Enclosure 9

The 2021 ICRANet Newsletters

ICRANet Newsletter

December 2020 - January 2021

SUMMARY

1. Shedding new light on sterile neutrinos from XENON1T experiment

A new paper co-authored by Shakeri, S., Hajkarim, F. & Xue, SS. has been published on December 30, 2020 in Journal of High Energy Physics.

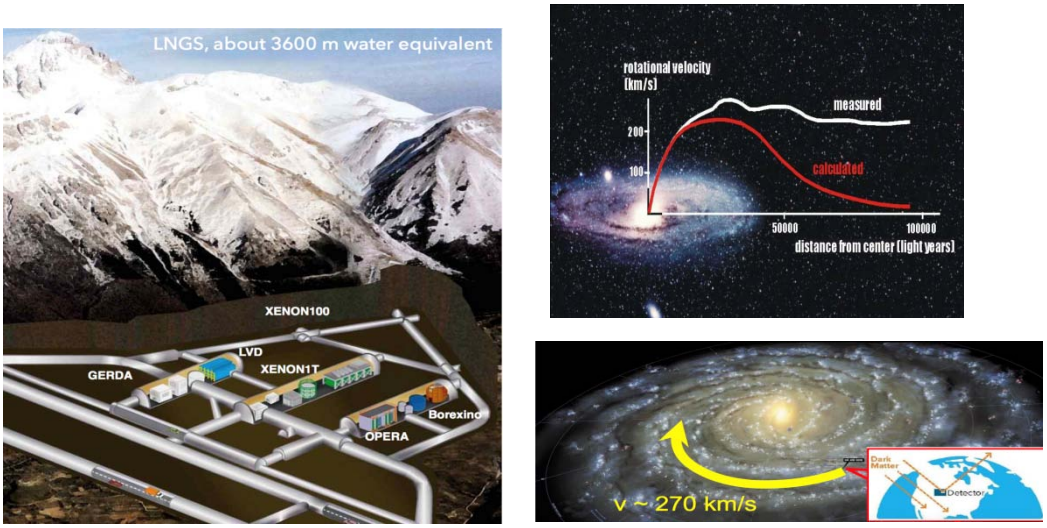


Fig. 1, 2 and 3: XENON1T experiment at INFN Laboratori Nazionali del Gran Sasso.

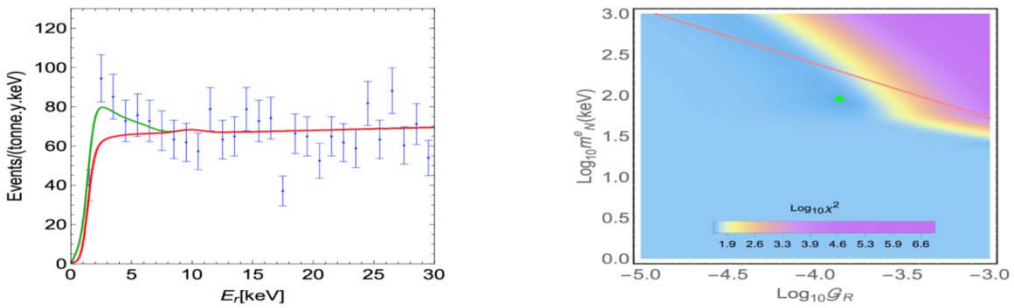


Fig. 4 and 5: In the left panel events versus recoil energy including the error bars are shown in blue color. The solid red line is the background model computed by XENON Collaboration. The additional recoil due to the sterile neutrino DM interaction with the Xenon electrons are shown by green solid curve. Right panel shows best fit points for the coupling and mass of electron sterile neutrino.

The XENON1T collaboration recently reported the excess of events from recoil electrons which may be sign of a fundamental new discovery about our universe. The XENON1T as the world's most sensitive dark matter experiment hosted in an underground laboratory beneath a mountain at Gran Sasso National Laboratory (INFN Laboratori Nazionali del Gran Sasso) in Italy. The evidence for the existence of dark matter (DM) which makes up 85% of the matter in the universe, is implied from various astrophysical and cosmological observations, but scientists still do not know the particle nature of this exotic material.

A group of scientists She-sheng Xue from ICRANet/ICRA, Soroush Shakeri from ICRANet-Isfahan and Isfahan University of Technology (IUT) and Fazlollah Hajkarim from Università degli Studi di Padova and Goethe Universität, claimed to have found a new interpretation for XENON1T excess by considering effective interactions between the DM sterile neutrinos and the SM particles.

Sterile neutrinos as a warm DM with masses at keV scale are well motivated from astrophysical and cosmological point of view. It is shown that sterile neutrinos with masses around 90 keV and specific effective coupling can fit well with the XENON1T data where the best fit points preserving

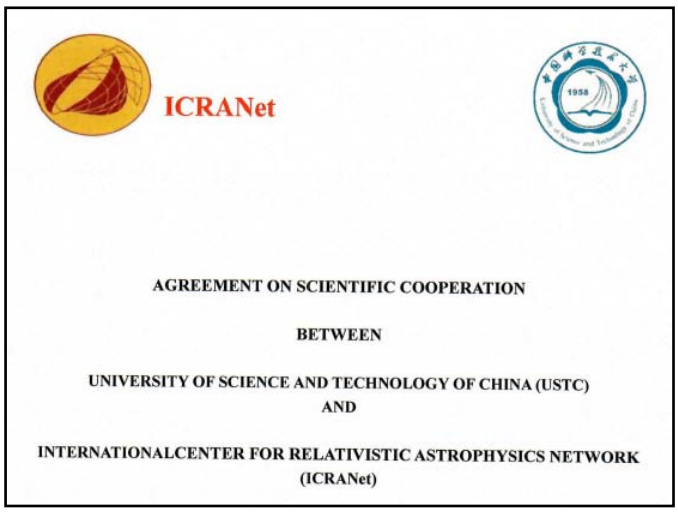
DM constraints and possibly describe the anomalies in other experiments. In addition to explain XENON1T anomaly, the scenario presented in this group has some distinctive features which can be used to distinguish between their scenario and other beyond SM proposals.
This research, as shown by the references below, has been well developed for many years in ICRANet to understand the nature of dark matter particles as a fermion with the mass in keV range. It has been individuated the window 50-350 keV for the mass of fermionic dark matter ("ino") from the analysis of the rotation curves of the Milky Way. Accurate analysis has been done by ICRANet member in the case of the S2 and G2 orbits around the Galactic center and explained them with the distribution of DM for 56 keV fermions.

The XENON1T new results attract so much attention in Physics community. Physicists will likely treat the XENON1T results as preliminary for the near future. An upcoming, larger XENON experiment called XENONnt, still under construction in Italy besides the next generation of XENON detectors may shed light on the dark matter nature and low energy neutrino physic beyond SM.

- XENON collaboration, *Excess electronic recoil events in XENON1T*, Phys. Rev. D 102(2020) 072004
- Soroush Shakeri, Fazlollah Hajkarim, She-Sheng Xue, *Shedding New Light on Sterile Neutrinos from XENON1T Experiment*, JHEP12(2020)194
- C.R. Argüelles, N.E. Mavromatos, J.A. Rueda and R. Ruffini, *The role of self-interacting right-handed neutrinos in galactic structure*, JCAP 04 (2016) 038
- N. E. Mavromatos, C. R. Argüelles, R. Ruffini, J. A. Rueda, *Self- interacting dark matter*, International Journal of Modern Physics D 26 (2017) 1730007
- R. Ruffini, C. R. Argüelles, J. A. Rueda, *On the core-halo distribution of dark matter in galaxies*, MNRAS 451 (2015) 622–628
- E. A. Becerra-Vergara, C. R. Argüelles, A. Krut, J. A. Rueda, R. Ruffini, *The geodesic motion of S2 and G2 as a test of the fermion dark matter constituency of our galactic core*, A&A 641, A34 (2020)
- R. Yunis, C. R. Argüelles, N. E. Mavromatos, A. Moliné, A. Krut, M. Carinci, J. A. Rueda, R. Ruffini, *Galactic center constraints on self-interacting sterile neutrinos from fermionic dark matter ("ino") models*, Physics of the Dark Universe 30 (2020) 100699

Link to the paper: https://doi.org/10.1007/JHEP12(2020)194

2. New Agreement on scientific cooperation between USTC and ICRANet, December 28, 2020

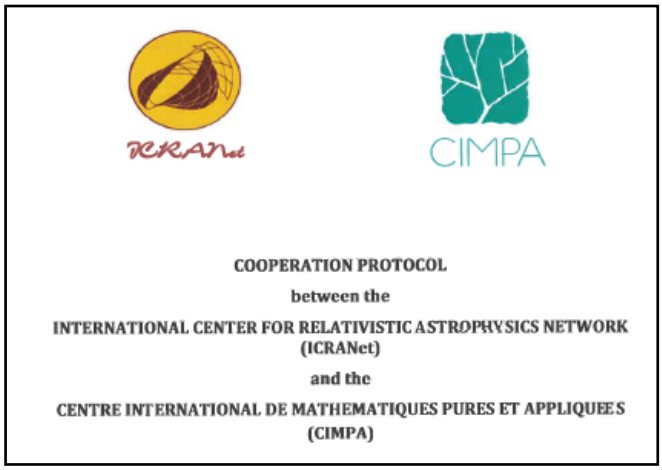


On December 28, 2020 an agreement on scientific cooperation between ICRANet and the University of Science and Technology of China was signed by Prof. Xinhe Bao (President of the USTC) and by Prof. Remo Ruffini (Director of ICRANet). The main joint activities to be developed under the framework of this 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. The agreement will be valid for 5 years.

