJ), the most important journal in the world in the field of astrophysics.

- **Academician Tolegen Abdisagiyevich Kozhamkulov visit to Rome, 21 - 25 January 2018**

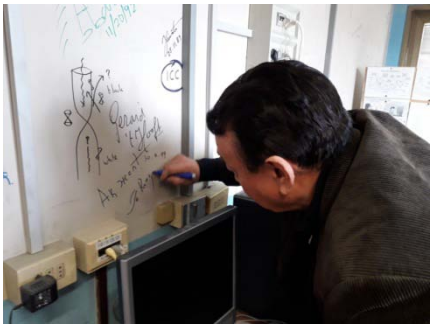


Fig. 9: Academician Tolegen Kozhamkulov during his visit at "La Sapienza" University in Rome.

Fig.10: Academician Tolegen Kozhamkulov with the research group of "La Sapienza" University.

From the 21 to the 25 of January, Academician Tolegen Abdisagiyevich Kozhamkulov, President of Kazakh Physical Society visited ICRA's offices in University "La Sapienza" in Rome. In his visit, he was accompanied by the Kazakh IRAP PhD Erasmus Mundus student Yerlan Aimuratov. Academician Kozhamkulov appreciated the opportunity he had to exchange fruitful scientific discussions with the research group of "La Sapienza" University.

- **Professor Clovis Achy Soares Maia from the University of Brasilia visit to ICRANet, 7 – 24 February 2018**

Fig.11: Professor Clovis Achy Soares Maia, signing the ICRANet center's wall in Pescara.

From the 7 to the 24 of February 2018, Professor Clovis Achy Soares Maia from the University of Brasilia, visited ICRANet seat in Pescara. During his visit, he had the opportunity to discuss his scientific research and to have fruitful exchange of ideas with other researchers from ICRANet and from different parts of the world. Professor Clovis Maia left his signature on the ICRANet Pescara wall, as previously done by those who visited the center and actively contributed to the key scientific topics of interests of ICRANet.

- **Seminar of Professor Krzysztof Belczynski in Rome, 22 February 2018**

Fig. 12: Professor Krzysztof Belczynski.

From the 21 to the 23 of February, Professor Krzysztof Belczynski from the Nicolaus Copernicus Astronomical Center in Warsaw – Poland, payed an official visit to Italy. On this occasion, thanks to the cooperation with ICRA, he organized an important seminar on Thursday February 22, 2018 at "La Sapienza" University of Rome on the "Origin of merging Neutron Star - Neutron Star binaries".

12. H.E. Gerardina Basilicata, Prefect of Pescara, visit to ICRANet, 15 February 2018

Fig. 12 – 13: H.E. Gerardina Basilicata, Prefect of Pescara, visiting ICRANet center on 15 February 2018.

On 15 February 2018, the New Prefect of Pescara, H.E. Gerardina Basilicata, visited ICRANet seat in Pescara and met Professor Remo Ruffini, Director of ICRANet. Professor Ruffini accompanied the Prefect in a comprehensive tour of the center, showing her ICRANet library and explaining her all the important achievements and current researches carried on by the center. Ms Basilicata also met ICRANet staff, Faculty and students, who told her about their important work and experience here in Pescara.

Fig. 14: The Prefect of Pescara talking with ICRANet IRAP PhD students during her visit.

13. Recent publications

L. Becerra, M. M. Guzzo, F. Rossi-Torres, J. A. Rueda, R. Ruffini and J. D. Uribe, "*Neutrino Oscillations within the Induced Gravitational Collapse Paradigm of Long Gamma-Ray Bursts*", The Astrophysical Journal, published on January 15, 2018.

The induced gravitational collapse paradigm of long gamma-ray bursts associated with supernovae (SNe) predicts a copious neutrino–antineutrino emission owing to the hypercritical accretion process of SN ejecta onto a neutron star (NS) binary companion. The neutrino emission can reach luminosities of up to 10^{57} MeV s^{-1}, mean neutrino energies of 20 MeV, and neutrino densities of 10^{31} cm^{-3}. Along their path from the vicinity of the NS surface outward, such neutrinos experience flavor transformations dictated by the neutrino-to-

electron-density ratio. We determine the neutrino and electron on the accretion zone and use them to compute the neutrino flavor evolution. For normal and inverted neutrino mass hierarchies and within the two-flavor formalism $\nu_e\nu_x$), we estimate the final electronic and nonelectronic neutrino content after two oscillation processes: (1) neutrino collective effects due to neutrino self-interactions where the neutrino density dominates, and (2) the Mikheyev–Smirnov–Wolfenstein effect, where the electron density dominates. We find that the final neutrino content is composed by ∼55% (∼62%) of electronic neutrinos, for the normal (inverted) neutrino mass hierarchy. The results of this work are the first step toward the characterization of a novel source of astrophysical MeV neutrinos in addition to core-collapse SNe and, as such, deserve further attention.

Reference: The Astrophysical Journal, Volume 852, Issue 2, article id. 120, 19 pp. (2018)
Link: http://iopscience.iop.org/article/10.3847/1538-4357/aaa296/meta

R. Ruffini, , Y. Wang, , Aimuratov, Y., Barres de Almeida, U., Becerra, L., Bianco, C. L., Chen, Y. C., Karlica, M., Kovacevic, M., Li, L., Melon Fuksman, J. D., Moradi, R., Muccino, M., Penacchioni, A. V., Pisani, G. B., Primorac, D., Rueda, J. A., Shakeri, S., Vereshchagin, G. V., Xue, S.-S., "*Early X-Ray Flares in GRBs*", The Astrophysical Journal, published on January 2018.

We analyze the early X-ray flares in the GRB "flare–plateau–afterglow" (FPA) phase observed by Swift-XRT. The FPA occurs only in one of the seven GRB subclasses: the binary-driven hypernovae (BdHNe). This subclass consists of long GRBs with a carbon–oxygen core and a neutron star (NS) binary companion as progenitors. The hypercritical accretion of the supernova (SN) ejecta onto the NS can lead to the gravitational collapse of the NS into a black hole. Consequently, one can observe a GRB emission with isotropic energy $E_{iso}\gtrsim 10^{52}$ erg, as well as the associated GeV emission and the FPA phase. Previous work had shown that gamma-ray spikes in the prompt emission occur at $\sim 10^{15}$--10^{17} cm with Lorentz Gamma factors $\Gamma\sim 10^2$-10^3. Using a novel data analysis, we show that the time of occurrence, duration, luminosity, and total energy of the X-ray flares correlate with E_{iso}. A crucial feature is the observation of thermal emission in the X-ray flares that we show occurs at radii $\sim 10^{12}$ cm with $\Gamma \lesssim 4$. These model-independent observations cannot be explained by the "fireball" model, which postulates synchrotron and inverse-Compton radiation from a single ultrarelativistic jetted emission extending from the prompt to the late afterglow and GeV emission phases. We show that in BdHNe a collision between the GRB and the SN ejecta occurs at $\simeq 10^{10}$ cm, reaching transparency at $\sim 10^{12}$ cm with $\Gamma \lesssim 4$. The agreement between the thermal emission observations and these theoretically derived values validates our model and opens the possibility of testing each BdHN episode with the corresponding Lorentz Gamma factor.

Reference: The Astrophysical Journal, Volume 852, Issue 1, article id. 53 (2018).
Link: http://adsabs.harvard.edu/abs/2018ApJ...852...53R

Ehsan Bavarsad, Sang Pyo Kim, Clément Stahl, She-Sheng Xue, "Effect *of a magnetic field on Schwinger mechanism in de Sitter spacetime*", Physical Review, published on 25 January 2018.

We investigate the effect of a uniform magnetic field background on scalar QED pair production in a four-dimensional de Sitter spacetime (dS_4). We obtain a pair production rate which agrees with the known Schwinger result in the limit of Minkowski spacetime and with Hawking radiation in dS spacetime in the zero electric field limit. Our results describe how the cosmic magnetic field affects the pair production rate in cosmological setups. In addition, using the zeta function regularization scheme we calculate the induced current and examine the effect of a magnetic field on the vacuum expectation value of the current operator.
We find that, in the case of a strong electromagnetic background the current responds as $E \cdot B$, while in the infrared regime, it responds as B/E, which leads to a phenomenon of infrared hyper conductivity. These results for the induced current have important applications for the cosmic magnetic field evolution.

Reference: Physical Review D 97, 025017 (2018)
Link: https://doi.org/10.1103/PhysRevD.97.025017

G. V. Vereshchagin, "*Cosmic horizon for GeV sources and photon-photon scattering*", Astrophysics and Space Science, published on 11 January 2018.

Photon-photon scattering of gamma-rays on the cosmic microwave background has been studied using the low energy approximation of the total cross section by Zdziarski and Svensson (Astrophys. J. 344:551, 1989), Svensson and Zdziarski (Astrophys. J. 349:415, 1990). Here, the cosmic horizon due to photon-photon scattering is accurately determined using the exact cross section and we find that photon-photon scattering dominates over the pair production at energies smaller than 1.68 GeV and at redshifts larger than 180.

Reference: Vereshchagin, G.V. Astrophys Space Sci. (2018) 363: 29.
Link: https://doi.org/10.1007/s10509-018-3247-8

J. F. Rodriguez, J. A. Rueda, R. Ruffini, "*Comparison and contrast of test-particle and numerical-relativity waveform templates*", published on 16 February 2018.

We compare and contrast the emission of gravitational waves and waveforms for the recently established "helicoidal-drifting-sequence" of a test particle around a Kerr black hole with the publicly available waveform templates of numerical-relativity. The merger of two black holes of comparable mass are considered. We outline a final smooth merging of the test particle into the final Kerr black hole. We find a surprising and unexpected agreement between the two treatments if we adopt, for the mass of the particle and the Kerr black hole a Newtonian-center-of-mass description, and for the Kerr black hole spin an effective value whose nature remains to be clarified.

Reference: J. F. Rodriguez, J. A. Rueda, R. Ruffini, Journal of Cosmology and Astroparticle Physics, Issue 02, article id. 030 (2018).
Link: https://doi.org/10.1088/1475-7516/2018/02/030

Donato Bini, Carmen Chicone, Bahram Mashhoon, "*Twisted Gravitational Waves*" accepted for publication in Physical Review D.

In general relativity (GR), linearized gravitational waves propagating in empty Minkowski spacetime along a fixed spatial direction have the property that the wave front is the Euclidean plane. Beyond the linear regime, exact plane waves in GR have been studied theoretically for a long time and many exact vacuum solutions of the gravitational field equations are known that represent plane gravitational waves. These have parallel rays and uniform wave fronts. It turns out, however, that GR also admits exact solutions representing gravitational waves propagating along a fixed direction that are nonplanar. The wave front is then nonuniform and the bundle of rays is twisted. We find a class of solutions representing nonplanar unidirectional gravitational waves and study some of the properties of these twisted waves.

Reference: Donato Bini, Carmen Chicone, Bahram Mashhoon, arXiv:1801.06003.
Link: https://arxiv.org/abs/1801.06003

ICRANet Newsletter

March – April 2018

SUMMARY

1. Scientific highlight - Publication of the article "*The spin evolution of fast-rotating, magnetized super-Chandrasekhar white dwarfs in the aftermath of white dwarf mergers*" on ApJ, 5 April 2018

The article "*The spin evolution of fast-rotating, magnetized super-chandrasekhar white dwarfs in the aftermath of white dwarf mergers"* by L. Becerra, J. A. Rueda, P. Lorén-Aguilar and E. Garcìa - Berro has been published on April 25 2018 in the Astrophysical Journal.

The paper deals with the evolution of the remnant of the merger of two white dwarfs – a hot topic in astrophysics. The post-merger evolution of a super-Chandrasekhar magnetized white dwarf is computed taking into account all the relevant physical processes. These include magnetic torques acting on the star, accretion from the Keplerian disk, the threading of the magnetic field lines through the disk, and the thermal evolution of the white dwarf core. The main finding is that the central remnant can reach the conditions suitable to develop a thermonuclear explosion before other instabilities (such as the inverse beta-decay instability or the secular axisymmetric instability) are reached, which would instead lead to gravitational collapse of the magnetized remnant.

During this long process our friend and colleague, Enrique García-Berro, one of the coauthors of the article, has sadly passed away after a tragic accident in Spain: this is why this work is dedicated to his memory.

2. In memory of Stephen Hawking, 8 January 1942 – 14 March 2018

Professor Stephen Hawking has died on March 14, 2018, at the age of 76. The iconic physicist was one of the greatest scientific minds in the history of the world, and worked to peer into the most mysterious parts of the universe.

Born in Oxford on 8 January 1942, he attended Oxford University before moving onto Cambridge. From 1979 to 2009, he was Lucasian Professor of Mathematics at Cambridge – a post once held by Sir Isaac Newton, and became, later, director of research in the university's Department of Applied Mathematics and Theoretical Physics. Hawking shot to international fame after the 1988 publication of A Brief History of Time, one of the most complex books ever to achieve mass appeal.

"*My goal is simple*," Hawking once said. "*It is complete understanding of the universe: why it is as it is, and why it exists at all*." He spent much of his career trying to find a way to reconcile Einstein's theory with quantum physics, and produce a "Theory of Everything". His work ranged from the origins of the universe itself, through the possibility of time travel to the mysteries of space's all-consuming black holes.

His most famous theoretical breakthrough was the idea that black holes are not really black, but can produce thermal radiation and potentially "evaporate". Scientists refer to such potential emanations as "Hawking radiation".

Professor Ruffini, Director of ICRANet, was a close friend of him, since their university studies. They joined numerous research activities and publications, and Professor Ruffini was also invited by Prof. Hawking to have dinner together in his apartment in Cambridge, last year at the

presence of the Crafoord Price Roy Kerr.

Professor Hawking had also a Public Lecture in the last Marcel Grossmann edition (MG14), held in Rome from 12 to18 July 2015 (https://www.youtube.com/watch?v=bvyIRqhY8iA&feature=youtu.be).

To see and read all the interviews Professor Ruffini released after Stephen Hawking death, please check:

http://www.icranet.org/index.php?option=com_content&task=view&id=1183

3. Professor Ruffini in Singapore for the "Conference on Particles and Cosmology", 5 – 9 March 2018

On March 4 - 10, 2018, Prof. Ruffini, Director of ICRANet, visited Singapore and joined the "Conference on Particles and Cosmology", held at the Nanyang Executive Centre (Nanyang Technological University NTU), from 5 to 9 March.
In the framework of this conference, Professor Ruffini was invited to give an important talk on "Gamma Ray Bursts in fundamental physics and Cosmology".