For the text of the agreement: http://www.icranet.org/index.php?option=com_content&task=view&id=1353

3. New Cooperation Protocol between CIMPA and ICRANet, January 20, 2021



On January 20, 2021 a new Cooperation Protocol between ICRANet and the Centre International de Mathématiques Pures et Appliquées (CIMPA) has been signed by Prof. Barry Green (President of CIMPA), Prof. Christophe Ritzenthaler (Executive Director of CIMPA), Prof. Remo Ruffini (Director of ICRANet) and Prof. Jorge A. Rueda H. (ICRANet Faculty Professor). 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. The agreement will be valid for 5 years.

For the text of the agreement: http://www.icranet.org/index.php?option=com_content&task=view&id=1353

4. *"The solar eclipse and the measurement of the solar diameter"*, online meeting, December 14, 2020

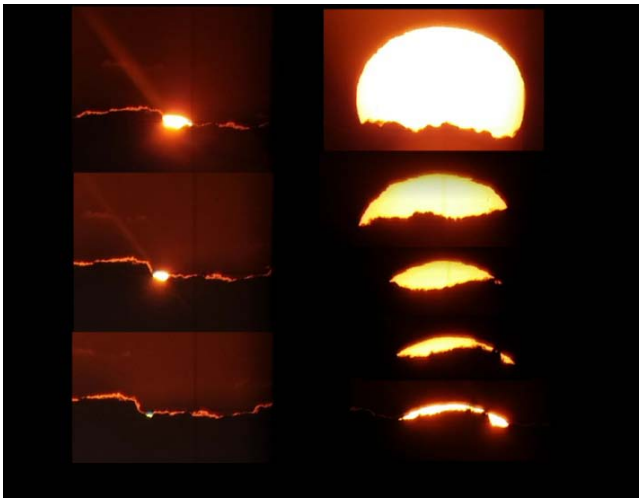


Fig. 6: November 19, 2020, Ostia (Italy) - Blue Baily's bead

The event *"The solar eclipse and the measurement of the solar diameter. Eclipses' hunters from 1500 to present: Cristoforo Clavio, Halley, padre Secchi, Eddington and the actual status of art"* has been held virtually on December 14, 2020. Prof. Costantino Sigismondi, ICRANet collaborator and chair of the event, thanks also to the support of ICRANet and many other scientists from all over the world, organized this virtual meeting as well as a podcast meeting in order to create a nice occasion for discussion among students and researchers.

The virtual meeting started at 4:30 PM on Monday December 14, with the opening remarks

made by Prof. Sigismondi and went on with presentations on *"The eclipse and solar physics in Turin"* by Prof. Alessandro Bemporad (INAF – Astrophysical Observatory in Turin, Italy), on *"The studies on Physics and on the Sun at the University of Rome Tor Vergata"* and on *"The legacy of Angelo Secchi: study on the connection between Sun and Earth"* by Prof. Francesco Berrilli (Department of Physics, University of Rome Tor Vergata - Accademia Nazionale dei Lincei), on *"The diameter of the Sun measured by eclipse observations"* by Prof. Andrea Raponi (INAF IAPS), on the Telescope Copernicus in Cima Ekar (an INFN Telescope of the Astronomical Observatory in Asiago) by Prof. Paolo Ochner and Prof. Armando Sorrenti (University of Padova), on *"Halley"* by Prof. Giuseppe Massara (University La Sapienza of Rome) and on *"Punto nave"* by Prof. Cosimo Palagiano (Accademia Nazionale dei Lincei). Then, Prof. Sigismondi showed and technically explained some live videos of solar eclipses in Argentina, Chile, Egypt and Paraguay. The last part of the event has been dedicated to the concluding remarks by Prof. Remo Ruffini, Director of ICRANet.

This theoretical section was also integrated with the podcast materials prepared by Prof. Sigismondi as well as by Prof. Berilli and Prof. Ramponi, available on the webpage of the meeting.

The program of the event and all the relevant podcast materials, can be found at the following link: http://www.icranet.org/index.php?option=com_content&task=view&id=1348

5. *"Conjunction and Solstice between history and celestial mechanics"*, online meeting, December 21, 2020 and ICRANet press release on that event

The event *"Conjunction and Solstice between history and celestial mechanics. As planetary conjunctions were sources of improved planetary theories"* has been held online on December 21, 2020, on the occasion of the Jupiter and Saturn's great conjunction. This allowed to reason on the hypothesis developed by Kepler on the Star of Bethlehem: in his opinion, the similar conjunction occurred in the year 7/6 b.c. was the cause of the appearance of the Star, it was not a star.

Fig. 7: the Star of Bethlehem in the Church of the Nativity (Bethlem).

Prof. Costantino Sigismondi, ICRANet collaborator and chair of the event, thanks also to the support of ICRANet and many other scientists from all over the world, organized this virtual meeting as well as a podcast meeting in order to create a nice occasion for discussion among students and researchers.

The virtual meeting started at 4:30 PM on Monday December 21, with the opening remarks made by Prof. Sigismondi and went on with presentations on *"Short history and some activity from IOTA/ES"* by Prof. Konrad Guhl (IOTA), on *"Conjunctions and occultation"* by Prof. Paolo Ochner (University of Padova), on *"Kepler and the great conjunction"* by Prof. Anna Maria Lombardi (University of Milan) and on *"Planetary conjunctions, Invariant inequalities and the solar-climate oscillations"* by Prof. Nicola Scafetta (University of Napoli). The concluding remarks have been made by Prof. Rahim Moradi (ICRANet Faculty Professor) on behalf of Prof. Remo Ruffini (Director of ICRANet).

This theoretical session has been also integrated with a lot podcast material prepared by Prof. Sigismondi (on *"Jupiter, Saturn, Uranus and Neptune 1821"*, on the *"Meridian transit in Saint Pieter, Vatican City"*, on *"Jupiter and Mars in 1591"*, on *"Jupiter and Saturn"* both in 1563 and 7/6 b. C. as well as on *"Astronomy in the Gospels: the Star of Bethlehem and the Eclipse on the Good Fridat"*), by Prof. Pascal Descamps (on the *"rapprochements Jupiter-Saturn 7 b.c"*, on the *"rapprochements Jupiter-Saturn in 1562"*, on the *"rapprochements Mars-Jupiter in 1591"* as well as on the *"rapprochements Mars-Saturn in 1604"*). Other materials have been prepared by Prof. Paolo Zanna (on *"The conjunction within us"*), by Prof. Giorgio Rossi (on the *"Conjunction Jupiter-Saturn in 1563"*), by Prof. Marco Di Capua and Prof. Elizabeth Stillwachs - Marina Green, San Francisco, California USA (with some photos of Jupiter and Saturn in San Francisco) as well as by Prof. Enrico Guliani and Prof. Paul Waddington (on the *"Conjunction Jupiter-Saturn"* and on the *"Moon at the winter solstice"*).

The program of the event and all the relevant podcast materials, can be found on the webpage of the meeting: http://www.icranet.org/index.php?option=com_content&task=view&id=1351

Fig. 8: Jupiter and Saturn between the Cicadee, December 15, 2020 (photo by Jorge Ruiz, Paraguay)

Fig 9: the Moon, Jupiter and Saturn from Ostia (Italy), December 18, 2020 (photo by Prof. Costantino Sigismondi)

On that occasion, Prof. Sigismondi and ICRANet staff have also prepared a press release, both in Italian (http://www.icranet.org/index.php?option=com_content&task=view&id=1352) and in English (http://www.icranet.org/documents/pr_ConjunctionSolstice_21122020.pdf).

6. Recent publications

Shakeri, S., Hajkarim, F. & Xue, SS. *Shedding new light on sterile neutrinos from XENON1T experiment,* published in J. High Energ. Phys. 2020, 194 (2020).

The XENON1T collaboration recently reported the excess of events from recoil electrons, possibly giving an insight into new area beyond the Standard Model (SM) of particle physics. We try to explain this excess by considering effective interactions between the sterile neutrinos and the SM particles. In this paper, we present an effective model based on one-particle-irreducible interaction vertices at low energies that are induced from the SM gauge symmetric four-fermion operators at high energies. The effective interaction strength is constrained by the SM precision measurements, astrophysical and cosmological observations. We introduce a novel effective electromagnetic interaction between sterile neutrinos and SM neutrinos, which can successfully explain the XENON1T event rate through inelastic scattering of the sterile neutrino dark matter from Xenon electrons. We find that sterile neutrinos with masses around 90 keV and specific effective coupling can fit well with the XENON1T data where the best fit points preserving DM constraints and possibly describe the anomalies in other experiments.

Link: https://doi.org/10.1007/JHEP12(2020)194

R. Yunis, C. R. Argüelles, N. E. Mavromatos, A. Moliné, A. Krut, M. Carinci, J. A. Rueda, R. Ruffini, *Galactic center constraints on self-interacting sterile neutrinos from fermionic dark matter ("ino") models*, published in Physics of the Dark Universe, Volume 30, article id. 100699 on December 2020.

The neutrino minimal standard model (*ν*MSM) has been tightly constrained in the recent years, either from dark matter (DM) production or from X-ray and small-scale observations. However, current bounds on sterile neutrino DM can be significantly modified when considering a *ν*MSM extension, in which the DM candidates interact via a massive (axial) vector field. In particular, standard production mechanisms in the early Universe can be affected through the decay of such a massive mediator. We perform an indirect detection analysis to study how the *ν*MSM parameter-space constraints are affected by said interactions. We compute the X-ray fluxes considering a DM profile that self-consistently accounts for the particle physics model by using an updated version of the Ruffini–Argüelles–Rueda (RAR) fermionic (“ino”) model, instead of phenomenological profiles such as the Navarro–Frenk–White (NFW) distribution. We show that the RAR profile accounting for interacting DM, is compatible with measurements of the Galaxy rotation curve and constraints on the DM self-interacting cross section from the Bullet cluster. A new analysis of the X-ray NuSTAR data in the central parsec of the Milky Way, is here performed to derive constraints on the self-interacting sterile neutrino parameter-space. Such constraints are stronger than those obtained with commonly used DM profiles, due to the dense DM core characteristic of the RAR profiles.

Link: https://www.sciencedirect.com/science/article/abs/pii/S221268641930370X?via%3Dihub

Link nasa-ads: https://ui.adsabs.harvard.edu/abs/2020PDU....3000699Y/abstract

J. D. Uribe, E. A. Becerra-Vergara, J. A. Rueda, *Neutrino Oscillations in Neutrino-Dominated Accretion Around Rotating Black Holes*, published in Universe, vol. 7, issue 1, p. 7 on January 2021.

In the binary-driven hypernova model of long gamma-ray bursts, a carbon–oxygen star explodes as a supernova in the presence of a neutron star binary companion in close orbit. Hypercritical (i.e.,

highly super-Eddington) accretion of the ejecta matter onto the neutron star sets in, making it reach the critical mass with consequent formation of a Kerr black hole. We have recently shown that, during the accretion process onto the neutron star, fast neutrino flavor oscillations occur. Numerical simulations of the above system show that a part of the ejecta stays bound to the newborn Kerr black hole, leading to a new process of hypercritical accretion. We address herein, also for this phase of the binary-driven hypernova, the occurrence of neutrino flavor oscillations given the extreme conditions of high density (up to 10^{12} g cm^{-3}) and temperatures (up to tens of MeV) inside this disk. We estimate the behavior of the electronic and non-electronic neutrino content within the two-flavor formalism ($\nu_e \nu_x$) under the action of neutrino collective effects by neutrino self-interactions. We find that in the case of inverted mass hierarchy, neutrino oscillations inside the disk have frequencies between $\sim(10^5–10^9)$ s^{-1}, leading the disk to achieve flavor equipartition. This implies that the energy deposition rate by neutrino annihilation ($\nu+\bar{\nu} \rightarrow e^- + e^+$) in the vicinity of the Kerr black hole is smaller than previous estimates in the literature not accounting for flavor oscillations inside the disk. The exact value of the reduction factor depends on the ν_e and ν_x optical depths but it can be as high as ∼5. The results of this work are a first step toward the analysis of neutrino oscillations in a novel astrophysical context, and as such, deserve further attention.

Link: https://www.mdpi.com/2218-1997/7/1/7

Link nasa-ads: https://ui.adsabs.harvard.edu/abs/2021Univ....7....7U/abstract

Sahakyan, N.; Giommi, P., *The strange case of the transient HBL blazar 4FGL J1544.3-0649*, published in Monthly Notices of the Royal Astronomical Society, 202, stab011.

We present a multifrequency study of the transient γ-ray source 4FGL J1544.3-0649, a blazar that exhibited a remarkable behavior raising from the state of an anonymous mid-intensity radio source, never detected at high energies, to that of one of the brightest extreme blazars in the X-ray and γ-ray sky. Our analysis shows that the averaged γ-ray spectrum is well described by a powerlaw with a photon index of 1.87 ± 0.04, while the flux above 100 MeV is (8.0 ± 0.9) × 10^{-9} photon cm^{-2} s^{-1}, which increases during the active state of the source. The X-ray flux and spectral slope are both highly variable, with the highest 2-10 keV flux reaching (1.28 ± 0.05) × 10^{-10} erg cm^{-2} s^{-1}. On several observations the X-ray spectrum hardened to the point implying as SED peak moving to energies larger than 10 keV. As in many extreme blazars the broadband spectral energy distribution can be described by a homogeneous one-zone synchrotron-self-Compton leptonic model. We briefly discuss the potential implications for high-energy multi-messenger astrophysics in case the dual behavior shown by 4FGL J1544.3-0649 does not represent an isolated case, but rather a manifestation of a so far unnoticed relatively common phenomenon.

DOI: https://doi.org/10.1093/mnras/stab011

Link: https://ui.adsabs.harvard.edu/abs/2021MNRAS.tmp...56S/abstract

Acciari, V. A.; Ansoldi, S.; Antonelli, L. A..... Sahakyan, N., et al., *Multiwavelength variability and correlation studies of Mrk 421 during historically low X-ray and γ-ray activity in 2015-2016*, published in Monthly Notices of the Royal Astronomical Society, 2020, staa3727.

We report a characterization of the multi-band flux variability and correlations of the nearby (z=0.031) blazar Markarian 421 (Mrk 421) using data from Metsähovi, Swift, Fermi-LAT, MAGIC, FACT and other collaborations and instruments from November 2014 till June 2016. Mrk 421 did not show any prominent flaring activity, but exhibited periods of historically low activity above 1 TeV ($F_{>1TeV}$ < 1.7× 10^{-12} ph cm^{-2} s^{-1}) and in the 2-10 keV (X-ray) band ($F_{2-10\,keV}$ < 3.6 × 10^{-11} erg

cm^{-2} s^{-1}), during which the Swift-BAT data suggests an additional spectral component beyond the regular synchrotron emission. The highest flux variability occurs in X-rays and very-high-energy (E>0.1 TeV) γ-rays, which, despite the low activity, show a significant positive correlation with no time lag. The HR_{keV} and HR_{TeV} show the harder-when-brighter trend observed in many blazars, but the trend flattens at the highest fluxes, which suggests a change in the processes dominating the blazar variability. Enlarging our data set with data from years 2007 to 2014, we measured a positive correlation between the optical and the GeV emission over a range of about 60 days centered at time lag zero, and a positive correlation between the optical/GeV and the radio emission over a range of about 60 days centered at a time lag of 43^{+9}_{-6} days. This observation is consistent with the radio-bright zone being located about 0.2 parsec downstream from the optical/GeV emission regions of the jet. The flux distributions are better described with a LogNormal function in most of the energy bands probed, indicating that the variability in Mrk 421 is likely produced by a multiplicative process.
DOI: https://doi.org/10.1093/mnras/staa3727

Link: https://ui.adsabs.harvard.edu/abs/2020MNRAS.tmp.3563A/abstract

ICRANet Newsletter

February – March 2021

SUMMARY

1. Astronomers get their First Look at the Dynamics of the Base of a Relativistic Jet

Synopsis of the Astrophysical Journal paper “Observing the Time Evolution of the Multi-Component Nucleus of 3C84” by Brian Punsly, Hiroshi Nagai, Tuomas Savolainen and Monica Orienti

Relativistic astrophysical jets are some of the most energetic objects in the Universe. They are driven by compact objects, primarily black holes. The jets from the supermassive black holes can have powers $>10^{40}$ Watts and last for a million years. They are intense pencil beams of energy that terminate in enormous plume or lobe, an order of magnitude larger than the largest galaxies. The bases of the jets, where the jets originate, are too small to be within the reach of modern telescopes. Thus, the Event Horizon Telescope (EHT) that can image the base of the jet in the nearby galaxy, M87. The observations are so difficult, that we are lucky to have one successful observation every few years. Thus, one cannot track the dynamics of the base of the jet over time scales of weeks to a year when all the significant changes occur.

Consequently, a team of astronomers looked to the nearby extragalactic radio source 3C84 that is much brighter than M87 to glimpse the dynamics of a jet near its source for the first time. They were able to use a high efficiency global network of telescopes, the Very Long Baseline Array, that is operated by National Radio Astronomy Observatory. This telescope can efficiently observe on a regular basis, but with a resolution of only 25% of EHT. The fact that 3C84 is the brightest extragalactic object in the sky at the observed frequency allows for very high signal to noise and the use of novel high resolution data reduction schemes invented for this purpose. ICRANet astrophysicist, Brian Punsly, patiently waited throughmany years of monthly monitoring until the base of the of the southerly directed jet started to evolve. Over twenty months, the central engine ejected a high energy plasma source to the east not the south – perpendicular to the pencil beam jet! Not only that it moved at only 9% of the speed of light, very slow by relativistic standards. Now that we can see the base of the jets, we can intelligently describe their genesis in the future.

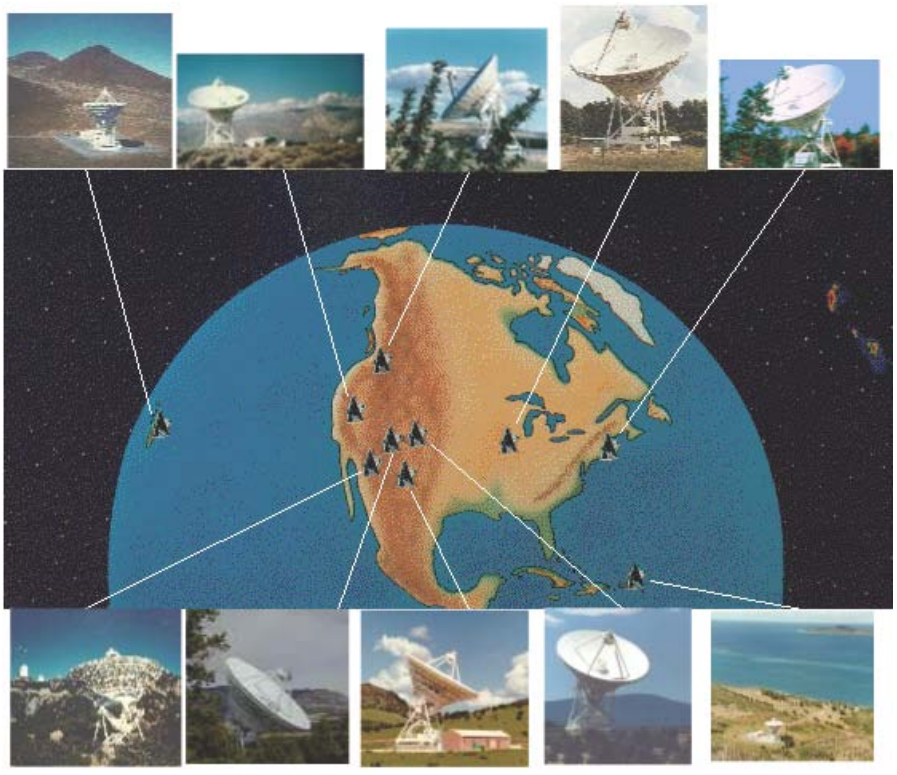


Fig. 1: This frame shows the VLBA.