Details about the event can be found here: http://www.ntu.edu.sg/ias/upcomingevents/COSMO18/Pages/default.aspx

4. Lecture at Tirana University in Albania by Prof. Remo Ruffini on the occasion of the signature of collaboration agreement between Tirana University and ICRANet, 23 March 2018

On the 23 March 2018, ICRANet signed a cooperation agreement with the Tirana University – Albania. The document was signed by Dr Mynyr Koni, Rector of the University, and Prof. Ruffini, Director of ICRANet and will be valid for 5 years, starting from the date of its signature. The main joint activities to be developed under the framework of this agreement include: the promotion of theoretical and observational activities within the field of Relativistic Astrophysics; the institutional exchange of faculty members, researchers, post-doctorat fellows and students; the promotion of technological developments; the development of Data Centers for Astrophysical data in all wavebands; the organisation of seminars, conferences, workshops, training and research courses, and the

development of inter-institutional research areas associated to local graduate programs; and joint publications.

During his visit to Albania Professor Ruffini was accompanied by Professor Mimoza Hafizi, a close collaborator of ICRANet from the University of Tirana.
After the Ceremony of Signature, Professor Ruffini gave an important talk "On the observation of the formation of a Black hole in a Gamma Ray burst ten billion years in our past light cone" in front of the university and faculty management, a group of students from the same institution, numerous academics as well as representatives of the government. To celebrate this special event, Professor Ruffini gave an interview at the Albanian Radio and Television TVSH (Radio Televizioni Shqiptar) in the morning emission "Good Morning Albania" (https://www.youtube.com/watch?v=tx94mQhYS7I&feature=youtu.be), and a second interview at News24 Television (https://www.youtube.com/watch?v=DWI3538SD2U). The Director of ICRANet reaffirmed his gratitude and satisfaction for visiting Albania and signing the collaboration agreement with one of its best Universities after almost 20 years of collaboration, mostly thank to the work of Professor Mimoza Hafizi. He also expressed his sincere hope that Albania will join the broader family of ICRANet member States and Institutions.



5. Special seminar of Prof. Ruffini in Stanford, U.S.A., 26 March 2018

From 24 to 26 March 2018, Professor Remo Ruffini, Director of ICRANet, flew to the United State, since he was invited to give an important seminar in Stanford University on the 26 of March.

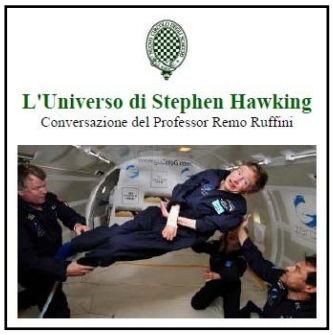
With this seminar, titled *"The moment of Formation of a Black Hole in Gamma Ray Bursts"*, Professor Ruffini analyzed the fundamental role of LAT Observations by the FERMI satellite, in identifying the birth of a Black Hole (BH) in Binary Driven Hipernovae (BdHNe) and short-GRBs, leading to the measurement of the mass and spin off of the BH.

6. UNOOSA / Holy See Seminar "Exploration and Development of Space Opportunities and Issues in the Context of the Sustainable Development Goals", Castel Gandolfo, Rome, 27 – 28 March 2018

In preparation for UNISPACE+50, the first United Nations Global Space Summit of the 21st Century, to celebrate the fiftieth anniversary of the first United Nations Conference on the Exploration and Peaceful Uses of Outer Space, an exceptional seminar was held in Castel Gandolfo and Specola Vaticana on 27- 28 March 2018. The joint UNOOSA / Holy See Seminar on 'Exploration and Development of Space

Opportunities and Issues in the Context of the Sustainable Development Goals', was aimed to progress together with representatives of the Holy See and selected experts from different fields towards the United Nations Global Space Summit in June 2018.
In this framework, Professor Ruffini was a keynote speaker in the session devoted to "Space as a Tool for Diplomacy and Peace", and presented to the audience his experience in international cooperation in space activities and in particular he insisted on the importance of open data access to everyone.
On the second day, all speakers of the seminar took part in the General Audience of Pope Francis and the Baciamano Special, an opportunity to individually greet the Pope.

7. Conference of Prof. Ruffini at Nuovo Circolo degli Scacchi, Rome, 11 April 2018



On Wednesday, April 11, 2018, Professor Ruffini, Director of ICRANet, delivered an important talk at Nuovo Circolo degli Scacchi in Rome, titled "*The Mass-Energy Formula of Black Holes*" in memory of his friend Stephen Hawking, with whom he joined numerous research activities and publications. Professor Ruffini also became an active member of Circolo degli Scacchi, and will join the group at least until the end of the summer.

8. The Third Zeldovich Meeting, Minsk, 23 – 27 April 2018

Fig. 1. Opening ceremony. From left to right: profs. Fortov, Kilin, Ruffini and Vereshchagin.

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

The opening address was given by the Deputy Chairman of the National Academy of Sciences of Belarus Academician Sergei Kilin and by Director of ICRANet Prof. Remo Ruffini. About 80 participants,

nationals of Argentina, Armenia, Belarus, Bosnia and Herzegovina, China, Colombia, Germany, Hungary, Italy, Kazakhstan, Poland, Russia, Slovenia, Taiwan, Ukraine and other countries took part in the meeting. The conference covered many topics including cosmology, relativistic astrophysics, general relativity, elementary particle and nuclear physics, detonations and explosions. This celebration was the third international conference in Minsk dedicated to Ya. B. Zeldovich. The previous meetings were held on 20-23 of April 2009 and was organized jointly by ICRANet and Belarusian State University celebrating also the 2009 Year of Astronomy, and on March 11-14, 2014 celebrating 100th anniversary of Ya. B. Zeldovich.

Fig. 2. Lecture of Prof. Vladimir Fortov.

Important scientific developments were discussed at the conference. In particular, the concept of induced gravitational collapse leading to cosmic Gamma-Ray Bursts was presented in details. The role of dark energy in cosmological structure formation on different scales was extensively discussed. The conference has created a stimulating environment for further scientific exchange and contacts between scientists in the West, those coming from the great Russian school of Zeldovich, and local scientist from Belarus.

During the meeting agreement was reached between ICRANet and the Editorial Board of the journal Astronomy Reports to publish proceedings of the conference as regular papers. It is expected that this

Fig. 3. Group photo of participants of the Third Zeldovich meeting.

conference series in Minsk celebrating Ya.B. Zeldovich will continue.

During the meeting important meetings took place, in particular the discussion between the delegation from ICRANet and the Ministry of Foreign Affairs of Belarus about the adhesion of Belarus to ICRANet, see http://mfa.gov.by/en/press/news_mfa/fd4a7f5e32424fda.html. Also a Memorandum of Understanding was signed between the National Research Nuclear University MEPhI and the National Academy of Sciences of Belarus.

The website of the meeting: http://www.icranet.org/zeldovich3, it contains relevant information, including scientific program, social program, international and local organizing committees, official conference photos, poster, abstract booklet, participants list, information about proceedings and other information.

Information about the conference has been posted on various websites, including:

- http://www.cei.int/content/%E2%80%8Bthird-zeldovich-meeting-held-minsk
- https://hyperspace.uni-frankfurt.de/2017/09/29/the-third-zeldovich-meeting/ http://nasb.gov.by/rus/news/3394/
- http://nasb.gov.by/rus/news/3417/
- http://ifan.basnet.by/?p=1403
- https://gazetaby.com/cont/art.php?&sn_nid=137961
- https://minsknews.by/uchenik-akademika-zeldovicha/
- https://www.sb.by/articles/uchenik-akademika-zeldovicha.html
- http://www.belta.by/society/view/issledovateli-iz-11-stran-primut-uchastie-v-nauchnom-simpoziume-po-fizike-v-minske-299541-2018/
- http://www.belta.by/society/view/mezhdunarodnoe-nauchnoe-sotrudnichestvo-v-oblasti-reljativistskoj-astrofiziki-obsudili-v-mid-300022-2018/

9. The XV Marcel Grossmann meeting

Marcel Grossmann Awards 2015 On-line registration for the 15th Marcel Grossmann Meeting, to be held from 1 to 7 July 2018 at “La Sapienza” University in Rome, is open.
Te deadline for oral communications and poster presentations has been extended up to 30 of May 2018.

The preliminary plenary program can be found at: http://www.icra.it/mg/mg15/plenary_program.htm

The current preliminary list of parallel sessions and related chairpersons can be found at: http://www.icra.it/mg/mg15/parallel_sessions.htm http://www.icra.it/mg/mg15/par_sessions_chairs_details.htm

Conference website: http://www.icra.it/mg/mg15/

Marcel Grossmann Awards 2018

The Individual Awards


Lyman Page (Princeton University)


Rashid Sunyaev (Max Planck Institute for Astrophysics)


Shing-Tung Yau (Princeton University)

10. Recent publications

Belinski, V. A., Vereshchagin, G. V., *"On the cosmological gravitational waves and cosmological distances"*, published in Physics Letters B, Volume 778 on 10 March 2018.

We show that solitonic cosmological gravitational waves propagated through the Friedmann universe and generated by the inhomogeneities of the gravitational field near the Big Bang can be responsible for increase of cosmological distances.

Link: http://adsabs.harvard.edu/abs/2018PhLB..778..332B

Christian Cherubini, Simonetta Filippi, Alessandro Loppini, Rahim Moradi, Remo Ruffini, Yu Wang, and She-Sheng Xue, *"Perfect relativistic magnetohydrodynamics around black holes in horizon penetrating coordinates"*, published on Physical Review D 97, 064038 on 28 March 2018.

Plasma accreting processes on black holes represent a central problem for relativistic astrophysics. In this context, here we specifically revisit the classical Ruffini-Wilson work developed for analytically modeling via geodesic equations the accretion of perfect magnetized plasma on a rotating Kerr black hole. Introducing the horizon penetrating coordinates found by Doran 25 years later, we revisit the entire approach studying Maxwell invariants, electric and magnetic fields, volumetric charge density and electromagnetic total energy. We finally discuss the physical implications of this analysis.

Link: https://doi.org/10.1103/PhysRevD.97.064038

L. Becerra, J. A. Rueda, P. Lorén-Aguilar, and E. García-Berro, "*The Spin Evolution of Fast-rotating, Magnetized Super-Chandrasekhar White Dwarfs in the Aftermath of White Dwarf Mergers*", published on The Astrophysical Journal, Volume 857, Number 2, on 25 April 2018.

The evolution of the remnant of the merger of two white dwarfs is still an open problem. Furthermore, few studies have addressed the case in which the remnant is a magnetic white dwarf with a mass larger than the Chandrasekhar limiting mass. Angular momentum losses might bring the remnant of the merger to the physical conditions suitable for developing a thermonuclear explosion. Alternatively, the remnant may be prone to gravitational or rotational instabilities, depending on the initial conditions reached after the coalescence. Dipole magnetic braking is one of the mechanisms that can drive such losses of angular momentum. However, the timescale on which these losses occur depend on several parameters, like the strength of the magnetic field. In addition, the coalescence leaves a surrounding Keplerian disk that can be accreted by the newly formed white dwarf. Here we compute the post-merger evolution of a super-Chandrasekhar magnetized white dwarf taking into account all the relevant physical processes. These include magnetic torques acting on the star, accretion from the Keplerian disk, the threading of the magnetic field lines through the disk, as well as the thermal evolution of the white dwarf core. We find that the central remnant can reach the conditions suitable to develop a thermonuclear explosion before other instabilities (such as the inverse beta-decay instability or the secular axisymmetric instability) are reached, which would instead lead to gravitational collapse of the magnetized remnant.

Link: http://iopscience.iop.org/article/10.3847/1538-4357/aabc12/meta

R. Ruffini, J. Rodriguez, M. Muccino, J. A. Rueda, Y. Aimuratov, U. Barres de Almeida, L. Becerra, C. L. Bianco, C. Cherubini, S. Filippi, D. Gizzi, M. Kovacevic, R. Moradi, F. G. Oliveira, G. B. Pisani, Y. Wang, *"On the rate and on the gravitational wave emission of short and long GRBs"*, accepted for publication in The Astrophysical Journal, on April 6, 2018.

On the ground of the large number of gamma-ray bursts (GRBs) detected with cosmological redshift, we classified GRBs in seven subclasses, all with binary progenitors originating gravitational waves (GWs). Each binary is composed by combinations of carbon-oxygen cores (CO core), neutron stars (NSs), black holes (BHs) and white dwarfs (WDs). The long bursts, traditionally assumed to originate from a BH with an ultra-relativistic jetted emission, not emitting GWs, have been subclassified as (I) X-ray flashes (XRFs), (II) binary-driven hypernovae (BdHNe), and (III) BH-supernovae (BH-SNe). They are framed within the induced gravitational collapse (IGC) paradigm with progenitor a CO core-NS/BH binary. The supernova (SN) explosion of the CO core triggers an accretion process onto the NS/BH. If the accretion does not lead the NS to its critical mass, an XRF occurs, while when the BH is present or formed by accretion, a BdHN occurs. When the binaries are not disrupted, XRFs lead to NS-NS and BdHNe lead to NS-BH. The short bursts, originating in NS-NS, are subclassified as (IV) short gamma-ray flashes (S-GRFs) and (V) short GRBs (S-GRBs), the latter when a BH is formed. There are (VI) ultra-short GRBs (U-GRBs) and (VII) gamma-ray flashes (GRFs), respectively formed in NS-BH and NS-WD. We use the occurrence rate and GW emission of these subclasses to assess their detectability by Advanced LIGO-Virgo, eLISA, and resonant bars. We discuss the consequences of our results in view of the announcement of the LIGO-Virgo Collaboration of the source GW 170817 as being originated by a NS-NS.