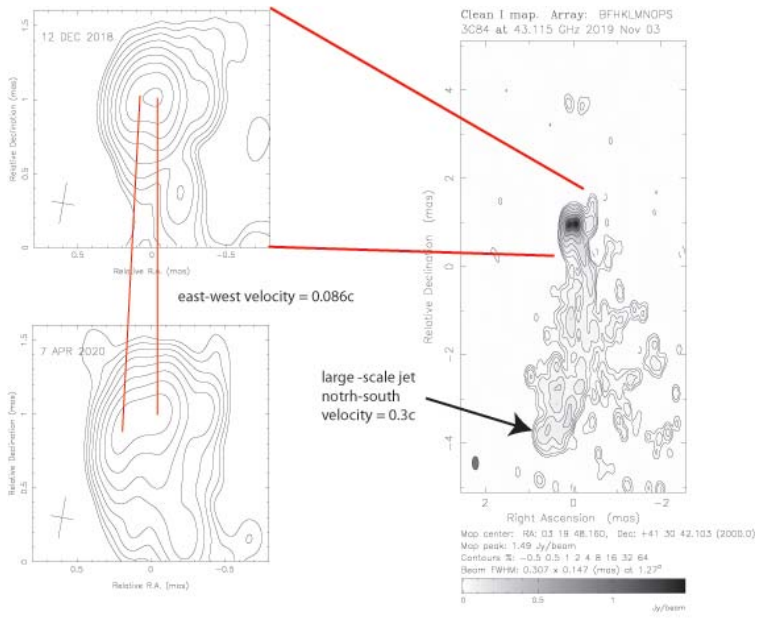


Fig. 2: This frame shows the east-west motion of the nucleus on the left contrasted with the north-south jet on the right.

Brian Mathew Punsly from Mathew California University, Los Angeles USA is a member of ICRANet Faculty Staff.

Link to the article: https://arxiv.org/abs/2102.07272

2. The Sixteenth Marcel Grossmann virtual Meeting (MG16), July 5–9, 2021

The Sixteenth Marcel Grossmann Meeting on Recent Developments in Theoretical and Experimental General Relativity, Astrophysics and Relativistic Field Theories (MG16) will take place virtually from Monday July 5 through Friday July 9, 2021.

It is organized by ICRA (Rome, Italy), ICRANet (Pescara, Italy) and the associated ICRANet centers including Yerevan, Armenia; Minsk, Belarus; Rio de Janeiro, Brazil; USTC, China; Isfahan, Iran; Stanford University and the University of Arizona, USA.

During this five days online conference, a variety of topics will be discussed in the plenary and parallel sessions. Each day of the meeting there will be three program blocks of three hours each: one plenary session and two parallel sessions in revolving order to address the three major continental time zones:

Central European Summer Time:

Block 1: 6:30-9:30
Block 2: 9:30-12:30
Block 3: 16:30-19:30

The first plenary session will start at 9:30 on Monday, the second one will start at 16:30 on Tuesday, the third one at 6:30 on Wednesday and so on. Recordings of plenary session will be available next day on YouTube. Each block will have 10 sessions running in parallel, each session will have 9 talks.

The MG16 website is http://www.icra.it/mg/mg16. All the information about the plenary and parallel session programs, the registration and the abstract submission are available on the Indico platform at the

following link: https://indico.icranet.org/event/1/. If you want to join the conference, please register both at our Indico website and at the MG16 conference at your earliest convenience:

Register at Indico website: https://indico.icranet.org/register/
Register at the MG16 meeting: https://indico.icranet.org/event/1/registrations/

Once you register, you will be in our database and you will receive further communications about the MG16 meeting.

The timeline is:
* March 15, 2021: registration opening
* April 15, 2021: abstract submission opening
* May 15, 2021: registration closure
* June 15, 2021: abstract submission closure

The registration fee will be:
* Regular fee: 150 Euros (up to April 1) - postponed to April 15
* Late fee: 250 Euros (after April 15)
* Reduced fee: 50 Euros (applied to students, retired scientists and auditors up to April 1) - postponed to April 15
* Late Reduced fee: 80 Euros (applied to students, retired scientists and auditors after April 15)

For any query, please contact mg16[AT]icranet.org

3. Inauguration of the ICRANet Mazandaran center, February 28, 2021

It is or pleasure to announce that on Saturday February 28, 2021, the ICRANet Center at the University of Mazandaran – UMZ (Iran) has been inaugurated. This is the second ICRANet center in Iran. The inauguration ceremony was attended by Dr. Kourosh Nozari, Professor of physics and President of the University of Mazandaran, and by Dr. Behzad Eslampanah, Professor of physics at the University of Mazandaran.

During a meeting held at the Office of International and Scientific Cooperation (OISC), President Nozari, a distinguished Iranian physicist, reiterated the importance of ICRANet and described it as an important research center which can play a pivotal role in enhancing physics research in the University of Mazandaran and, indeed, in Iran. He also welcomed any sort of academic collaboration between ICRANet and the UMZ and said that the center is ready to further strengthen the bilateral collaboration with ICRANet.



Fig. 1,2 and 3: The inauguration ceremony of the ICRANet center at the University of Mazandaran (Iran), February 28, 2021

For the press release (in English) please see the University of Mazandaran official website: http://en.int.umz.ac.ir/index.aspx?siteid=122&fkeyid=&siteid=122&pageid=13816&newsview=26386

4. New Cooperation Protocol ICRA-ICRANet-Alzahra University, February 9, 2021

On February 9, 2021 an agreement on scientific cooperation between ICRA, ICRANet and Alzahra University (Iran) was signed by Dr. Mahnaz Molanazari (Chancellor of Alzahra University), Prof. Mohammad Taghi Mirtorabi (Associate Professor, Physics and Chemistry Department of Alzahra University), by Prof. Remo Ruffini (Director of ICRANet) and by Prof. Jorge A. Rueda (ICRANet Faculty Professor). 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, the development of inter-institutional research areas associated to local graduate programs and joint publications. The agreement will be valid for 5 years.

For the text of the agreement (both in English and Persian) please see:
http://www.icranet.org/index.php?option=com_content&task=view&id=1360

5. Renewal of 3 ICRANet Cooperation Agreements in Iran

Renewal of the Cooperation Protocol ICRANet - Isfahan University of Technology (IUT), February 26, 2021

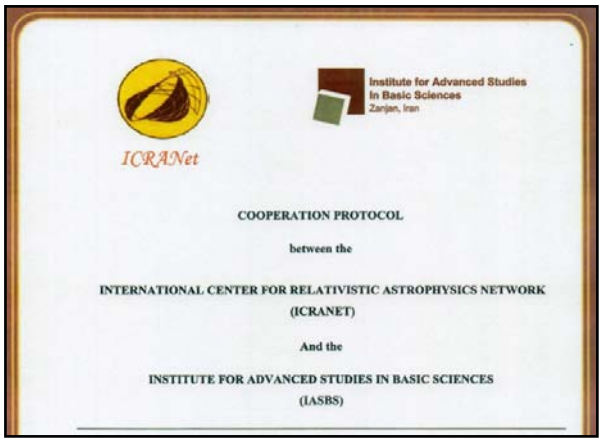
On February 26, 2021 the Cooperation Protocol between ICRANet and Isfahan University of Technology – IUT (Iran) has been renewed. The renewal has been signed by Prof. Sayyed Mahdi Abtahi (President of IUT) and by Prof. Remo Ruffini (Director of ICRANet). This agreement will be valid for further 5 years and the main joint activities to be developed under its framework 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,

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/index.php?option=com_content&task=view&id=1059

For the IUT newsletter on this issue (in English) see:
https://internationalnews.iut.ac.ir/book_treasure.php?mod=viewbook&book_id=31&slc_lang=en&sid=1

Renewal of the Cooperation Protocol ICRANet - Institute for Advanced Studies in Basic Sciences (IASBS), March 1, 2021



On March 1, 2021 the Cooperation Protocol between ICRANet and Institute for Advanced Studies in Basic Sciences - IASBS (Iran) has been renewed. The renewal has been signed by Prof. Babak Karimi (President of IASBS) and by Prof. Remo Ruffini (Director of ICRANet). This agreement will be valid for further 5 years and the main joint activities to be developed under its framework 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, the development of inter-institutional research areas associated to local graduate programs and joint publications.

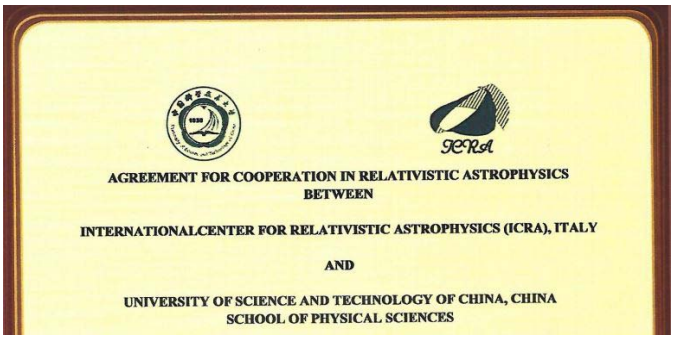
For the text of the agreement see: http://www.icranet.org/index.php?option=com_content&task=view&id=1058

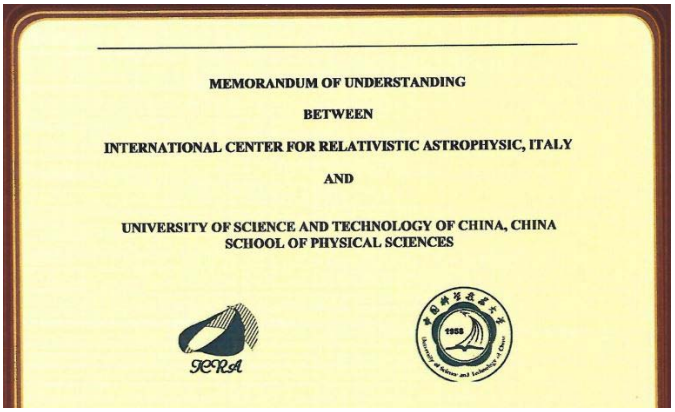
Renewal of the Agreement ICRANet - Shiraz University, March 5, 2021