ArXiv link: https://arxiv.org/abs/1602.03545

ICRANet Newsletter

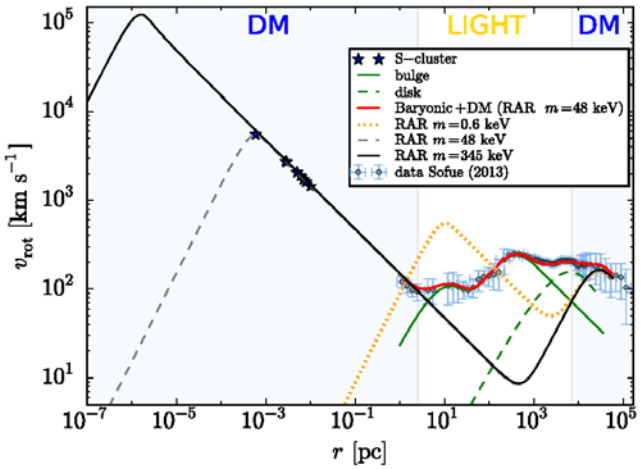
May – June - July 2018

SUMMARY

1. The paper by C.R. Argüelles, A. Krut, J.A. Rueda, R. Ruffini, "*Novel constraints on fermionic dark matter from galactic observables I: The Milky Way*" is accepted for publication in Physics of the Dark Universe on 12 July 2018

Since near a century already, Astronomers ans Asrtrophysists have been gathering and analyzing data coming from galaxies, either small, or large ellipticals, or clumped in large clusters; to realize that about the 85% of the matter content of the Universe cannot be made of any of the building blocks we know (such as electrons, protons, neutrons, or its combinations). They came to the conclusion that the gravity exerted by all these possible known forms of matter, as combined in stars, gas or dust, is not enough to explain the observed stability and the kinematical properties in galaxies: an extra matter content was needed, called dark matter (DM).

A consensus has been reached within the scientific community about the nature of the DM, pointing towards an unknown fundamental particle created at the dawn of times. These particles would have started to gather together due to its own self-gravity into many different clumps of matter, dubbed as DM halos. Such pristine agglomerations are spherical configurations which constitute the progenitors of the galaxies we see today, with the halo component spreading typically about ten times the extension of the bright and normal matter composing the disk (as in the case of our home, the Milky Way). An important open question in the field, is precisely *how* this DM is distributed along a given galaxy, as well as the exact nature of the particle constituting the DM. The traditional approach to tackle this issue is given in terms of big numerical simulations involving a large amount of classical point masses. While such simulations provide the needed dark mass to account for the rotation curve of a galaxy, it has several problems on smaller scales below 10 kpc when confronted with observations.



For the first time, the authors in [1] have presented an alternative approach to this problem, which allows to consider the quantum nature of the dark constituents as well as the particle mass dependence, directly in the DM profiles. Such a model consists in solving the equations of a self-gravitating gas of elementary neutral fermions at finite temperature allowing for escape of particle effects. The theory has been recently applied to the case of our own Galaxy, which is certainly the best benchmark to test it, given the vast and precise amount of data available to the date. For particle masses in the range of few 10 to 100 keV (see Figure), the solutions obtained by the authors provide the right description for the rotation curve of the Galactic halo, and predict at the same time, a dense and compact core of quantum nature harbored at the center. The key novelty of such dark matter core, is the possibility to explain the dynamics of the closest star orbiting around the SgrA* Galaxy center, *without* the need to introduce a super massive black hole (BH).

Read more: https://doi.org/10.1016/j.dark.2018.07.002

2. The Fifteenth Marcel Grossmann Meeting (MG15) – Rome, 1 – 7 July 2018

Fig. 1 - MG15 group photo in Aula Magna, Sapienza University, Rome

The Fifteenth Marcel Grossmann Meeting on Recent Developments in Theoretical and Experimental General Relativity, Astrophysics and Relativistic Field Theories (MG15) took place at "Sapienza" University in Rome – Italy, from July 1 to 7, 2018. The meeting exceeded every expectation and confirmed once again its world leading role in the field of Relativistic Astrophysics, developed in the years since 1985 by ICRA at Sapienza University, and, in the most recent years, thanks to the collaboration with ICRANet center in Pescara.

Fig.2 – MG15 Awards Ceremony From left to right: Prof. Leo Hollberg, Prof. Rashid Sunyaev, Prof. Shing-Tung Yau, Prof. Remo Ruffini, Rector Eugenio Gaudio, Prof. Roy Kerr, Prof. Lyman Page, Prof Jean-Loup Puget and Prof. Elia Battistelli.

More than 800 participants from 70 different countries in the world, joined the conference and presented the most relevant recent results on the understanding of the Universe, achieved thanks to Albert Einstein's equations of general relativity. Thanks to the financial support provided by IUPAP, ICTP and ESA, a lot of scientists from developing countries had also the possibility to attend the conference.

Registration started since Sunday, July 1, from 10:00 am to 7:00 pm and the official opening of the meeting took place on

Monday morning, (July 2), at the presence of Professor Eugenio Gaudio, Rector of Sapienza University with the Marcel Grossmann Awards' ceremony, see: https://youtu.be/Mz5ZY0WzTDQ

This year, the Institutional Awards went to:

- **The Planck Scientific Collaboration (ESA)**, presented to **Jean-Loup Puget**, the Principal Investigator of the High Frequency Instrument (HFI) - "*for obtaining important constraints on the models of inflationary stage of the Universe and level of primordial non-Gaussianity; measuring with unprecedented sensitivity gravitational lensing of*

Cosmic Microwave Background fluctuations by large-scale structure of the Universe and corresponding B-polarization of CMB, the imprint on the CMB of hot gas in galaxy clusters; getting unique information about the time of reionization of our Universe and distribution and properties of the dust and magnetic fields in our Galaxy".

Fig. 3 – Prof Jean-Loup Puget (ESA) receiving the MG15 institutional award.

Hansen Experimental Physics Laboratory At Stanford University, presented to Research Professor **Leo Hollberg**, HEPL Assistant Director - "to *HEPL for having developed interdepartmental activities at Stanford University at the frontier of fundamental physics, astrophysics and technology*".

Fig. 4 – Prof. Leo Hollberg (HEPL) receiving the MG15 institutional award.

The Individual Awards went to:

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

- **Rashid Alievich Sunyaev** "*for the development of theoretical tools in the scrutinising, through the CMB, of the first observable electromagnetic appearance of our Universe*".

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

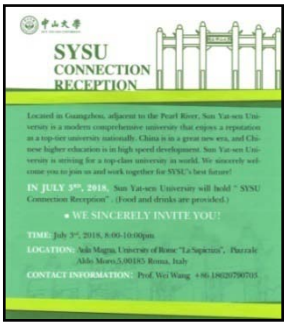


Fig 5, 6, 7 – From left to right: Prof. Lyman Page, Prof. Rashid Sunyaev and Prof. Shing-Tung Yau receiving the MG15 individual awards.

During this six day conference, a variety of topics were discussed in the morning plenary sessions, beginning with Mathematical and general relativity topics on Monday, Kilonovae and Gravitational Waves on Tuesday, Future Precision Tests of GR on Wednesday, GRBs and CMB on Thursday, Multimessanger Astrophysics on Friday and The Frontiers on Saturday.

Up to 26 parallel sessions per days took place in every afternoon sessions, within the University Campus and the nearby CNR building, covering the following topics: Accretion, Alternative Theories, Black Holes, Binaries, Boson Stars, Cosmic Microwave, Cosmic Strings, Dark Energy And Large Scale Structure, Dark Matter, Education, Early Universe, Gamma Ray Bursts, Gravitational Waves, High Energy, History Of Relativity, Neutron Stars, Precision Tests, Quantum Gravity, Strong Field and White Dwarfs.

There were several public lectures delivered in the evening sessions, namely by Jeremiah Ostriker, Malcolm Longair, Marc Henneaux, Jean-Loup Puget, Lyman Page and Anne Archibald.



Several social events were organized for all the participants of the meeting: on Tuesday evening, eminent Professors and researches from Sun Yat-Sen University (China) presented their Institute and celebrated the signature of the cooperation agreement with ICRANet, by organizing the interesting event "*SYSU Connection reception*". On Wednesday evening there was the official MG15 banquet, held at Palazzo Colonna, an ancient palace in the core of Rome, and this was the occasion for Ms Claudia Graf-Grossmann (niece of Marcel Grossmann), to present to the auditors the biography of her grandfather, whose preface was edited thanks to the collaboration with Professor Remo Ruffini, Director of ICRANet. The participants had also the possibility, on the same day, to visit Galleria Colonna, the private art collection of the Palace.

Several publishing companies were present along all the meeting in a space devoted to exhibitions (namely Cambridge University Press, IOP Publishing, Universe and Springer Nature) and also the Chinese state television was present to film and document the event, see: https://youtu.be/KbTgZuPEGgc and https://youtu.be/cbYbSn2BoFE
Currently, ICRA and ICRANet are taking care of the MG15 Proceedings, which will consist in open access e-book proceedings and will be published by World Scientific, Singapore, in 2019.

Here are some useful links to consult:

- Interview with Prof. Remo Ruffini: https://www.youtube.com/watch?v=i24U7SGoVAc&feature=youtu.be;
- MG15 website: http://www.icra.it/mg/mg15

3. Professor Ruffini visit to Albania, 23 – 24 May 2018

On 23 and 24 May 2018, Professor Ruffini, thanks to the collaboration of Professor Mimoza Hafizi, flew to Albania to met Prof. Dr. Mynyr Koni, Rector of the University of Tirana: this meeting was the opportunity for them to discuss about the possibility for that institute, to become full Member of the IRAP-PhD with all the rights and privileges envisaged by the IRAP-PhD Statute. The visit was a follow up of the unanimously proposal of the University of Tirana as potential member of the joint doctorate, as emerged in the meeting of the IRAP-PhD Faculty, held on 30 April 2018.

4. Professor Ruffini appointed as Member of the *Horizon 2020 Advisory Group for the Marie Sklodowska-Curie actions on skills, training and career development (MSCA) programme* – Bruxelles, 28 June 2018

EUROPEAN COMMISSION
Directorate-General for Education, Youth, Sport and Culture
Innovation, International Cooperation and Sport
Marie Skłodowska-Curie actions

Professor Ruffini was officially appointed as member of the "*Horizon 2020 Advisory Group for the Marie Sklodowska-Curie actions on skills, training and career development (MSCA) programme*" for the period 2018-2020 (3rd mandate). The European Commission was renewing the membership of its Advisory Groups which provide external high-quality input to help inform, assess, enrich and keep up-to-date its reflections and ideas for the monitoring and development of the Horizon 2020 Work Programme and Professor Ruffini was selected for his specific knowledge, skills and experience in the field of science. His biography was also inserted in the Who's Who booklet of the group.
The appointment took place on the occasion of the 12th Meeting of the MSCA Advisory Group, held in Brussels on 28 June 2018: this was the first meeting of the AG under its third configuration for Horizon 2020.
The MSCA financially support researchers at all stages of their careers, irrespective of nationalities and disciplines. Funding may be attributed to individual researchers, networks, staff exchange programmes and doctoral/postdoctoral programmes. In addition to providing research funding, MSCA enable scientists to gain international, inter-sectoral and interdisciplinary experience and to complete their scientific training with transferable competences that will enhance their employability and career prospects.
For more information about the MSCA Advisory Group, see the link: http://ec.europa.eu/research/mariecurieactions/

5. Collaboration Agreement between Sun Yat-Sen University and ICRANet, 4 July 2018


中山大學
SUN YAT-SEN UNIVERSITY
AGREEMENT ON SCIENTIFIC COOPERATION
BETWEEN
THE SUN YAT-SEN UNIVERSITY
AND
THE INTERNATIONAL CENTER FOR RELATIVISTIC ASTROPHYSICS NETWORK (ICRANET)

On the 4 July 2018, ICRANet signed a cooperation agreement with the Sun Yat-Sen University of Guangzhou – China, which will be valid for 5 years. The document was signed by Prof. Luo Jun, President of the Sun Yat-Sen University, and Prof. Ruffini, Director of ICRANet, during Professor Luo participation as a plenary speaker to the 15th Marcel Grossmann Meeting, held in Rome from 1 to 7 July 2018.

Fig. 8 - Prof. Luo Jun, President of the Sun Yat-Sen University, and Prof. Ruffini, Director of ICRANet, after the signing the Collaboration Agreement.

Eminent Professors and researches from this University enjoyed MG15, and took this opportunity to present their Institute and celebrate the signature of the cooperation agreement with ICRANet, by organizing the interesting event "SYSU Connection reception" in University of Rome La Sapienza.

The main joint activities to be developed under the framework of this agreement include: the promotion of theoretical and observational activities within the field of Relativistic Astrophysics; the institutional exchange of faculty members, researchers, post-doctorate fellows and students; the promotion of technological developments; the development of Data Centers for Astrophysical

data in all wavebands; the organization of training and teaching courses, seminars, conferences, workshops or short courses, and the development of inter-institutional research areas associated to local graduate programs; and joint publications.

For the text of the agreement, see: http://www.icranet.org/documents/agreementICRANet-SunYatSenUniversity.pdf

For more information about Prof. Luo participation to MG15: http://www.sysu.edu.cn/2012/en/news/news01/32725.htm

6. Closing Ceremony of the project "*Del Talento e della curiosità. Quando l'aquila e il passero volano insieme*"- Presentation of the results, 4 May 2018


Cerimonia di presentazione dei risultati del progetto

Programma

Official program of the closing ceremony event – ICRANet, 4 May 2018

On Friday 4 May 2018, ICRANet center in Pescara hosted the closing ceremony of the project supported by the Italian Ministry of Education, University and Research (MIUR) "*Del Talento e della curiosità. Quando l'aquila e il passero volano insieme*" ("*Of Talent and Curiosity. When the eagle and the sparrow fly together*"), in collaboration with the Besso Foundation, ICRA and ECIPA. The event was also attended by more than 50 students from the classes 4D and 4I of "Liceo scientifico Galileo Galilei" of Pescara, under the supervision of Professors Gabriele Fraternali and Tiziana Pompa. This event concluded a series of other initiatives developed since last year in the framework of this project, and was devoted to present the attended results and the possible future perspectives. The referents of the event were Professor Remo Ruffini, director of ICRANet and Mr. Marco Trisi, Director of ECIPA. After a press conference, the two referents resumed to the highlight of the past events occurred in the framework of the project, and showed them some videos realized on those occasions. Namely, the videos concerned the two exhibitionsF on "*Einstein, Fermi and Heisenberg and the birth of Relativistic Astrophysics*" and on "*ICRANet and China*" held in Besso Foundation (Rome) from 12 December 2017 to 12 January 2018 and the three seminars organized in parallel on 12 December 2017, 8 and 12 January 2018. At the end of this presentations, the students took the floor to present the scientific instruments they produced on their own in the framework of this project.



Fig. 9, 10, 11 - Students from the classes 4D and 4I of "Liceo scientifico Galileo Galilei" of Pescara, attending the event at ICRANet center, 4 May 2018.