On March 5, 2021 the Cooperation Agreement between ICRANet and Shiraz University (Iran) has been renewed. The renewal has been signed by Prof. Dr. Hamid Nadgaran (Chancellor of Shiraz University) and by Prof. Remo Ruffini (Director of ICRANet). This agreement will be valid for further 5 years and the main joint activities to be developed under its framework 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, 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/index.php?option=com_content&task=view&id=1062

6. New Memorandum of Understanding and Agreement for cooperation in Relativistic Astrophysics ICRA – University of Sciences and Technology of China (USTC), March 16, 2021


AGREEMENT FOR COOPERATION IN RELATIVISTIC ASTROPHYSICS
BETWEEN
INTERNATIONALCENTER FOR RELATIVISTIC ASTROPHYSICS (ICRA), ITALY
AND
UNIVERSITY OF SCIENCE AND TECHNOLOGY OF CHINA, CHINA
SCHOOL OF PHYSICAL SCIENCES


MEMORANDUM OF UNDERSTANDING
BETWEEN
INTERNATIONAL CENTER FOR RELATIVISTIC ASTROPHYSIC, ITALY
AND
UNIVERSITY OF SCIENCE AND TECHNOLOGY OF CHINA, CHINA
SCHOOL OF PHYSICAL SCIENCES

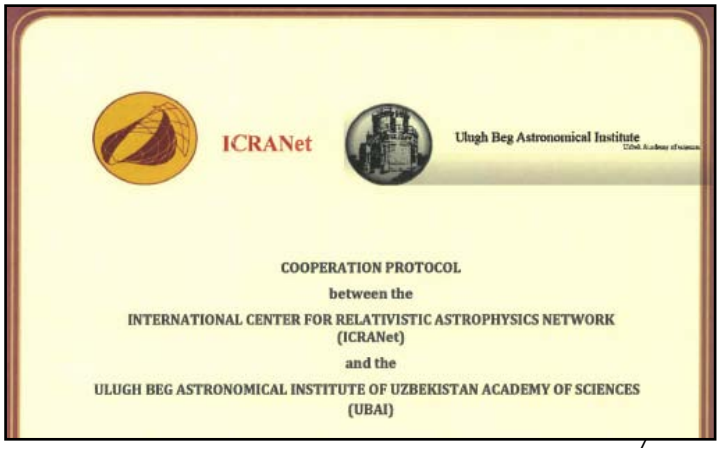
On March 16, 2021 ICRA (International Center for Relativistic Astrophysics) has signed both a Memorandum of Understanding and an Agreement for cooperation in Relativistic Astrophysics with the University of Sciences and Technology of China (USTC). Both the documents have been signed by Prof. Yuao Chen (Dean of the School of Physical Sciences) and by Prof. Remo Ruffini (President of ICRA and Director of ICRANet).

The mission of both the Agreement for cooperation in Relativistic Astrophysics and the MoU will be to cooperate in research and education in the field of Relativistic Astrophysics. The ways in which collaboration in these fields may be realized include the exchange and visit of faculty/staff Professors as well as the implementation of joint education and research programs. Both parties agree to collaborate on graduate education in the field of Relativistic Astrophysics and each party can nominate up to five students annually as program candidates: those students should gain the required degree qualification and skill training in USTC first, and then screened out to come to ICRA for joint project R&D with attendance of the relevant lectures, if necessary. Both those joint documents will be valid for 5 years.

For the text of the Agreement for cooperation in Relativistic Astrophysics see: http://www.icranet.org/documents/agreementICRA-USTC.pdf

For the text of the Memorandum of Understanding see: http://www.icranet.org/documents/mouICRA-USTC.pdf

7. Cooperation Protocol ICRANet - Ulugh Beg Astronomical Institute of Uzbekistan Academy of Sciences (UBAI), March 26, 2021



On March 26, 2021 a Cooperation Protocol between ICRANet and the Ulugh Beg Astronomical Institute of Uzbekistan Academy of Sciences (UBAI) was signed. The document has been signed by Prof. Shuhrat Ehgamberdiev (Director of UBAI), by Prof. Bobomurat Ahmedov (UBAI), by Prof. Remo Ruffini (Director of ICRANet) and by Prof. Jorge A. Rueda (ICRANet Faculty Professor). 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, the development of inter-institutional research areas associated to local graduate programs and joint publications. The agreement will be valid for 5 years.

For the text of the agreement see: http://www.icranet.org/index.php?option=com_content&task=view&id=1362

8. 43° COSPAR Scientific Assembly meeting (online), January 28-February 4, 2021

The 43° COSPAR Scientific Assembly meeting has been held virtually from January 28 to February 4, 2021. On February 3, Prof. Ruffini, Director of ICRANet, gave a lecture titled *"On the energy extraction from a Kerr Black Hole by Blackholic quanta in GRBs and AGNs"*.

Here is the abstract: *Almost fifty years after the paper "Introducing the Black Hole" by Ruffini and Wheeler and the Black Hole (BH) mass energy formula by Christodoulou, Ruffini and Hawking, we can finally assert that we have been observing the moment of creation of a BH in the BdHN I in GRB 190114C, GRB 130427A, GRB 160509A and GRB 160625B, with the corresponding rotational energy extraction process. The first appearance of the Supernova, the SN-rise, triggering the BdHN has been identified. The hypercritical accretion on the SN ejecta on the new NS (vNS) created in the SN, is shown to originate the X-ray afterglow observed by the NASA Niels-Gehrels SWIFT satellite (SWIFT). The hypercritical accretion of the SN on the NS binary companion in the BdHN I model leads to the formation of the newly formed BH. The onset of the GeV radiation coinciding with the BH formation has revealed self similar structures in the time resolved spectral analysis of all sources. Consequently, we find evidence for quantized-discrete-emissions in all sources, with energy quanta of 10^{37} ergs with repetition time of 10^{-14} sec. GRBs are the most complex systems ever successfully analyzed in Physics and Astrophysics, and they may well have a role in the appearance of life in the Cosmos. The corresponding analysis for Active Galactic Nuclei (AGN), scaling simply by the Black Hole mass, will be illustrated. These results have been made possible by a long-lasting theoretical activity, a comprehensive unprecedented high quality data analysis, an observational multi-messenger effort by the astronomical, the physical and the space research communities. This observational effort is well epitomized by the original Vela Satellites, the NASA Compton space mission (CGRO), the Italo-Dutch Beppo SAX satellite, the Russian Konus Wind Satellite, the SWIFT satellite, the Italian AGILE satellite, the NASA FERMI mission and most recently the Chinese satellite HXMT. These space missions have been assisted by radio and optical equally outstanding observational facilities from the ground.*

Link to Prof. Ruffini presentation on YouTube: https://youtu.be/vT-msfF4E7s

9. Prof. Ruffini seminar for Space Science at Drop tower , ZARM Bremen (Germany), March 8, 2021

On March 8, 2021, Prof. Ruffini, Director of ICRANet, has been invited by Prof. Claus Laemmerzahl to give an online seminar at the ZARM Centrum in Bremen (Germany). This seminar has been inserted in the series of the "Space Science at the Drop Tower seminars" regularly held in the month of march in

Bremen. Prof. Ruffini presented a talk titled *"Discovery of energy extraction from a Kerr Black Hole by discrete "Blackholic" quanta in GRBs and AGNs"*.

Here is the abstract: *Almost fifty years after the paper "Introducing the Black Hole" by Ruffini and Wheeler and the Black Hole (BH) mass energy formula by Christodoulou, Ruffini and Hawking, we can finally assert that we have been observing the moment of creation of a BH in the BdHN I in GRB 190114C, GRB 130427A, GRB 160509A and GRB 160625B, with the corresponding rotational energy extraction process. The first appearance of the Supernova, the SN-rise, triggering the BdHN has been identified. The hypercritical accretion on the SN ejecta on the new NS (vNS) created in the SN, is shown to originate the X-ray afterglow observed by the NASA Niels-Gehrels SWIFT satellite (SWIFT). The hypercritical accretion of the SN on the NS binary companion in the BdHN I model leads to the formation of the newly formed BH. The onset of the GeV radiation coinciding with the BH formation has revealed self similar structures in the time resolved spectral analysis of all sources. Consequently, we find evidence for quantized-discrete-emissions in all sources, with energy quanta of 10^{37} ergs with repetition time of 10^{-14} sec. GRBs are the most complex systems ever successfully analyzed in Physics and Astrophysics, and they may well have a role in the appearance of life in the Cosmos. The corresponding analysis for Active Galactic Nuclei (AGN), scaling simply by the Black Hole mass, will be illustrated. These results have been made possible by a long-lasting theoretical activity, a comprehensive unprecedented high quality data analysis, an observational multi-messenger effort by the astronomical, the physical and the space research communities. This observational effort is well epitomized by the original Vela Satellites, the NASA Compton space mission (CGRO), the Italo-Dutch Beppo SAX satellite, the Russian Konus Wind Satellite, the SWIFT satellite, the Italian AGILE satellite, the NASA FERMI mission and most recently the Chinese satellite HXMT. These space missions have been assisted by radio and optical equally outstanding observational facilities from the ground.*

Link to Prof. Ruffini presentation on YouTube: https://youtu.be/ekYHvNbhv_g

10.Rencontres de Moriond on Gravitation (poster session), March 9-11, 2021

The meeting "Rencontres de Moriond on Gravitation" has been held virtually from March 9 to 11, 2021 through poster presentations from the participants. On Wednesday March 10, Prof. Ruffini, Director of ICRANet, presented a poster titled "Morphology of the X-ray afterglows and of the jetted GeV emission in long GRBs", while Prof. Simonetta Filippi, ICRANet collaborator presented a poster titled "Inferences of GRB 190114C for the Crab pulsar and the supernova remnant".