To conclude the event, Professor Zurab Berezhiani from the Department of Physical and Chemical Sciences of University of L'Aquila, gave an important seminar titled *"Parallel dark world"* at ICRANet center in Pescara. In this context, he discussed the possibility that dark matter is a sort of "baryonic" matter from parallel/mirror hidden sector of particles which can be exactly identical to that of ordinary particles, or represent its somewhat deformed version. Possible interaction processes between ordinary and dark particles are of particular interest since they can be at the origin of baryogenesis and dark baryogenesis and naturally explain why ordinary and dark matter fractions in the Universe are comparable. On the other hand, these interactions can be tested at laboratories via specific low-cost experiments.

Please, see the link: http://www.icranet.org/index.php?option=com_content&task=blogcategory&id=89&Itemid=781

7. Technical -scientific report of the project "*Del Talento e della curiosità. Quando l'aquila e il passero volano insieme*" (ICRA,ICRANET, Fondazione Marco Besso, ECIPA)

Among the objects that have successfully followed the development of human being, the most significant and important has been the "Crab Nebula", chosen as symbol of the project. Discovered in 1054 as a "guest star", it is now called "Crab Nebula" for its morphological appearance, similar to a crab, which has inside a Pulsar NPO532, which rotates with a period of 33 milliseconds and which in 1968 was identified as a rotating neutron star.

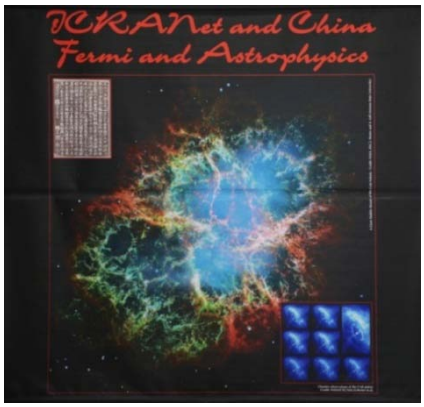


Figure 12 – The Chinese writing concerning the discovery of the *"guest star"* (1054), the of the Crab Nebula made by the Hubble Space Telescope and the X-ray emission from the Crab pulsar and its wind nebula.

Figure 13 – Professor Remo Ruffini receives the Cressy-Morrison Award (1972) form the New York Academy of Science, for the discovery of the first black hole in the galaxy.

Please, look at Figure 12 where are:

I. The Chinese writing concerning the discovery of the "guest star", registered in July 1054 from Chinese, Korean and Japanese astronomers;

II. The splendid image of the Crab Nebula made by the Hubble Space Telescope in 2014 with its filamentary structures, still expanding today with velocity about 250 km / sec;

III. The X-ray emission from the Crab pulsar and its wind nebula observed by the satellite CHANDRA.

This has been the thread of the exhibitions organized by ICRA and ICRANet, whose major analysis carried on in the last 50 years have been devoted to the comprehension of Neutron Stars, at the discovery of the first Black Hole (see **Figure 13**) and, recently, to the physics of Gamma Ray Bursts. Those have allowed to join and light up the most distant and darkest parts of the Universe, going back to its early stages and to the Big Bang. The energy emitted by a GRB is equivalent to the one emitted by a billion of galaxies, each consisting of 100 billions of stars, even if only for a time duration of about hundreds of seconds.

The comprehension of those phenomena has a long and progressive history, in which relevant events have became possible thanks to the cooperation among East and West and to fundamental conceptual revolutions introduced by three "giants": Albert Einstein, Werner Heisenberg and Enrico Fermi. All those have been possible also thanks to the special relationship between Italy and China, to the crucial role played by Italy in the Albert Einstein's formulation of general and special relativity, to the collaboration among Michele Besso and Marcel Grossmann with the major Italian mathematicians (as Ricci Curbastro and Tullio Levi Civita), and thanks also to the revolutionary role of Fermi in Cosmology, still unknown to the public.

To check the material of the 2 exhibitions "*ICRANet and China*" and "*Einstein, Fermi and Heisenberg: the birth of Relativistic Astrophysics*", see:
http://www.fondazionemarcobesso.it/3362/inaugurazione-mostre-einstein-fermi-e-heisenberg-e-la-nascita-della-astrofisica-relativistica-e-icranet-e-cina-2/

To read the biography "*Marcel Grosmann. For the love of Mathematics*", please see:

- https://www.amazon.it/Marcel-Grossmann-Mathematics-Springer-Biographies-ebook/dp/B07DMD4VNH/ref=sr_1_1?ie=UTF8&qid=1532701370&sr=8-1&keywords=Marcel+Grossmann+For+the+Love+of+Mathematics (English)
- https://www.amazon.it/Marcel-Grossmann-Aus-Liebe-Mathematik/dp/3905894327/ref=sr_1_fkmr0_1?ie=UTF8&qid=1532701370&sr=8-1-fkmr0&keywords=Marcel+Grossmann+For+the+Love+of+Mathematics (German)

In the framework of this project, the books "*Fermi e l'Astrofisica*" (being printed in Singapore) and "*Einstein, Heisenberg and Fermi and the birth of Relativistic Astrophysics*", have been completed.

Figure 14 – Prof. Roy Patrick Kerr, Crafoord Prize for Astronomy 2016, during his conference "*Cracking the Einstein code*", held at Fondazione Besso in Rome.

Several chapters of those books have been presented during the conferences held in the framework of the project from Professor Roy Patrick Kerr, Crafoord Prize for Astronomy 2016, awarded by the King of Sweden (see **Figure 14**). In those conferences, held at Fondazione Besso and Sapienza University in Rome, several eminent astrophysics (see **Figures 15, 16, 17, 18**) as Marco Tavani (https://youtu.be/E7t0TkuK6Bc), Massimo Della Valle (https://youtu.be/9rjA-5ZgkOE), Fulvio Ricci (https://youtu.be/BXUH2hxlZGU), Roy Kerr (https://youtu.be/9rjA-5ZgkOE), Paolo de Bernardis (https://youtu.be/dJGBH6cuaXA) and Paolo Giommi, as well as several ICRANet PhD students (see **Figures 19, 20, 21, 22**), have presented their high levels scientific reports, filmed and broadcasted in order so that can be used for important researches in the following years.

Figure 15 – Professor Marco Tavani during his conference "*L'arcobaleno e le stelle d'oro*". "*Radiazioni di GeV osservate da AGILE*".

Figure 16 – Professor Massimo Della Valle during his conference "*L'arcobaleno e le stelle d'oro*".

Figure 17 – Il Professor Fulvio Ricci during his Lectio Magistralis "*Gravitational Waves*"

Figure 18 – Professor Paolo De Bernardis during his Lectio Magistralis "*La luce più antica dell'universo*".

Figures 19, 20, 21, 22 – From left to right: ICRANet PhD students Daria Promorac, Rahim Moradi, Wang Yu e Yerlan Aimuratov, during their presentations at Fondazione Besso.

8. Congratulations to ICRANet Faculty Professor Gregory Vereshchagin, awarded of the Doctor of Sciences (DSc) degree in theoretical physics, 13 June 2018

Fig. 23 - Professor Gregory Vereshchagin during his dissertation on the 27 December 2017.

On the 13 June 2018, ICRANet Faculty Professor Gregory Vereshchagin has been awarded the Doctor of Sciences (D Sc) degree in theoretical physics, as announced by the Higher Attestation Commission (VAK) of Belarus (http://www.vak.org.by/node/4418). His dissertation "*Kinetics, hydrodynamics and radiation of relativistic plasma*" has been successfully defended on the 27 December 2017 (http://vak.org.by/node/3942). Professor Vereshchagin has

become one of the few young Belarusian researchers, awarded of this highest scientific degree in his country under the age of 40.

9. Seminars at ICRANet center in Pescara

- **Seminars by Professor Shadi Tahvildar-Zadeh**

From 17 to 30 June 2018, Professor Shadi Tahvildar-Zadeh (Rutgers, The State University of New Jersey – USA), visited ICRANet center in Pescara and gave a series of seminars to faculty members and students. The main topics discussed in his talks were: Theories of matter: Weyl, Einstein and Mie, the classification of singularities, the Bianchi identities and equations of motion, the Born-In field non linear electrodynamics, the Bopp-Landé-Thomas-Podolsky linear electrodynamics, the zero-gravity space times and Ring-like particles, the general relativistic hydrogen, the ground state of positronium and dark matter, the photons as particles and the electron-photon systems.

- **Seminar by Sergio Andrés Vallejo Peña, 24 July 2018**

On the 24 July 2018, Sergio Andrés Vallejo Peña, a visiting student from the Universidad de Antioquia (UDEA) – Colombia, gave two seminars on "*The effects of anisotropy and non-adiabaticity on the evolution of the curvature perturbation*" (https://arxiv.org/abs/1804.05005) and "*The MESS of cosmological perturbations*" (https://arxiv.org/abs/1806.01941).

- **Seminar by Mikalai Prakapenia, 24 July 2018**

On the 24 July 2018, Mikalai Prakapenia (Researcher at ICRANet-Minsk center and PhD student at Belarusian State University), gave an important seminar titled "*Thermalization of electron-positron plasma with quantum degeneracy*". He reported on the analysis of the non-equilibrium electron-positron-photon plasma thermalization process studied using relativistic Boltzmann solver, taking into account quantum corrections both in non-relativistic and relativistic cases. Collision integrals are computed from exact QED matrix elements for all binary and triple interactions in the plasma. It is shown that in non-relativistic case binary interaction rates dominate over triple ones, resulting in establishment of kinetic equilibrium prior to final relaxation towards thermal equilibrium, in agreement with previous studies. On the contrary, in relativistic case triple interaction rates are fast enough to prevent establishment of kinetic equilibrium. It is shown that thermalization process strongly depends on quantum degeneracy in initial state, but does not depend on plasma composition.

10. Scientific visits to ICRANet

- **Dr. Sonila Boçi visit to ICRANet, 30 April – 13 May 2018**

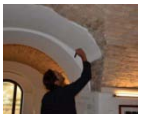
From 30 April to 13 May 2018, Professor Sonila Boçi from University of Tirana – Albania, visited ICRANet center in Pescara. During her visit, she had the opportunity to discuss her scientific research and to have fruitful exchange of ideas with other researchers from ICRANet and from different parts of the world.

During the summer, several others relevant scientist and students visited our ICRANet center in Pescara, namely:

- **Professor Clovis Achy Soares Maia** (University of Brasilia – Brazil), 7 - 14 July 2018

- **Phd students Sílvia Pereira Nunes, Ronaldo Vieira Lobato and Marcelo Montenegro Lapola** (Instituto Tecnológico de Aeronáutica de São José dos Campos, SP – Brazil), 7 – 12 July 2018
- **Prof**essor Shadi Tahvildar-Zadeh (Rutgers, The State University of New Jersey – USA), 17 – 30 June 2018
- **Soroush Shakeri** (Isfahan University of Technology - Iran),19 June – 17 July 2018
- **Prof. Mathews Grant** (Center for Astrophysics at Notre Dame University – USA), 7 – 9 July 2018
- **Professor Wenbin Lin** (School of Physical Science and Technology, Southwest Jiaotong University – China), 8 – 14 July 2018
- **Professor Hyung Won Lee** (Inje University – South Korea), 16 July – 15 August 2018
- **Sergio Andrés Vallejo Peña** (Universidad de Antioquia – Colombia), 1 July – 9 September 2018
- **Mikalai Prakapenia** (ICRANet-Minsk center and Belarusian State University – Belarus), 1 – 27 July 2018


Prof. Sonila Boci


Prof. Clovis Achy Soares Maia


Prof. Shadi Tahvildar-Zadeh


Soroush Shakeri


Prof. Mathews Grant


Professor Hyung Won Lee


Mikalai Prakapenia

Prior and/or during their visit, those scientists had the opportunity to participate to the 15th Marcel Grossmann meeting in Rome, and to carry on important analysis and research with other ICRANet scientists from all over the world.

Following the Agreement between ICRANet and Al-Farabi Kazakh National University, two groups of Kazakh students, under the supervision of Professor Medeu Abishev, visited ICRANet center in Pescara. The first group came from 11 to 25 June 2018, and was composed by: Fariza Aitzhan, Makpal Akhmetzhanova, Albina Bazarova, Aizhan Duysenbaeva, Mamak Tangsholpan, Ernat Nurtazin, Balzhan Mamadkarimova and Tileuberdi Akhat.

A second group came from 30 June to 11 July, and was composed by: Sadirkhanov Zhandos, Abdramanova Gulbanu, Assel Kuanysh, Anel Imangaliyeva, Symbat Nurakhmetova, Anapiya Meruyert, Zaltay Aklen, Gaukhar Askhanova, Niyazov Kaiyrzhan, Yesbol Meirambekuly, Botakoz Seifullina and Fatima Dankenova.


Fig. 24 - Kazakh students during their visit at ICRANet center in Pescara.

11. Recent publications

S. Gasparyan, N. Sahakyan, V. Baghmanyan, D. Zargaryan, *"On the multi-wavelength Emission from CTA 102"*, accepted for publication on The Astrophysical Journal, on 8 July 2018.

We report on broadband observations of CTA 102 (z=1.037) during the active states in 2016-2017. In the γ-ray band, Fermi LAT observed several prominent flares which followed a harder-when-brighter behavior: the hardest photon index $\Gamma=1.61\pm0.10$ being unusual for FSRQs. The peak γ-ray flux above 100 MeV $(3.55\pm0.55)\times10^{-5}$ photon $cm^{-2}s^{-1}$

observed on MJD 57738.47 within 4.31 minutes, corresponds to an isotropic γ-ray luminosity of $L_\gamma=3.25\times10^{50}$ergs^{-1}, comparable with the highest values observed from blazars so far. The analyses of the Swift UVOT/XRT data show an increase in the UV/optical and X-ray bands which is contemporaneous with the bright γ-ray periods. The X-ray spectrum observed by Swift XRT and NuSTAR during the γ-ray flaring period is characterized by a hard photon index of ∼1.30. The shortest e-folding time was 4.08±1.44 hours, suggesting a very compact emission region $R\leq\delta\times2.16\times10^{14}$ cm. We modeled the spectral energy distribution of CTA 102 in several periods (having different properties in UV/optical, X-ray and γ-ray bands) assuming a compact blob inside and outside the BLR. We found that the high-energy data are better described when the infrared thermal radiation of the dusty torus is considered. In the flaring periods when the correlation between the γ-ray and UV/optical/X-ray bands is lacking, the γ-ray emission can be produced from the interaction of fresh electrons in a different blob, which does not make a dominant contribution at lower energies.

Link: https://arxiv.org/abs/1807.02869v1

P. Padovani, P. Giommi, E. Resconi, T. Glauch, B. Arsioli, N. Sahakyan, M. Huber,*"Dissecting the region around IceCube-170922A: the blazar TXS 0506+056 as the first cosmic neutrino source"*, accepted for publication in MNRAS on 12 July 2018.

We present the dissection in space, time, and energy of the region around the IceCube-170922A neutrino alert. This study is motivated by: (1) the first association between a neutrino alert and a blazar in a flaring state, TXS 0506+056; (2) the evidence of a neutrino flaring activity during 2014 - 2015 from the same direction; (3) the lack of an accompanying simultaneous γ-ray enhancement from the same counterpart; (4) the contrasting flaring activity of a neighbouring bright γ-ray source, the blazar PKS 0502+049, during 2014 - 2015. Our study makes use of multi-wavelength archival data accessed through Open Universe tools and includes a new analysis of Fermi-LAT data. We find that PKS 0502+049 contaminates the γ-ray emission region at low energies but TXS 0506+056 dominates the sky above a few GeV. TXS 0506+056, which is a very strong (top percent) radio and γ-ray source, is in a high γ-ray state during the neutrino alert but in a low though hard γ-ray state in coincidence with the neutrino flare. Both states can be reconciled with the energy associated with the neutrino emission and, in particular during the low/hard state, there is evidence that TXS 0506+056 has undergone a hadronic flare with very important implications for blazar modelling. All multi-messenger diagnostics reported here support a single coherent picture in which TXS 0506+056, a very high energy γ-ray blazar, is the only counterpart of all the neutrino emissions in the region and therefore the most plausible first non-stellar neutrino and, hence, cosmic ray source.

Link: https://arxiv.org/abs/1807.04461

T. Hayashinaka, S. Xue, "*Physical renormalization condition for de Sitter QED*", Published in Rapid communication section of Phys. Rev. D 97, 105010, on 13 February 2018.

We considered a new renormalization condition for the vacuum expectation values of the scalar and spinor currents induced by a homogeneous and constant electric field background in de Sitter spacetime. Following a semiclassical argument, the condition named maximal subtraction imposes the exponential suppression on the massive charged particle limit of the renormalized currents. The maximal subtraction changes the behaviors of the induced currents previously obtained by the conventional minimal subtraction scheme. The maximal subtraction is favored for a couple of physically decent predictions including the identical asymptotic behavior of the scalar and spinor currents, the removal of the infrared (IR) hyperconductivity from the scalar current, and the finite current for the massless fermion.

Link: https://journals.aps.org/prd/abstract/10.1103/PhysRevD.97.105010

C.R. Argüelles, A. Krut, J.A. Rueda, R. Ruffini, "*Novel constraints on fermionic dark matter from galactic observables I: The Milky Way*", accepted for publication on Physics of the Dark Universe, Volume 21, on 12 July 2018.

We have recently introduced a new model for the distribution of dark matter (DM) in galaxies based on a self-gravitating system of massive fermions at finite temperatures, the Ruffini–Argüelles–Rueda (RAR) model. We show that this model, for fermion masses in the keV range, explains the DM halo of the Galaxy and predicts the existence of a denser quantum core at the center. We demonstrate here that the introduction of a cutoff in the fermion phase-space

distribution, necessary to account for the finite Galaxy size, defines a new solution with a central core which represents an alternative to the black hole (BH) scenario for SgrA*. For a fermion mass in the range mc^2=48-345 keV, the DM halo distribution is in agreement with the Milky Way rotation curve data, while harbors a dense quantum core of about $4x10^6$ solar masses within the S2-star pericenter.

Link: https://www.sciencedirect.com/science/article/pii/S2212686418300815

M.A. Prakapenia, I.A.Siutsou, G.V. Vereshchagin, "*Numerical scheme for treatment of Uehling–Uhlenbeck equation for two-particle interactions in relativistic plasma*, accepted for publication on the Journal of Computational Physics, on 4 July 2018.

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

Link: https://www.sciencedirect.com/science/article/pii/S0021999118304650?via%3Dihub

B. Arsioli, U. Barres de Almeida, E. Prandini, B. Fraga, L. Foffano, "*Extreme & High Synchrotron Peaked Blazars at the limit of Fermi-LAT detectability: the γ-ray spectrum of 1BIGB sources*", published on Monthly Notices of the Royal Astronomical Society, sty1975, on 24 July 2018.

We present the 1-100 GeV spectral energy distribution for a population of 148 high-synchrotron-peaked blazars (HSPs) recently detected with Fermi-LAT as part of the First Brazil-ICRANet Gamma-ray Blazar catalogue (1BIGB). Most of the 1BIGB sources have their γ-ray spectral properties presented here for the first time, representing a significant new extension of the γ-ray blazar population. Since our sample was originally selected from an excess signal in the 0.3 - 500 GeV band, the sources stand out as promising TeV blazar candidates, potentially in reach of the forthcoming very-high-energy (VHE) γ-ray observatory, CTA. The flux estimates presented here are derived considering PASS8 data, integrating over more than 9 years of Fermi-LAT observations. We also review the full broadband fit between 0.3-500 GeV presented in the original 1BIGB paper for all sources, updating the power-law parameters with currently available Fermi-LAT dataset. The importance of these sources in the context of VHE population studies with both current instruments and the future CTA is evaluated. To do so, we select a subsample of 1BIGB sources and extrapolate their γ-ray SEDs to the highest energies, properly accounting for absorption due to the extragalactic background light. We compare those extrapolations to the published CTA sensitivity curves and estimate their detectability by CTA. Two notable sources from our sample, namely 1BIGB J224910.6-130002 and 1BIGB J194356.2+211821, are discussed in greater detail. All γ-ray SEDs, are made publicly available via the Brazilian Science Data Center (BSDC) service, maintained at CBPF, in Rio de Janeiro.

Link:
https://academic.oup.com/mnras/advance-article-abstract/doi/10.1093/mnras/sty1975/5057880

R. Ruffini, J. Rodriguez, M. Muccino, J. A. Rueda, Y. Aimuratov, U. Barres de Almeida, L. Becerra, C. L. Bianco, C. Cherubini, S. Filippi, D. Gizzi, M. Kovacevic, R. Moradi, F. G. Oliveira, G. B. Pisani, and Y. Wang, "*On the Rate and on the Gravitational Wave Emission of Short and Long GRBs*" published on The Astrophysical Journal, Volume 859, Number 1 on 18 May 2018.

On the ground of the large number of gamma-ray bursts (GRBs) detected with cosmological redshift, we classified GRBs in seven subclasses, all with binary progenitors which emit gravitational waves (GWs). Each binary is composed of combinations of carbon–oxygen cores (COcore), neutron stars (NSs), black holes (BHs), and white dwarfs (WDs). The long bursts, traditionally assumed to originate from a BH with an ultrarelativistic jetted emission, not emitting GWs, have been subclassified as (I) X-ray flashes (XRFs), (II) binary-driven hypernovae (BdHNe), and (III) BH–supernovae (BH–SNe). They are framed within the induced gravitational collapse paradigm with a progenitor COcore–NS/BH binary. The SN explosion of the COcore triggers an accretion process onto the NS/BH. If the accretion does not

lead the NS to its critical mass, an XRF occurs, while when the BH is present or formed by accretion, a BdHN occurs. When the binaries are not disrupted, XRFs lead to NS–NS and BdHNe lead to NS–BH. The short bursts, originating in NS–NS, are subclassified as (IV) short gamma-ray flashes (S-GRFs) and (V) short GRBs (S-GRBs), the latter when a BH is formed. There are (VI) ultrashort GRBs (U-GRBs) and (VII) gamma-ray flashes (GRFs) formed in NS–BH and NS–WD, respectively. We use the occurrence rate and GW emission of these subclasses to assess their detectability by Advanced LIGO-Virgo, eLISA, and resonant bars. We discuss the consequences of our results in view of the announcement of the LIGO/Virgo Collaboration of the source GW 170817 as being originated by an NS–NS.

Link: http://iopscience.iop.org/article/10.3847/1538-4357/aabee4/meta

D. Bini, T. Damour, A. Geralico, "*Spin-orbit precession along eccentric orbits: Improving the knowledge of self-force corrections and of their effective-one-body counterparts*", published on Phys. Rev. D 97, 104046 (2018) on 25 May 2018.

The (first-order) gravitational self-force correction to the spin-orbit precession of a spinning compact body along a slightly eccentric orbit around a Schwarzschild black hole is computed through the ninth post-Newtonian order, improving recent results by Kavanagh et al. [Phys. Rev. D 96, 064012 (2017).] This information is then converted into its corresponding Effective-One-Body counterpart, thereby determining several new post-Newtonian terms in the gyrogravitomagnetic ratio gS_*.

Link: https://journals.aps.org/prd/abstract/10.1103/PhysRevD.97.104046

D**. Bini, T. Damour, A. Geralico, C. Kavanagh, "*Detweiler's redshift invariant for spinning particles along circular orbits on a Schwarzschild background*", published on Phys. Rev. D 97, 104022 (2018) on 18 May 2018.**

We study the metric perturbations induced by a classical spinning particle moving along a circular orbit on a Schwarzschild background, limiting the analysis to effects which are first order in spin. The particle is assumed to move on the equatorial plane and has its spin aligned with the z-axis. The metric perturbations are obtained by using two different approaches, i.e., by working in two different gauges: the Regge-Wheeler gauge (using the Regge-Wheeler-Zerilli formalism) and a radiation gauge (using the Teukolsky formalism). We then compute the linear-in-spin contribution to the first-order self-force contribution to Detweiler's redshift invariant up to the 8.5 post-Newtonian order. We check that our result is the same in both gauges, as appropriate for a gauge-invariant quantity, and agrees with the currently known 3.5 post-Newtonian results.

Link: https://journals.aps.org/prd/abstract/10.1103/PhysRevD.97.104022

ICRANet Newsletter

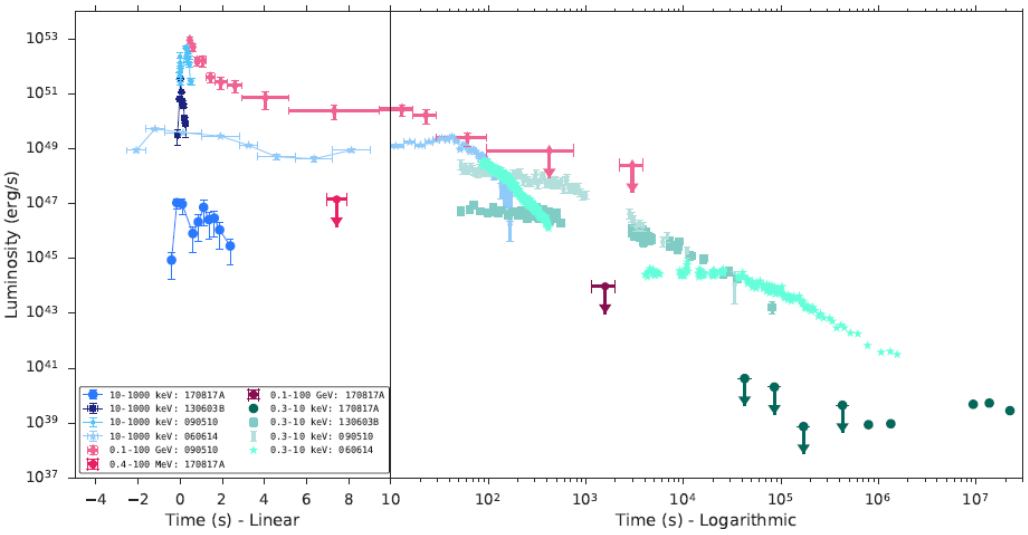
August – September 2018

SUMMARY

1. The event GRB 170817A-GW170817-AT 2017gfo as WD-WD merger

The paper "*GRB 170817A-GW170817-AT 2017gfo and the observations of NS-NS, NS-WD and WD-WD mergers*" by J. A. Rueda, R. Ruffini, Y. Wang, Y. Aimuratova; U. Barres de Almeida, C. L. Bianco, Y. C. Chen, R. V. Lobato, C. Maia, D. Primorac, R. Moradia, and J. F. Rodriguez, is published in JCAP 10 (2018) 006 on October 3, 2018.

The LIGO-Virgo Collaboration has announced the detection of GW170817 and has associated it with the gamma-ray bursts (GRB) 170817A. These signals have been followed after 11 hours by the optical and infrared kilonova emission of AT 2017gfo. The origin of this complex phenomenon has been attributed to a neutron star-neutron star (NS-NS) binary merger. The kilonova in this case would be powered by the radioactive decay of r-process heavy material synthesized in the NS-NS merger. However, as we show in this work, the gamma- and X-rays emissions of GRB 170817A are in clear contrast with the ones of any short-duration GRB associated either with a NS-NS merger or with other merger types (see details below). In fact, in order to probe the GW-GRB-kilonova association we confront our current understanding of the gravitational waves and associated electromagnetic radiation with four observed GRBs originating in binaries with NS and white dwarf (WD) components: 1) GRB 090510 the prototype of the authentic short GRB (S-GRB) subclass produced by a NS-NS merger leading to a black hole (BH); 2) GRB 130603B the prototype of the short gamma-ray flash (S-GRF) subclass produced by a NS-NS merger leading to massive NS (MNS); 3) GRB 060614 the prototype of the GRF subclass produced by a NS-WD merger leading to a MNS; and 4) we propose GRB 170817A as the prototype of a new subclass of GRB by a WD-WD merger leading to massive WD, and an AT 2017gfo-like kilonova. None of them support the triptych GW-GRB-kilonova.



Light-curves of GRBs 060614, 090510A, 130603 and 170817A in the cosmological rest-frame. We show the gamma-ray (10-1000 keV) prompt and the X-ray (0.3-10 keV) emissions. The first 10 s are plotted in a linear scale and longer times in the logarithmic scale.

There are a number of new astrophysical results:

a. The NS-NS scenario cannot explain GRB170817A-GW170817 since this solution implies an X and gamma-ray prompt emission missing in GRB 170817A (see data up to 10 s data in the figure).
b. Instead, X- and gamma-ray observations of GRB 170817A have led us to propose a new subclass of GRBs originating from WD-WD mergers leading to a massive WD. The occurrence rate of these mergers

can explain the rate of GRB 170817A-like sources, they produce a gamma- and X-ray emission consistent with GRB 170817A and cannot be associated with GW170817.