Here is the abstract of Prof. Ruffini poster: *We recall evidence that all short and long gamma-ray bursts (GRBs) have binary progenitors and give new detailed examples. We focus on the binary progenitors of long GRBs, the binary-driven hypernovae (BdHNe), that consist of a carbon-oxygen core (CO core) and a binary neutron star (NS) companion. For binary periods of the order of 5 min, the energetic subclass BdHN I originates when the CO core collapses. They are characterized by: 1) an outstanding energetic supernova (the "SN-rise"); 2) a newborn black hole (BH) originating from the SN hypercritical accretion onto the NS companion. Only in some cases, the newborn BH via the "inner engine"' mechanism, is observed to lead to GeV emission characterized by an isotropic power-law luminosity $L_{GeV} = A_{GeV}*t^{(-a)}$. 3) The new NS (vNS), created at the SN center, accretes matter from the SN ejecta originating the X-ray afterglow with $L_X = A_X*t^{(-\alpha)}$, always present in all BdHN I. We analyze 378 BdHN I and, among them, select four prototypes: GRB 130427A, GRB 160509A, GRB 180720B and GRB 190114C using a time-resolved spectral analysis and derive 1) the spectra, the luminosities and the duration of the SN-rise; 2) the amplitude A_X, the power-law index $\alpha_X=1.48\pm0.32$ of their X-ray afterglows, 3) the time-evolution of the vNS spin, and 4) A_{GeV} and $\alpha_{GeV}=1.19\pm0.04$. From the latter, we infer for the first time the mass and spin of the BH powering long GRBs. We also deduce that there is a special morphology which explains why the GeV emission is present only in some BdHN I, and it is confirmded by dedicated three-dimensional smoothed-particle-hydrodynamics simulations of BdHN I.*

We conclude that the GeV radiation is observed only when emitted within a cone of half-opening angle of nealry 60 degrees from the normal to the orbital plane. The mass and spin of the Kerr BHs are obtained based upon the GRB "inner engine" originating the GeV emission by extracting the BH rotational energy. We obtain initial BH masses $2.3<M/M_{Sun}<8.9$ and spins $0.27<a/M<0.87$, and from their time evolution, we verify, for the first time, the validity of the BH mass-energy formula.

Here is the abstract of Prof. Filippi poster: *The understanding of binary-driven hypernovae of type I (BdHNe I) has identified the central role of the explosion of the supernova ("SN-rise") as well as of the role of the hypercritical accretion of the SN ejecta onto the binary companion neutron star (NS) and onto the newborn NS (vNS) in determining the GRB dynamics. We model the vNS through the equilibrium sequence of Maclaurin spheroids. By requiring that the vNS period extrapolated on 1000 yr coincides with the one of PSR B0531 + 21 (the Crab pulsar), we determine the initial spin of the vNS to be 0.9 ms, and follow the subsequent rotational and gravitational evolution of the eccentricity. The observed changes in the braking index are proposed to be correlated to pulsar glitches, whose intensities are predicted to be strongly correlated with the pulsar spin. We propose that the progenitor of the Crab nebula and of the Crab pulsar is a GRB very similar to GRB 190114C.*

11. New results on the AXP 4U 01242+61 out of collaboration of ICRANet and ITA

Sarah Villanova Borges, a student of Prof. Manuel Malheiro graduated in 2017 at ITA, and a received a master degree under Dr. Claudia Rodrigues at INPE in 2018 published an important article on the AXP 4U 01242+61 explaining all the light curve (in particular the hard x-ray spectrum) of this source using a Hot and massive White Dwarf model in the "The Astrophysical Journal" last year. This work, the modeling and calculations and, the article writing was all done by Sarah, who participated previously in the MGXV meeting with the oral talk on earlier results on this topic.

Now Sarah is accepted for a PhD program in the Department of Physics and Astronomy at the University of Wisconsin Milwaukee with a scholarship.

These results are presented at the AAS channel on YouTube: https://www.youtube.com/watch?v=JPqG7-ifE_k&t=1s

The link to the ApJ article: https://iopscience.iop.org/article/10.3847/1538-4357/ab8add

12.Recent publications

Behzad Eslam Panah, *Can the power Maxwell nonlinear electrodynamics theory remove the singularity of electric field of point-like charges at their locations?*, accepted for publication in Europhysics Letters (EPL).

YES! We introduce a variable power Maxwell nonlinear electrodynamics theory which can remove the singularity of electric field of point-like charges at their locations. One of the main problems of Maxwell's electromagnetic field theory is related to the existence of singularity for electric field of point-like charges at their locations. In other words, the electric field of a point-like charge diverges at the charge location which leads to an infinite self-energy. In order to remove this singularity a few nonlinear electrodynamics (NED) theories have been introduced. Born-Infeld (BI) NED theory is one of the most famous of them. However the power Maxwell (PM) NED cannot remove this singularity. In this paper, we show that the PM NED theory can remove this singularity, when the power of PM NED is less than $s<1/2$.

Link ArXiv: https://arxiv.org/abs/2103.08343

Bing Zhang, Yu Wang and Liang Li, *Dissecting the Energy Budget of a Gamma-Ray Burst Fireball*, published in ApJL on March 1, 2021, Volume 909, number L3.

The jet composition and radiative efficiency of gamma-ray bursts (GRBs) are poorly constrained from the data. If the jet composition is matter-dominated (i.e., a fireball), the GRB prompt emission spectra would include a dominant thermal component originating from the fireball photosphere and a nonthermal component presumably originating from internal shocks whose radii are greater than the photosphere radius. We propose a method to directly dissect the GRB fireball energy budget into three components and measure their values by combining the prompt emission and early afterglow data. The measured parameters include the initial dimensionless specific enthalpy density (η), bulk Lorentz factors at the photosphere radius ($\Gamma_{\rm ph}$) and before fireball deceleration (Γ_0), the amount of mass loading (M), and the GRB radiative efficiency ($\eta\gamma$). All the parameters can be derived from the data for a GRB with a dominant thermal spectral component, a deceleration bump feature in the early afterglow lightcurve, and a measured redshift. The results only weakly depend on the density n of the interstellar medium when the composition $\mathcal{Y}$ parameter (typically unity) is specified.

DOI: https://doi.org/10.3847/2041-8213/abe6ab

Liang Li and Bing Zhang, *Testing the High-latitude Curvature Effect of Gamma-Ray Bursts with Fermi Data: Evidence of Bulk Acceleration in Prompt Emission*, published in ApJS on March 23, 2021, Volume 253, number 43.

When a gamma-ray burst (GRB) emitter stops emission abruptly, the observer receives rapidly fading emission from high latitudes with respect to the line of sight, known as the "curvature effect." Identifying such emission from GRB prompt-emission lightcurves would constrain the radius of prompt emission from the central engine and the composition of GRB jets. We perform a dedicated search of high-latitude emission (HLE) through spectral and temporal analyses of a sample of single-pulse bursts detected by the Gamma-ray Burst Monitor on board the Fermi satellite. We identify HLE from a subsample of bursts and constrain the emission radius to be $R_{\rm GRB} \sim (10^{15}–10^{16})$ cm from the central engine. Some bursts have the HLE decay faster than predicted by a constant Lorentz factor jet, suggesting that the emission region is undergoing acceleration during prompt emission. This supports the Poynting-flux-dominated jet composition for these bursts. The conclusion is consistent with previous results drawn from spectral-lag modeling of prompt emission and HLE analysis of X-ray flares.

DOI: https://doi.org/10.3847/1538-4365/abded1

Liang Li, Felix Ryde, Asaf Pe'er, Hoi-Fung Yu, and Zeynep Acuner, *Bayesian Time-Resolved Spectroscopy of Multi-Pulsed GRBs: Variations of Emission Properties amongst Pulses*, in press on ApJS 2021.

Gamma-ray bursts (GRBs) are highly variable and exhibit strong spectral evolution. In particular, the emission properties vary from pulse to pulse in multi-pulsed bursts. Here, we present a time-resolved Bayesian spectral analysis of a compilation of GRB pulses observed by the {\it Fermi}/Gamma-ray Burst Monitor (GBM). The pulses are selected to have at least four time-bins with a high statistical significance, which ensures that the spectral fits are well determined and that spectral correlations can be established. The sample consists of 39 bursts, 117 pulses, and 1228 spectra. We confirm the general trend that pulses become softer over time, with mainly the low-energy power-law index α becoming smaller. A few exceptions from this trend exist with the hardest pulse occurring at late times. The first pulse in a burst is clearly different from the later pulses: 3/4 of them violate the synchrotron line-of-death \citep{Preece1998}, while around half of them significantly prefer photospheric emission. These fractions decrease for subsequent pulses. We also find that in 2/3 of the pulses the spectral parameters (α and peak energy) track the light-curve variations. This is a larger fraction compared to what is found

in previous samples. In conclusion, emission compatible with the GRB photosphere is typically found close to the trigger time, while the chance of detecting synchrotron emission is greatest at late times. This allows for coexistence of emission mechanisms at late times.

Link: https://arxiv.org/abs/2012.03038

MAGIC collaboration, *MAGIC Observations of the Nearby Short Gamma-Ray Burst GRB 160821B*, published on February 16, 2021 on ApJ, Volume 908, number 1.