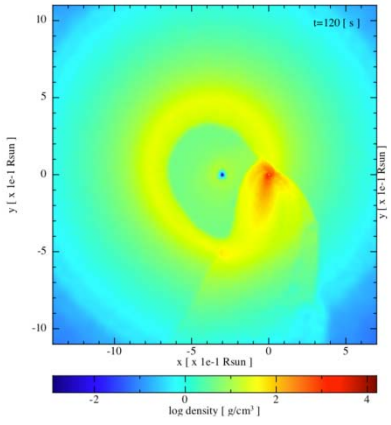
c. The kilonova AT 2017gfo can be powered by a different physical mechanism that the radioactive decay of r-processed heavy nuclei in the ejecta of NS-NS mergers: the cooling of the ejecta expelled in a WD-WD merger and heated up by fallback accretion onto the newly-formed massive WD.
d. The WD-WD merger ejecta have a lighter nuclear composition with respect to the r-processed heavy nuclei present in the ejecta of a NS-NS merger. The identification of atomic species in kilonova spectra can therefore discriminate between the two scenarios. However, such an identification has not been possible in observed kilonovae since it needs accurate models of atomic spectra, nuclear reaction network, density profile, as well as radiative transport (opacity), not yet available in the literature.
e. The outcome configuration of a GRB from WD-WD merger, namely a massive, highly magnetized, fast rotating WD, can become observable as a soft gamma repeater (SGR) or anomalous X-ray pulsar (AXP) as indicated in the WD-pulsar model introduced by Malheiro, Rueda and Ruffini in 2012.
f. The association of GRB 170817A and GW170817, from an observational point of view is, in our opinion, not yet sufficiently established to formulate a well-motivated answer on the non-null chance coincidence probability of the events. It is thus auspicable that the LIGO collaboration releases the templates of GW170817 in the interferometers to reconstruct the precise chronology of the space-time sequence of events in the LIGO detectors and in the Fermi and Integral satellites, necessary to validate the GW170817-GRB 170817A association.

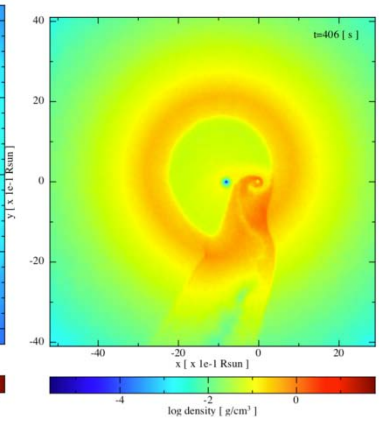
JCAP website: http://iopscience.iop.org/article/10.1088/1475-7516/2018/10/006

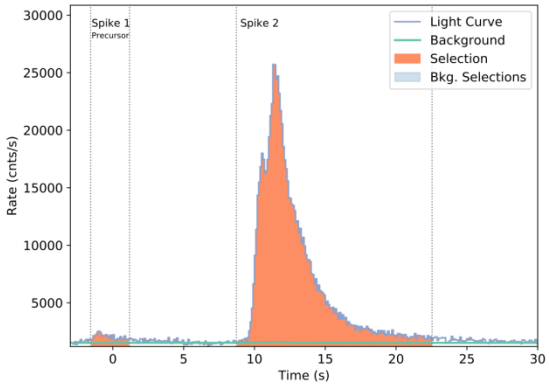
arXiv: https://arxiv.org/abs/1802.10027

2. Prediction and Confirmation of GRB 180728A / SN 2018fip by ICRANet scientists

After having successfully predicted the SN 2013cq associated with GRB 130427A (Ruffini et al.2013), as an example for the BdHN case, on 28 July 2018, ICRANet researchers led by prof. Remo Ruffini had the opportunity to predict of the supernova (SN) appearance in an X-ray flash (XRF) case.







At 17:29:00 UT, on 28 July 2018, the Swift-BAT triggered and located GRB 180728A. The BAT light curve shows a small precursor followed ∼ 10 s later by a bright pulse of ∼ 20 s duration (Starling2018). Swift-XRT did not slew immediately due to the Earth limb constraint, it began observing the field 1730.8 s after the BAT trigger (Perri2018). The Fermi-GBM triggered and located GRB 180728A at 17:29:02.28 UT. The angle from the Fermi-LAT boresight at the GBM trigger time is 35 degrees. The GBM light curve consists of a precursor and a very bright peak with a duration (T90) of about 6.4 s (50-300 keV) (Veres2018). A red continuum is detected across the spectral range of VLT/X-shooter, the absorption features due to Mg II (3124, 3132), Mg I (3187), and Ca II (4395, 4434) at a consistent redshift of z = 0.117. Although Galactic extinction in this direction is significant, a cam- paign to study the anticipated associated supernova should still be practical with moderate-aperture telescopes at this redshift (Rossi2018).

With the above first 3 days observations after the trigger of the GRB, the group has predicted that a supernova would appear in 14.7 ± 2.9 days (Ruffini2018), quoted here:

GCN 23066: GRB 180728A: A long GRB of the X-ray flash (XRF) sub- class, expecting supernova appearance

Link: https://gcn.gsfc.nasa.gov/gcn3/23066.gcn3

GRB 180728A has T90 = 6.4 s (Rossi2018), peak energy 142(−15, +20) keV, and isotropic energy Eiso = (2.33 ± 0.10) × 1051 erg (Frederiks2018). It presents the typical characteristic of a subclass of long GRBs called X-ray flashes (XRFs, seeRuffini et al.2016), originat- ing from a tight binary of a COcore undergoing a supernova explosion in presence of a companion neutron star (NS) that hypercritically accretes part of the supernova matter. The outcome is a new binary composed by a more massive NS (MNS) and a newly born NS (vNS). Using the averaged observed value of the optical peak time of supernova (Cano et al.2017) and considering the redshift z = 0.117 (Rossi2018), a bright optical signal will peak at 14.7 ± 2.9 days after the trigger (12 August 2018, uncertainty from August 9th to August 15th) at the location of RA=253.56472 and DEC=-54.04451, with an uncertainty 0.43 arcsec (LaPorte2018). The follow-up observations, especially the optical bands for the SN, as well as attention to binary NS pulsar behaviours in the X-ray afterglow emission, are recommended.

On 18 July 2018, Izzo (2018) reported the discovery of the supernova appearance:

GCN 23142: GRB 180728A: discovery of the associated supernova

Link: https://gcn.gsfc.nasa.gov/gcn3/23142.gcn3

... Up to now, we have observed at three epochs, specifically at 6.27, 9.32 and 12.28 days after the GRB trigger. The optical counterpart is visible in all epochs using the X-shooter acquisition camera in the g, r and z filters. We report a rebrightening of 0.5 ± 0.1 mag in the r band between 6.27 and 12.28 days. This is consistent with what is observed in many other low-redshift GRBs, which in those cases is indicative of an emerging type Ic SN ... For the last spectrum, we attempted the identification of a few features. In particular, we identify the broad dip at 7600 AA as due to the blend O I 8446 AA and Ca II 8492 AA, at the expansion velocity of 30,000 km s−1. At this velocity, we also identify the Si II 6355 doublet, as well as C II 6580. The width of the lines spans several thousand km s−1. Independent of the interpretation of the lines, the overall shape of the continuum, together with the presence of several absorption features a few thousands km s−1 wide, strongly indicate that this is a SN. The lack of identified H and He in the spectra suggests a classification of type Ic ... and the SN was confirmed in Selsing (2018). This SN associated with GRB 180728A is named SN 2018fip by the Transient Name Server. Therefore the prediction was confirmed.

3. Researchers' Night at ICRANet center in Pescara, 28 September 2018

Also this year ICRANet organized the event "Researchers' night at ICRANet" on the occasion of the European Researchers' Night, in order to create a nice occasion for discussion among citizens and researchers. This event attracted a lot of people, as every year, and offered visitors a unique opportunity to take part in science activities aiming to showcase both the fascination of research as a career and its significant societal impact.

Group photo of all the participants to the "Researchers' Night at ICRANet", 28 September 2018.

The event was held in ICRANet center in Pescara on Friday 28 September 2018, from 4 PM to 10 PM. Also the Prefect of Pescara, Mrs Gerardina Basilicata was present.

After the opening remarks of professor Ruffini, Director of ICRANet, Dr Wang Yu, Yerlan Aimuratov (ICRANet researchers and PhD students) illustrated the GRB 180727A and the supernova predicted and observed on the 15 of August 2018; Dr Luca Izzo, former PhD student of prof. Ruffini also joined the discussion from Spain, where he currently works. Then Prof. Costantino Sigismondi (ITIS Galileo Ferraris – Rome) celebrated with a conference the 50 years anniversary of the man on the moon and Professor Ruffini, together with ICRANet Faculty professors, discussed with participants about the present and future perspectives of science.

Students and citizens listening to ICRANet Professors explanations during the Researchers' night at ICRANet

The conferences left the place to several video projections in all the ICRANet building, concerning the "Caso Neutrino", the "l'Assoluto Relativo" and the conferences held at Besso Foundation in Rome I the framework of the MIUR project "*Del Talento e della curiosità. Quando l'aquila e il passero volano insieme*". During the event, participants had also the possibility to visit the 2 exhibitions on "*Einstein, Fermi and Heisenberg and the birth of Relativistic Astrophysics*" and on "*ICRANet and China*". Moreover, from 8.30 PM, ICRANet organized the observations of Saturn and Mars with different telescopes, and this part was illustrated by the students of the Liceo Scientifico Galileo Galilei of Pescara.

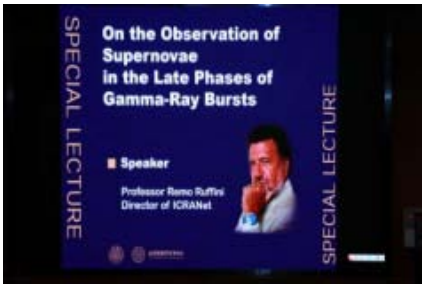
The program of this event can be found here:
http://www.icranet.org/Notte_dei_ricercatori_2018/programma.pdf

To know more about the event:
http://www.icranet.org/index.php?option=com_content&task=view&id=1210

4. Professor Ruffini visit to Tsinghua University (Beijing) and TD Lee Institute (Shanghai), 8 -15 August 2018

From 8 to 15 August 2018, Professor Remo Ruffini, Director of ICRANet, visited China, invited by Professor Shing-Tung Yau, to gave a seminar in his Yau Mathematical Sciences Center at Tsinghua University in Beijing on the 9 August 2018. The seminar, titled "*On the observation of supernovae in the late phases of Gamma-Ray Bursts*", illustrated to the public the results otained by Professor Ruffini, ICRANet researchers and PhD students (Y. Aimuratov, L. Becerra, C.L. Bianco, Y.C. Chen, D.M. Fuksman, M. Karlica, G. Mathews, R. Moradi, D. Primorac, J.A. Rueda, N. Sahakyan, Y. Wang, S.-S. Xue).

For the video of the seminar, please see the link: https://www.youtube.com/watch?v=Q6xssDI7a84&t=805s



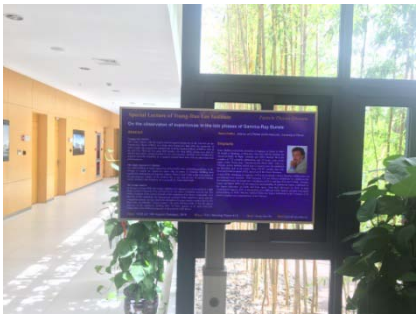
Professor Remo Ruffini during his seminar at Tsinghua University in Beijing, 9 August 2018.

From left to right: Dr. Yu Wang, ICRANet PhD student, Prof. Remo Ruffini, Director of ICRANet, and Prof. Shing-Tung Yau, Director of Yau Mathematical Sciences Center at Tsinghua University.

Accompanied by Dr Yu Wang, ICRANet PhD student, Professor Ruffini also visited the Tsung-Dao Lee Institute in Shanghai, where he was invited to deliver a C. C. Lin lecture on the same subject presented few days before in Beijing. During his visit in the Institute, Professor Ruffini had also the possibility to see the MG14 Award delivered in 2015 to T. D. Lee "f*or his work on white dwarfs motivating Enrico Fermi's return to astrophysics and guiding the basic understanding of neutron star matter and fields*".

Prof Remo Ruffini with the MG14 Award delivered in 2015 to T. D. Lee.

Professor Remo during his seminar at the Tsung-Dao Lee Institute in Shanghai, 14 August 2018.



For more details on the seminar and the prediction of the 2 GCNs:
http://www.icranet.org/documents/Abstract+2GCNs.pdf

5. Professor Ruffini visit to LAPP and special seminar, Annecy, 4 September 2018

On the 4 September 2018, Professor Remo Ruffini, Director of ICRANet, visited LAPP (Laboratoire d'Annecy de Physique des Particules) in Annecy, France, where he was invited to give a seminar by its Director, Professor Giovanni Lamanna. In this seminar, titled "*GRB180728A, our predicted Supernova denominated on 27 August SN2018fip and conceptual inferences*" (https://indico.in2p3.fr/event/17864/), Professor Ruffini illustrated how a sequence of fortunate events occurred after the 28 of July, when GRB190728A was observed by SWIFT and Fermi satellites. With his collaborators, they have identified this source as a member of the X-ray Flash (XRF) subclass of gamma-ray bursts (GRBs) in which a supernovae (SN) ejecta hypercritically accretes onto the neutron star (NS) companion leading to a more massive NS (MNS) and to a νNS-MNS binary. On the other hand, in the GCN23066 on 31 July 2018, they predicted the occurrence of a SN, indeed observed on 15 August (GCN23142). The significance of this result in discriminating the 8 different GRBs subclass has been analyzed.