The coincident detection of GW170817 in gravitational waves and electromagnetic radiation spanning the radio to MeV gamma-ray bands provided the first direct evidence that short gamma-ray bursts (GRBs) can originate from binary neutron star (BNS) mergers. On the other hand, the properties of short GRBs in high-energy gamma-rays are still poorly constrained, with only ∼20 events detected in the GeV band, and none in the TeV band. GRB 160821B is one of the nearest short GRBs known at z = 0.162. Recent analyses of the multiwavelength observational data of its afterglow emission revealed an optical-infrared kilonova component, characteristic of heavy-element nucleosynthesis in a BNS merger. Aiming to better clarify the nature of short GRBs, this burst was automatically followed up with the MAGIC telescopes, starting from 24 s after the burst trigger. Evidence of a gamma-ray signal is found above ∼0.5 TeV at a significance of ∼ 3σ during observations that lasted until 4 hr after the burst. Assuming that the observed excess events correspond to gamma-ray emission from GRB 160821B, in conjunction with data at other wavelengths, we investigate its origin in the framework of GRB afterglow models. The simplest interpretation with one-zone models of synchrotron-self-Compton emission from the external forward shock has difficulty accounting for the putative TeV flux. Alternative scenarios are discussed where the TeV emission can be relatively enhanced. The role of future GeV-TeV observations of short GRBs in advancing our understanding of BNS mergers and related topics is briefly addressed.

DOI: https://doi.org/10.3847/1538-4357/abd249

Alessandro Loppini, Alessandro Barone, Alessio Gizzi, Christian Cherubini, Flavio H. Fenton, and Simonetta Filippi, *Thermal effects on cardiac alternans onset and development: A spatiotemporal correlation analysis*, accepted for publication in Physical Review E on March 9, 2021.

Alternans of cardiac action potential duration represent critical precursors for the development of life-threatening arrhythmias and sudden cardiac death. The system's thermal state affects these electrical disorders requiring additional theoretical and experimental effort to improve a patient-specific clinical understanding. In such a scenario, we generalize a recent work from {Loppini et al. 100 :020201 (2019)} by performing an extended spatiotemporal correlation study. We consider high-resolution optical mapping recordings of canine ventricular wedges' electrical activity at different temperatures and pacing frequencies. We aim to recommend the extracted characteristic length as a potential predictive index of cardiac alternans onset and evolution within a wide range of system states. In particular, we show that a reduction of temperature results in a drop of the characteristic length, confirming the impact of thermal instabilities on cardiac dynamics. Moreover, we theoretically investigate the use of such an index to identify and predict different alternans regimes. Finally, we propose a novel constitutive phenomenological law linking conduction velocity, characteristic length, and temperature in view of future numerical investigations.

Link: https://journals.aps.org/pre/accepted/db078R10MbeEb01f012d1f947e5adcb79433e8120

ICRANet Newsletter

April – May 2021

SUMMARY

1. International joint PhD programme in Relativistic Astrophysics USTC-UNIFE with the participation of ICRA and ICRANet, April 28, 2021

It is our pleasure to announce that on April 2021, a cooperation agreement has been signed concerning the establishment of an international joint PhD programme in Relativistic Astrophysics (JIRA PhD) by the University of Sciences and Technology of China (USTC) and the University of Ferrara (UNIFE), with the participation of ICRA and ICRANet.

Both USTC and UNIFE have ongoing cooperation agreements with ICRANet; moreover, USTC has also signed 2 agreements with ICRA, aiming at the development of scientific research and academic training at Ph.D. level in the field of Relativistic Astrophysics, with the support of the infrastructures and the scientists of all the institutions with signed cooperation agreements with ICRA and ICRANet. As a result, ICRA and ICRANet will be collaborating with both parties in the framework of this agreement.

The main intent of this programme is to ensure a high level of education and high quality academics research in the field of Relativistic Astrophysics. It is addressed to highly qualified candidates from all the European and non-European nations who meet the admission criteria established by regulations in force at the Partner Institutions. With regard to the mobility of the Ph.D. students, the Parties agree that the curriculum of the Programme will include at least 12 months of research activity at each of the Partner Institutions. The mobility program can take place in one of the ICRANet centers, including institutions with a signed collaboration agreement with ICRANet, when approved by the Joint Coordination Committee, as long as it is located in a country different from the Institution of first enrolment of the doctoral students. In this case, the Joint Coordination Committee will assign a research co-tutor identified among the researchers associated with ICRANet with the appropriate qualification in the field of interest.

More details about this PhD programme will be announced soon.

2. ICRANet scientists received the third Award for the Gravity Research Foundation Award for Essays Competition 2021

The article *"The Quantum Emission of an Alive Black Hole"* by Prof. J. A. Rueda (ICRANet Faculty Professor) and Prof. R. Ruffini (Director of ICRANet) received the Third Award by the Gravity Research Foundation (www.gravityresearchfoundation.org) in the 2021 Essay Competition. A long fifty-years march of successive theoretical progress and new physics discovered using observations of gamma-ray bursts, has finally led to the formulation of an efficient mechanism able to extract the rotational energy of a Kerr black hole to power these most energetic astrophysical sources and active galactic nuclei. We here present the salient features of this long-sought mechanism, based on gravito-electrodynamics, and which represents an authentic shift of paradigm of black holes as forever "alive" astrophysical objects.

The five award-winning essays of 2021 competition will be also posted on Gravity Research Foundation web site and will be published in the October 2021 SPECIAL ISSUE of the International Journal of Modern Physics D (IJMPD).

The paper can be downloaded here: https://arxiv.org/abs/2105.07890

For details see:

https://static1.squarespace.com/static/5852e579be659442a01f27b8/t/609d66c823a9a352bc3b24c3/1620928201758/2021-GRF-Abstracts.pdf

3. Marcel Grossmann Awards 2021

We are very happy to announce that the MG16 Individual Awards this year will go to:

- Prof. Gerard 't Hooft (Utrecht University) *"for his persistent devotion to the study of the quantum field theory boundary conditions at the black hole horizon";*
- Prof. Tsvi Piran (Hebrew University of Jerusalem) *"for extending Relativistic Astrophysics across international frontiers, a true companion in the search for the deeper meaning of Einstein's great theory"*; and
- Prof. Steven Weinberg (University of Texas at Austin) *"for unwavering support for the MG meetings since their inception, a true companion in the search for the deeper meaning of Einstein's great theory"*.
- Prof. Demetrios Christodoulou (ETH Zurich) *"for the 50th anniversary of the discovery of the Mass Energy Formula of a Kerr Newmann Black Hole by Christodoulou, Ruffini and Hawking (see Christodoulou, Phys. Rev.Lett. 25 (1970) 1596 – Christodoulou-Ruffini, Phys. Rev. D,4 (1971)3552 – Hawking, Phys. Rev. Lett. 26 (1971) 1344)"*.

It is also our great pleasure to announce that the shared MG16 Institutional Award will be presented to:

- Prof. Alexander Shirshakov (on behalf of the S.A. Lavochkin Association);
- Prof. Peter Predehl (on behalf of the Max Planck Institute for Extraterrestrial Physics – MPE); and
- Prof. Rashid Sunyaev (on behalf of the Space Research Institute IKI of the Russian Academy of Sciences)

"for the creation of the world's best X-ray map of the entire sky, for the discovery of millions of previously unknown accreting supermassive black holes at cosmological redshifts, for the detection of X-rays from tens of thousands of galaxy clusters, filled mainly with dark matter, and for permitting the detailed investigation of the growth of the large-scale structure of the universe during the era of dark energy dominance".

4. The Sixteenth Marcel Grossmann virtual Meeting (MG16), July 5 - 10, 2021

We are happy to present the official poster of the MG16 meeting http://www.icra.it/mg/mg16/MG16_official_poster.pdf with explanatory notes (http://www.icra.it/mg/mg16/MG16_official_poster_info.pdf), as well as the MG16 special poster, celebrating the 50th anniversary of the article *"Introducing the Black Hole"* and the Black Hole mass energy formula http://www.icra.it/mg/mg16/MG16_special_poster.pdf with explanatory text (http://www.icra.it/mg/mg16/MG16_special_poster_info.pdf).

The Sixteenth Marcel Grossmann Meeting on Recent Developments in Theoretical and Experimental General Relativity, Astrophysics and Relativistic Field Theories (MG16) will be organized in virtual format from July 5 to 10, 2021. During this six days online conference, a variety of topics will be discussed in the plenary and parallel sessions. Each day there will be three blocks of three hours with the plenary and the parallel sessions (Central European Summer Time):

First block: h 6:30 – h 9:30 (CEST)
Second block: h 9:30 – h 12:30 (CEST)
Third block: h 16:30 – h 19:30 (CEST)

Recordings of plenary session will be available next day on YouTube. Each block will have 10 sessions running in parallel, each parallel session will have 9 talks.

The deadline for registration has been postponed to June 15, 2021 with regular fee of 150 Euro and reduced fee of 50 Euro applicable to students, retired scientists and auditors. We recall that the abstract submission deadline is June 15, 2021.

The meeting program will include a set of plenary lectures, public lectures, round tables as well as parallel sessions. As soon as more information on plenary and parallel programs will be available, they will be posted on the MG16 meeting website (www.icra.it/mg/mg16) as well as on the associated Indico website (https://indico.icranet.org/event/1/) after June 15.

For any query, please contact mg16[AT]icranet.org

5. ICRA-ICRANet press release *"The morphology of the X-ray afterglows and of the jetted GeV emission in long gamma-ray bursts"*, May 12, 2021

What is the fate of very massive binary stars, which kind of signatures/observables are associated with their stepwise evolution, which kind of new physical laws are revealed, represent the most relevant questions at the heart of relativistic astrophysics. The answer to these questions is intimately related to the explanation of the most powerful transients in the Universe, supernovae (SNe) and gamma-ray bursts (GRBs), and with the formation of neutron star-black hole (NS-BH), of neutron star-neutron star (NS-NS), and possibly BH-BH binaries. A crucial question then arises: how large are the mass and how fast are the rotational spin of those astrophysical BHs and NSs?

A clue to this answer comes out from decades of electromagnetic observations of X-ray binaries in which a BH accretes mass from a stellar companion. From their continuous monitoring, it has turned out that these BHs have masses ranging ~5-20 $M_{\odot}$, where the upper edge is given by the very recently updated mass of the BH harbored by the X-ray binary Cygnus X-1 [1]. While the origin of X-ray binaries is well established, focus is needed to identify the evolutionary channels leading to the onset of GRBs, to their time evolution, as well as to the new physical laws and astrophysical regimes envisaged for their description.