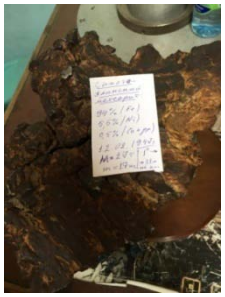
6. Professor Ruffini visit to Kazakhstan and 3 new Collaboration Agreements of ICRANet, 6 - 8 September 2018

From the 6th to the 8th September 2018, Professor Remo Ruffini, Director of ICRANet, visited Kazakhstan. On the first day of his mission, he went to the Nazarbayev University in Astana, where he has delivered a seminar "*GRB180728A, our predicted Supernova denominated on 27 August SN2018fip and conceptual inferences*" and met its Vice President for Innovation& Research, Mr Kanat Baigarin. In the same afternoon, he met H.E. Pasquale D'Avino, Ambassador of Italy in Astana in the Italian Embassy residence, with whom he had fruitful discussions on the multiple and interesting possibilities of collaboration between Italy and Kazakhstan in the field of science. During his visit, Professor Ruffini signed also a cooperation agreement with the L.N. Gumilyov Eurasian National University (ENU) in Astana, together with its Rector, Prof. Yerlan Battashevich Sydykov. The main joint activities envisaged in the framework of this agreement include: the promotion of theoretical and observational activities within the field of Relativistic Astrophysics; institutional exchanges of faculty members, researchers, post-doctorate fellows and students; the promotion of technological developments; the organization of seminars, conferences, workshops, training and research courses, and joint publications.

On the following day, Professor Ruffini flew to Almaty, where he had in the morning, accompanied by Professor Abishev Medeu (Al-Farabi Kazakh National University), a meeting with Professor Chingis Omarov, President of the National Center for Space Research & Technology (NCSR). On this occasion a Memorandum of cooperation in science and education with the NCR – Kazakhstan was signed by Professor Omarov, President of the center, and Prof. Ruffini, Director of ICRANet. It will be valid for 5 years, starting from the date of its signature. The main forms of cooperation envisaged in the framework of this agreement include: exchange of scientific expertise, joint research activities, joint participation in research grants, exchange of scientific materials and experience.

Professor Remo Ruffini, accompained by Prof. Abishev Medeu, during the signature ceremony of the Memorandum of cooperation in science and education with the Center for Space Research & Technology (NCSR) in Almaty.

After the signature ceremony Professor Ruffini visited Fesenkov Astrophysical Institute (FAPHI) and had the opportunity to observe the Sikhote-Alin meteorite, an iron meteorite felt down on the Sikhote-Alin Mountains, in southeastern Russia, in 1947. Though large iron meteorite falls had been witnessed previously and fragments recovered, never before in recorded history had a fall of such magnitude been observed. In this institute, Professor Ruffini addressed the public with the seminar "*GRB180728A, our predicted Supernova denominated on 27 August SN2018fip and conceptual inferences*".



The photo of the Sikhote-Alin meteorite located in the Fesenkov Astrophysical Institute.

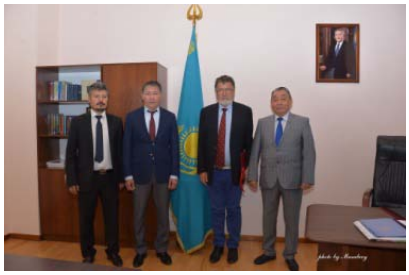
Professor Ruffini with the Sikhote-Alin meteorite in Fesenkov Astrophysical Institute (FAPHI).

Professor Ruffini during his seminar "GRB180728A, our predicted Supernova denominated on 27 August SN2018fip and conceptual inferences" at the Fesenkov Astrophysical Institute.

Professor Rufifni with Academician Tolegen Kozhamkulov, President of the Kazakh Physical Society (KPS), during the signature ceremony of the cooperation agreement with KPS in Almaty.

Moreover, Professor Ruffini met Academician Tolegen Kozhamkulov, President of the Kazakh Physical Society (KPS) and, on that occasion, the President of KPS, signed a cooperation agreement with ICRANet, represented by Professor Remo Ruffini. The main joint activities envisaged in the framework of this agreement include: the promotion of theoretical and observational activities within the field of Relativistic Astrophysics; institutional exchanges of faculty members, researchers, post-doctorate fellows and students; the promotion of technological developments; the organization of seminars, conferences, workshops, training and research courses, and joint publications.

On Saturday 8 September, Professor Ruffini, accompanied by Prof. Kozhamkulov, Prof. Abishev and Yerlan Aimuratov, met H. E. Yerlan Sagadiyev, Minister of Education and Science of Kazakhstan at the Academy of Sciences building in Almaty. The main issue of discussion was the Kazakhstan's cooperation with ICRANet.



Professor Ruffini, accompanied by Academician Kozhamkulov and Prof. Abishev Medeu, during his meeting with H. E. Yerlan Sagadiyev, Minister of Education and Science of Kazakhstan at the Academy of Sciences building in Almaty.

For the video of the seminar of Professor Ruffini at Fesenkov Astrophysical Institute (FAPHI), Almaty, 7 September 2018:
https://www.youtube.com/watch?v=f_w5-UZ1-sQ&t=16s

For the press releases, please see the links:
http://www.kaznu.kz/en/3/news/one/14314/
https://www.inform.kz/ru/kazahstanskie-astrofiziki-sovmestno-s-ital-yancami-budut-izuchat-chernye-dyry_a3390191 (in russian)

For the text of the agreements, see:

- http://www.icranet.org/documents/AgreementICRANet-ENU.pdf (Agreement ICRANet - ENU)
- http://www.icranet.org/index.php?option=com_content&task=view&id=1203 (Agreement ICRANet – KPS)
- http://www.icranet.org/documents/AgreementICRANet-JSC-NCRS.pdf (MoU ICRANet - JSC NCRS)

7. Scientific visits to ICRANet

- From the 16 to the 30 September 2018, Professor **Klaudio Peqini** from University of Tirana – Albania, visited ICRANet center in Pescara. During his visit, he had the opportunity to discuss his scientific results and to have fruitful exchange of ideas with other researchers from ICRANet and from different parts of the world.

- On the 24 September 2018, Professor **Sang Pyo Kim** (Kunsan National University, Korea), who visited ICRANet center in Pescara from 22 to 25 September, gave a seminar titled "*QED Phenomena in de Sitter Space*". On that occasion he discussed with ICRANet faculty members QED effective action and pair production for uniform electric and parallel magnetic fields in dS space, possible scenarios for magneto genesis, and physical implications of QED vacuum polarization in cosmology as well as astrophysics. The vacuum persistence is related to the Schwinger effect of spontaneous pair production in dS space. We obtain a pair production rate in the electromagnetic field which agrees with the known Schwinger result in the limit of Minkowski space-time and with Hawking radiation in dS space in the zero electromagnetic field limit. Using the zeta function regularization scheme, we calculate the induced current and examine the effect of a magnetic field on the vacuum expectation value of the current operator. We discuss Schwinger effect as a possible scenario for magneto genesis. We employ the in-out formalism introduced by Schwinger and DeWitt and apply the gamma-function regularization to find the one-loop QED action in the proper-time integral representation in dS space. The one-loop effective action becomes the famous Heisenberg-Euler-Schwinger action in the limit of Minkowski space-time and yields the one-loop gravity action in the zero electromagnetic field limit, which is a nonperturbative analog of Heisenberg-Euler-Schwinger QED action. Finally we discuss the physical implications of QED vacuum polarization in cosmology as well as astrophysics.

8. Special issue of the "Science and Innovation" journal in Belarus

Following the Third Zeldovich Meeting organized by ICRANet and the National Academy of Sciences of Belarus in April 2018 the leading Belarusian science popular Journal "*Science and Innovation*" published by the National Academy of Sciences of Belarus has prepared a special issue "*How the Universe thinks*" devoted to astrophysics and cosmology.

Among the articles presented in this special issue three were prepared by ICRANet scientists:

- "*Current state art in astrophysics and perspectives in Belarus*" by Gregory Vereshchagin, ICRANet Faculty Professor;
- "*Cosmology and astrophysics today: dark energy and dark matter*" by Ivan Siutsou and Yuri Vyblyi, researchers at ICRANet-Minsk;
- "*Gamma-ray bursts – the most bright and mysterious objects in the Universe*" by Ivan Siutsou and Gregory Vereshchagin.

Details (in Russian) can be found here: http://innosfera.by/content_2018_08

9. Recent publications

Bini D., Geralico A., *Gravitational self-force corrections to tidal invariants for spinning particles on circular orbits in a Schwarzschild spacetime*, to appear on Phys. Rev. D (2018), arXiv:1806.03495

Bini D., Geralico A., *Gravitational self-force corrections to tidal invariants for particles on eccentric orbits in a Schwarzschild spacetime*, published on Phys. Rev. D, Vol. 98, Iss. 6 - 15 September 2018, arXiv:1806.06635.

We study tidal effects induced by a particle moving along a slightly eccentric equatorial orbit in a Schwarzschild spacetime within the gravitational self-force framework. We compute the first-order (conservative) corrections in the mass ratio to the eigenvalues of the electric-type and magnetic-type tidal tensors up to the second order in eccentricity and through the 9.5 post-Newtonian order. Previous results on circular orbits are thus generalized and recovered in a proper limit.

Link: https://journals.aps.org/prd/abstract/10.1103/PhysRevD.98.064026

Bini D., Geralico A., *Gravitational self-force corrections to tidal invariants for particles on circular orbits in a Kerr spacetime*, published on Phys. Rev. D, Vol. 98, Iss. 6 - 15 September 2018, arXiv:1806.08765

We generalize to the Kerr spacetime existing self-force results on tidal invariants for particles moving along circular orbits around a Schwarzschild black hole. We obtain linear-in-mass-ratio (conservative) corrections to the quadratic and cubic electric-type invariants and the quadratic magnetic-type invariant in series of the rotation parameter up to the fourth order and through the ninth and eighth post-Newtonian orders, respectively. We then analytically compute the associated eigenvalues of both electric and magnetic tidal tensors.

Link: https://journals.aps.org/prd/abstract/10.1103/PhysRevD.98.064040

Rosquist K., Bini D., Mashhoon B., *Twisted Gravitational Waves of Petrov type D*, published on Phys. Rev. D 98, 064039 (2018), Iss. 6 - 15 September 2018, arXiv:1807.09214

Twisted gravitational waves (TGWs) are nonplanar unidirectional Ricci-flat solutions of general relativity. Thus far only TGWs of Petrov type II are implicitly known that depend on a solution of a partial differential equation and have wave fronts with negative Gaussian curvature. A special Petrov type D class of such solutions that depends on an arbitrary function is explicitly studied in this paper and its Killing vectors are worked out. Moreover, we concentrate on two solutions of this class, namely, the Harrison solution and a simpler solution we call the w-metric and determine their Penrose plane-wave limits. The corresponding transition from a nonplanar TGW to a plane gravitational wave is elucidated.

Link: https://journals.aps.org/prd/abstract/10.1103/PhysRevD.98.064039

N. Sahakyan, *Lepto-hadronic γ-ray and neutrino emission from the jet of TXS 0506+056*, Accepted for publication in ApJ on 16 Aug 2018, arXiv:1808.05651

The observation of IceCube-170922A event from the direction of TXS 0506+056 when it was in its enhanced γ-ray emission state offers a unique opportunity to investigate the lepto-hadronic processes in blazar jets. Here, the observed broadband emission of TXS 0506+056 is explained by boosted synchrotron/synchrotron self Compton emission from the jet whereas the γ-ray data observed during the neutrino emission- by inelastic interactions of the jet-accelerated protons in a dense gaseous target. The proton energy distribution is ∼E−2.50p, calculated straightforwardly from the data obtained by Fermi-LAT and MAGIC and if such distribution continues up to Ec,p=10 PeV, the expected neutrino rate is as high as ∼0.46 events during the long active phase of the source or ∼0.15 if the activity lasts 60 days. In this interpretation, the energy content of the protons above > GeV in blazar jets can be estimated as well: the required proton injection luminosity is ≃2.0×1048ergs−1 exceeding 103 times that of electrons ≃1045ergs−1 which are in equipartition with the magnetic field. As the required parameters are physically realistic, this can be an acceptable model for explanation of the neutrino and γ-ray emission from TXS 0506+056.

Link: https://arxiv.org/abs/1808.05651

Hagen Kleinert and She-Sheng Xue, ***Composite fermions and their pair states in a strongly-coupled Fermi liquid*****, published in Nuclear Physics B936 (2018), 352–363.**

Our goal is to understand the phenomena arising in optical lattice fermions at low temperature in an exter-nal magnetic field. Varying the field, the attraction between any two fermions can be made arbitrarily strong, where composite bosons form via so-called Feshbach resonances. By setting up strong-coupling equations for fermions, we find that in spatial dimension d>2 they couple to bosons which dress up fermions and lead to new massive composite fermions. At low enough temperature, we obtain the critical temperature at which composite bosons undergo the Bose–Einstein condensate (BEC), leading to BEC-dressing massive fermions. These form tightly bound pair states which are new bosonic quasi-particles producing a BEC-type condensate. A quantum critical point is found and the formation of condensates of complex quasi-particles is speculated over.

Link: https://doi.org/10.1016/j.nuclphysb.2018.09.023

ICRANet Newsletter

October – November 2018

SUMMARY

1. A GRB afterglow model consistent with hypernovae observations

The paper with this title co-authored by R. Ruffini, M. Karlica, N. Sahakyan, J.A. Rueda, Y. Wang, G.J. Mathews, C.L. Bianco and M. Muccino has been accepted for publication by the Astrophysical Journal (ApJ) on October 21, 2018.

In this paper our group presents an important paradigm shift in contrast to the traditional ultrarelativistic external shock scenario of the GRB afterglows which can be found in most of traditional literature. For our first investigation we used data of famous GRB 130427A with time resolved afterglow observations from radio till GeV band in timeframe from 604 till 5184000 seconds after the trigger. From model independent measurements for GRB 130427A of thermal emission expansion from 196 till 461 seconds after trigger with inferred velocity v/c~0.95 and corresponding Lorentz factor Γ~3 which decays after 16.7 days toward v/c~0.1 based of FeII 5169 measurements it was clear that the traditional ultrarelativistic scenario could not be used for description of

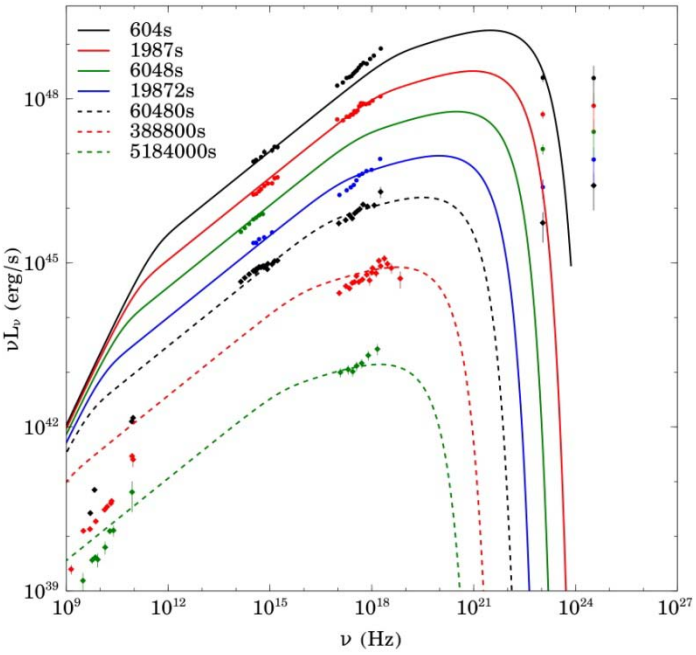


Fig. 1. Model evolution (lines) of synchrotron spectral luminosity at various times compared with measurements (points with error bars) in various spectral bands for GRB 130724A.

afterglow.

Another novelty of this paper is the build up of synchrotron radiation within hypernova ejecta magnetized by the newly born neutron star as expected by the BdHN model of long GRBs. Following the geometry and strength of the newly born pulsar's magnetic field together with the mildly relativistic expansion of hypernova ejecta it was possible to asses and solve the kinetic equation for radiating electrons giving us the spectral evolution of synchrotron radiation which fit genuinely well with observed time resolved spectra of GRB 130427A as shown on figure 1.

Analysis presented in this paper goes more in line with the long GRB-SN connection cause all of the known supernovae associated with long GRBs, among them SN 2013cq associated with GRB 130427A, are broad lined type Ic supernovae indicating a binary system progenitor what is also expected by BdHN GRB model. Also it stresses the importance of model independent expansion velocity measurements of GRBs in afterglow phase which are an crucial ingredient in understanding of the astrophysical system and their subsequent theoretical treatment.

The paper is available here: https://arxiv.org/abs/1712.05000

2. New collaboration Agreement between Campus Bio-Medico University of Rome and ICRANet, 11 October 2018

The official ceremony hel on 14 November 2018 in the Campus Bio-Medico University. From left to right: Prof.ssa Simonetta Filippi, the President Raffaele Calabrò, Dr Benedetto Marino, Prof. Marco Tavani, Prof. Remo Ruffini, Prof. Paolo Giommi, Prof. Christian Cherubini.

On the 11 October 2018, ICRANet established a collaboration agreement with the Campus Bio-Medico University of Rome – Italy, which will be valid for 2 years. The document was signed by Prof. Raffaele Calbrò (President) and by Dr Andrea Rossi (Director General) for the Campus Bio-Medico University and by Prof. Ruffini, Director of ICRANet.

In order to celebrate the signature, the Campus Bio-Medico University organized an official ceremony in their seat in Rome, on Wednesday 14 November 2018, at the presence of Prof. Ruffini (Director of ICRANet), Raffaele Calabrò (President of Campus Bio-Medico), Prof.ssa Simonetta Filippi (Campus Bio-Medico), Prof. Christian Cherubini (Campus Bio-Medico), Prof. Paolo Giommi (ASI) , Prof. Marco Tavani (INAF) and Dr. Benedetto Marino.

The main joint activities to be developed under the framework of this agreement include: the promotion of theoretical and observational activities within the field of Relativistic Astrophysics; the joint collaboration of faculty members, researchers, post-doctorate fellows and students; the organization of training and teaching courses, seminars, conferences, workshops or short courses, and the joint work on scientific publications.

For the text of the agreement, see: http://www.icranet.org/documents/agreementICRANet-CampusBiomedico.pdf

3. 13th Meeting of the Marie Skłodowska-Curie actions' Advisory Group, Bruxelles, 7 November 2018

On the 7 November 2018, professor Ruffini took part in the 13th Meeting of the MSCA Advisory Group, held in Brussels. The MSCA financially support researchers at all stages of their careers, irrespective of nationalities and disciplines. Funding may be attributed to individual researchers, networks, staff exchange programmes and doctoral/postdoctoral programmes. In addition to providing research funding, MSCA enable scientists to gain international, inter-sectoral and interdisciplinary experience and to complete their scientific training with transferable competences that will enhance their employability and career prospects. During the meeting, the Horizon 2020 (H2020) Advisory Group for the Marie Skłodowska Curie Actions worked on the preparation of a report focused on the 2020 part of the H2020 Working Programme (WP) for the period 2018-2020. A more comprehensive report will be prepared next year.

For more information about the MSCA Advisory Group, see the link:
http://ec.europa.eu/research/mariecurieactions/

4. UNOOSA High Level Forum: The way forward after UNISPACE+50 and on Space2030, Bonn, Germany 13 - 16 November 2018

Group photo of the UNOOSA High Level Forum in Bonn, Germany.

From the 13 to the 16 November 2018, Professor Ruffini, director of ICRANet, attended the High Level Forum "*The way forward after UNISPACE+50 and on Space2030*", organized by the United Nations Office for Outer Space Affairs (UNOOSA) and the German Space Administration (DLR). This High Level Forum served as an important platform for providing updates and recommendations on the potential of space innovations to address new and emerging sustainable development challenges. As the first High Level Forum after UNISPACE+50, this meeting offered the opportunity to discuss the outcomes on UNISPACE+50, across two days of sessions on the thematic priorities, followed by two days of high-level panel discussions focusing on the four pillars: Space Diplomacy, Space Society, Space Economy and Space Accessibility. During the meeting, Professor Ruffini presented a poster titled "*The Role of Space Sciences for Relativistic Astrophysics in the knowledge of our Universe*", demonstrating the latest research results obtained by ICRANet scientists.

5. Joint Call for Proposals "BRFFR – ICRANet – 2018"

In November 2018 the Belarusian Republican Foundation for Fundamental Research (BRFFR) and ICRANet announced a call for proposals for joint basic research projects in relativistic astrophysics. The scientific areas covered by the call are Relativistic astrophysics, Cosmology and Gravitation. Joint applications from international research teams, including Belarusian scientists, have to be submitted simultaneously using agreed application forms to both organizations: Belarusian team apply to the BRFFR, international ones – to ICRANet. The duration of the projects is up to 2 years, and the deadline for applications is December 14, 2018.

For more information about the call and to download the application form, please use the link: http://www.icranet.org/index.php?option=com_content&task=view&id=1218

Detailed information for Belarusian applicants is available on the website of BRFFR (in Russian): http://fond.bas-net.by/if264.html.

Information for ICRANet Applicants: http://www.icranet.org/documents/general_terms.pdf

6. Scientific visits to ICRANet

Ms Somayyeh Mahmoudikooshkeqazi and Saeidehalsadat Modaresvamegh.

From the 3 November to the 8 December 2018, 2 Iranian students from Shiraz University visited ICRANet center in Pescara, in the framework of the Memorandum of Understanding between the two Institutions: Mrs Somayyeh Mahmoudikooshkeqazi and Saeidehalsadat Modaresvamegh. During their visit, the students had the opportunity to discuss their scientific research and to have fruitful exchange of ideas with other ICRANet researchers from different parts of the world.

7. Recent publications

J. A. Rueda, R. Ruffini, L. M. Becerra, C. L. Fryer, *Simulating the induced gravitational collapse scenario of long gamma-ray bursts*, International Journal of Modern Physics A, Volume 33, Issue 31, id. 1844031 (2018), published on 19 November 2018.

We present the state-of-the-art of the numerical simulations of the supernova (SN) explosion of a carbon-oxygen core (COcore) that forms a compact binary with a neutron star (NS) companion, following the induced gravitational collapse (IGC) scenario of long gamma-ray bursts (GRBs) associated with type Ic supernovae (SNe). We focus on the consequences of the hypercritical accretion of the SN ejecta onto the NS companion which either becomes a more massive NS or gravitationally collapses forming a black hole (BH). We summarize the series of results on this topic starting from the first analytic estimates in 2012 all the way up to the most recent three-dimensional (3D) smoothed-particle-hydrodynamics (SPH) numerical simulations in 2018. We present a new SN ejecta morphology, highly asymmetric, acquired by binary interaction and leading to well-defined, observable signatures in the gamma- and X-rays emission of long GRBs.

Link: https://www.worldscientific.com/doi/abs/10.1142/S0217751X18440311

M. A. Prakapenia, I. A. Siutsou, G. V. Vereshchagin, *Thermalization of electron–positron plasma with quantum degeneracy*, Physics Letters A, available online from 25 October 2018, in press.

The non-equilibrium electron–positron–photon plasma thermalization process is studied using relativistic Boltzmann solver, taking into account quantum corrections both in non-relativistic and relativistic cases. Collision integrals are computed from exact QED matrix elements for all binary and triple interactions in the plasma. It is shown that in non-relativistic case (temperatures $k_B T \leq 0.3\ m_e c^2$) binary interaction rates dominate over triple ones, resulting in establishment of the kinetic equilibrium prior to final relaxation towards the thermal equilibrium, in agreement with the previous studies. On the contrary, in relativistic case (final temperatures $k_B T \geq 0.3\ m_e c^2$) triple interaction rates are fast enough to prevent the establishment of

kinetic equilibrium. It is shown that thermalization process strongly depends on quantum degeneracy in initial state, but does not depend on plasma composition.

Link: https://www.sciencedirect.com/science/article/abs/pii/S0375960118310594

Becerra, L.; Ellinger, C. L.; Fryer, C. L.; Rueda, J. A.; Ruffini, R., *SPH simulations of the induced gravitational collapse scenario of long gamma-ray bursts associated with supernovae*, accepted for publication in The Astrophysical Journal on the 4 December 2018.

We present the first three-dimensional (3D) smoothed-particle-hydrodynamics (SPH) simulations of the induced gravitational collapse (IGC) scenario of long-duration gamma-ray bursts (GRBs) associated with supernovae (SNe). We simulate the SN explosion of a carbon-oxygen core (COcore) forming a binary system with a neutron star (NS) companion. We follow the evolution of the SN ejecta, including their morphological structure, subjected to the gravitational field of both the new NS (νNS) formed at the center of the SN, and the one of the NS companion. We compute the accretion rate of the SN ejecta onto the NS companion as well as onto the νNS from SN matter fallback. We determine the fate of the binary system for a wide parameter space including different COcore and NS companion masses, orbital periods and SN explosion geometry and energies. We identify, for selected NS nuclear equations-of-state, the binary parameters leading the NS companion, by hypercritical accretion, either to the mass-shedding limit, or to the secular axisymmetric instability for gravitational collapse to a black hole (BH), or to a more massive, fast rotating, stable NS. We also assess whether the binary remains or not gravitationally bound after the SN explosion, hence exploring the space of binary and SN explosion parameters leading to νNS-NS and νNS-BH binaries. The consequences of our results for the modeling of long GRBs, i.e. X-ray flashes and binary-driven hypernovae, are discussed.
Link: https://arxiv.org/abs/1803.04356

Ruffini, R.; Becerra, L.; Bianco, C. L.; Chen, Y. C.; Karlica, M.; Kovacevic, M.; Melon Fuksman, J. D.; Moradi, R.; Muccino, M.; Pisani, G. B.; Primorac, D.; Rueda, J. A.; Vereshchagin, G. V.; Wang, Y.; Xue, S.-S., *On the ultra-relativistic Prompt Emission (UPE), the Hard and Soft X-ray Flares, and the extended thermal emission (ETE) in GRB 151027A*, accepted for publication in The Astrophysical Journal on 3 November 2018.

We analyze GRB 151027A within the binary-driven hypernova (BdHN) approach, with progenitor a carbon-oxygen core on the verge of a supernova (SN) explosion and a binary companion neutron star (NS). The hypercritical accretion of the SN ejecta onto the NS leads to its gravitational collapse into a black hole (BH), to the emission of the GRB and to a copious e^+e^- plasma. The impact of this e^+e^- plasma on the SN ejecta explains the early soft X-ray flare observed in long GRBs. We here apply this approach to the UPE and to the hard X-ray flares. We use GRB 151027A as a prototype. From the time-integrated and the time-resolved analysis we identify a double component in the UPE and confirm its ultra-relativistic nature. We confirm the mildly-relativistic nature of the soft X-ray flare, of the hard X-ray flare and of the ETE. We show that the ETE identifies the transition from a SN to the HN. We then address the theoretical justification of these observations by integrating the hydrodynamical propagation equations of the e^+e^- into the SN ejecta, the latter independently obtained from 3D smoothed-particle-hydrodynamics simulations. We conclude that the UPE, the hard X-ray flare and the soft X-ray flare do not form a causally connected sequence: Within our model they are the manifestation of **the same** physical process of the BH formation as seen through different viewing angles, implied by the morphology and the ~300s rotation period of the HN ejecta.

Link: https://arxiv.org/abs/1712.05001

Ruffini, R.; Karlica, M.; Sahakyan, N.; Rueda, J. A.; Wang, Y.; Mathews, G. J.; Bianco, C. L.; Muccino, M., *On a GRB afterglow model consistent with hypernovae observations*, accepted for publication in The Astrophysical Journal on 21 October 2018.

We describe the afterglows of the long gamma-ray-burst (GRB) 130427A within the context of a binary-driven hypernova (BdHN). The afterglows originate from the interaction between a newly born neutron star (νNS), created by an Ic supernova (SN), and a mildly relativistic ejecta of a hypernova (HN). Such a HN in turn results from the impact of the GRB on the original SN Ic. The mildly relativistic expansion velocity of the afterglow ($\Gamma\sim3$) is determined, using our model independent approach, from the thermal emission between 196 s and 461 s. The power-law in the optical and X-ray bands of the afterglow is shown to arise from the synchrotron emission of relativistic electrons in the expanding magnetized HN ejecta. Two components contribute to the injected energy: the kinetic energy of the mildly relativistic expanding HN and the rotational energy of the fast rotating highly magnetized νNS. We reproduce the afterglow in all wavelengths from the optical (10^{14}Hz) to the X-ray band (10^{19}Hz) over times from 604s to 5.18×10^{6} s relative to the Fermi-GBM trigger. Initially, the emission is dominated by the loss of kinetic energy of the HN component. After 10^{5} s the emission is dominated by the loss of rotational energy of the νNS, for which we adopt an initial rotation period of 2~ms and a dipole plus quadrupole magnetic field of $\lesssim7\times10^{12}$G or $\sim10^{14}$ G. This scenario with a progenitor composed of a COcore and a NS companion differs from the traditional ultra-relativistic-jetted treatments of the afterglows originating from a single black hole.

Link: https://arxiv.org/abs/1712.05000