In a new article published in the Monthly Notices of the Royal Astronomical Society [2], an ICRA-ICRANet research team (some of them INAF associates) sheds light on the mass and spin of stellar-mass BHs from an extensive analysis of long-duration GRBs. This has been allowed by fifty years of exponential growth of multiwavelength observations of GRBs and theoretical progress, from which it has been possible to identify the \inner engine" of the GRB, and verify the validity of the BH mass-energy formula established fifty years ago. The subject of study are 380 energetic long GRBs with energy release above 10^{52} erg in gamma-rays, all with a measured cosmological redshift, and an X-ray afterglow. These systems are accompanied by an SN of type Ic, namely an SN produced by a star which has lost its hydrogen and helium layers. The binary-driven hypernova (BdHN) scenario of long GRBs bridges what we know from binary evolution, with high-energy relativistic astrophysics to explain these extreme systems.

The GRB progenitor system is a binary composed of a carbon-oxygen (CO) star and a companion NS. During their long lifetime, a very massive binary experiences several stages, each one characterized by specific physical phenomena and observables (see left side of Figure 1). The more massive of the two stellar components evolves faster through the nuclear burning phases, leading it to make a first SN explosion, with consequent formation of a NS. Mass-transfer from the ordinary stellar component to the NS leads to an X-ray binary stage. Further binary interactions lead to multiple common envelope phases in which mass loss is enhanced and the ordinary star gets rid of

its outer low-density envelope, forming a CO star. The binary orbit shrinks while thermonuclear evolution of the CO star proceeds until its iron core becomes unstable against gravitational collapse, forming a new NS (*ν*NS) at its center, and driving an SN explosion. At this point, a powerful transient starts and its ultimate fate depends crucially on the distance separating the exploding CO star and the NS companion. The SN ejected material triggers a massive accretion process onto the NS companion as well as onto the *ν*NS by matter fallback (see Figure 2).

For compact binaries with orbital periods of the order of 5 minutes (see right side of Figure 1), the companion NS accretes sufficient matter to trigger its gravitational collapse, forming a BH which emanates a distinct, associated emission at high-energies (GeV) characterized by a luminosity as a function of time that follows a power-law. The fallback accretion onto the *ν*NS and its pulsar emission power the GRB X-ray and optical afterglow, characterized by power-law luminosities, different from the one of the GeV emission. BdHNe forming a BH have been called of type I.

From the statistics of the GeV emission, it has been inferred the morphology of the GRB emission process: it occurs within a conical region of 60° measured from the normal to the orbital plane. No GeV radiation is observable outside such a conical region. The X-ray afterglow is instead present in all the BdHN I, independently of the inclination angle of the GRB with respect to the orbital plane. This detailed understanding have allowed the team to infer, from the analysis of the X-ray afterglow, the spin and magnetic field of the *ν*NS. The analysis of the GeV emission have led, for the first time in about fifty years of GRB observations, to directly evaluate the precise mass and spin of the BHs formed in these powerful transients. The specific mass and spin of 11 BHs have been obtained and they range 2.3- 8.9 $M_{\odot}$ and 0.27- 0.87, respectively.

This treatment of long GRBs, originating from the very massive binary stars, makes ample use of a description based on the four fundamental interactions: relativistic gravity and electrodynamics describe the “inner engine”, weak interactions drive the neutrino emission in the accretion process, and the strong interactions shape the inner structure of the NSs responsible of the X-ray afterglow.

Since the pioneering observations of BATSE instrument on board the Compton satellite [3], we know that GRBs are isotropically distributed when mapped in galactic coordinates. Similarly, following the discovery of their cosmological redshift thanks to BeppoSAX [4], observations of BdHN I have occurred all the way to $z = 8.2$ (e.g. GRB 090423 [5, 6]). We can safely assert that GRBs, also thanks to their outstanding energetic, have a fundamental role in relativistic astrophysics processes in the 95.5% of our known Universe. Their prolonged emission of polarized synchrotron radiation in the X-rays and in the GeV regime may well have a fundamental role in the life in and of our Universe.

Having said all the above, it comes as a surprise the vision carried forward by the LIGO-Virgo observatories that very massive binary stars should rapidly gravitationally collapse, evolve into two BHs, crossing the space time of our Universe, finally merging into a larger BH. Such a vision avoids the role of any fundamental interactions with the sole exception of gravity, which seems at odds with the field of relativistic astrophysics.

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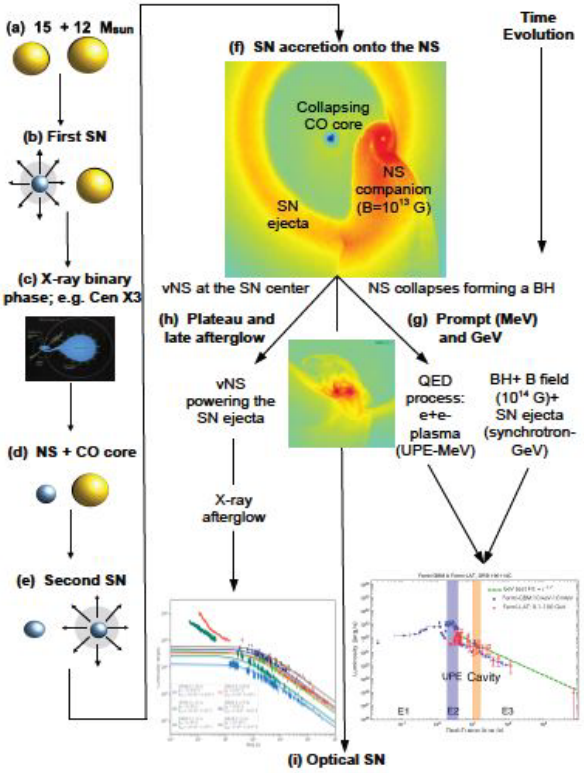

FIG. 1. Taken from [7]. Schematic evolutionary path of a massive binary up to the emission of a BdHN. (a) Binary system composed of two main-sequence stars, say 15 and 12 $M_{\odot}$, respectively. (b) At a given time, the more massive star undergoes the core-collapse SN and forms a NS (which might have a magnetic field B~10^{13} G). (c) The system enters the X-ray binary phase. (d) The core of the remaining evolved star, rich in carbon and oxygen, for short CO star, is left exposed since the hydrogen and helium envelope have been striped by binary interactions and possibly multiple common-envelope phases (not shown in this diagram). The system is, at this stage, a CO-NS binary, which is taken as the initial configuration of the BdHN model [8]. (e) The CO star explodes as SN when the binary period is of the order of few minutes, the SN ejecta of a few solar masses start to expand and a fast rotating, newborn NS, for short *v*NS, is left in the center. (f) The SN ejecta accrete onto the NS companion, forming a massive NS (BdHN II) or a BH (BdHN I; this example), depending on the initial NS mass and the binary separation. Conservation of magnetic flux and possibly additional MHD processes amplify the magnetic field from the NS value to B~10^{14} G around the newborn BH. At this stage the system is a *v*NS-BH binary surrounded by ionized matter of the expanding ejecta. (g) The accretion, the formation and the activities of the BH contribute to the GRB prompt gamma-ray emission and GeV emission. (h) X-ray afterglow powered by the fallback accretion and pulsar-like emission of the *v*NS. (i) Optical emission of the SN due to nickel decay in the ejecta.

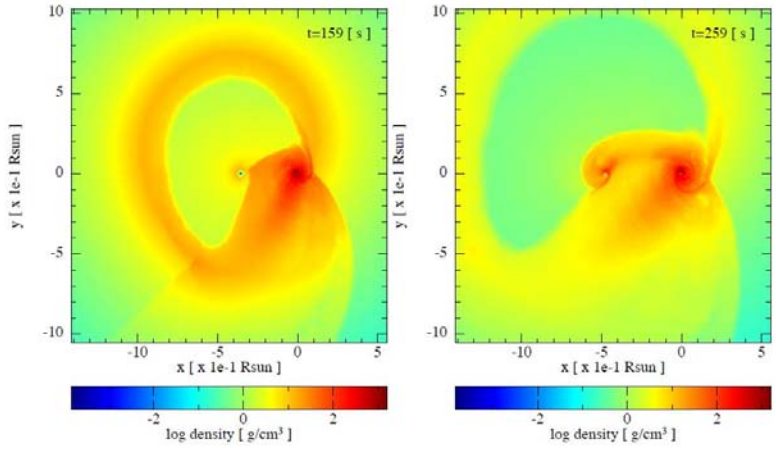

FIG. 2. A SPH simulation from Becerra et al. [8] of the exploding CO-star as the SN in the presence of a companion NS. The CO-star is obtained from the evolution of a 25 M⊙ zero-age main-sequence (ZAMS) progenitor which leads to a pre-SN CO-star mass MCO= 6.85 M⊙. The initial mass of the vNS (formed at the center of the SN) is 1.85 M⊙ and the one of the NS companion is MNS = 2 M⊙. The initial orbital period is 4.8 min. The panels show the mass density on the binary equatorial plane at two selected times from the SN explosion (t = 0 of the simulation), 159 s and 259 s. The reference system is rotated and translated so that the x-axis is along the line that joins the vNS and the NS, and the axis origin (0, 0) is located at the NS position. In this simulation, the NS collapses when it reaches 2.26 M⊙ and angular momentum 1.24 G M⊙2/c, while the vNS is stable with mass and angular momentum, respectively, 2.04 M⊙ and 1.24 G M⊙2/c. Up to the final simulation time, the binary system kept bound although the binary orbit widens, reaching an orbital period of 16.5 min and an eccentricity of $\epsilon = 0.6$. The collapse of the NS to the newly-formed BH, characteristic of a BdHN I, occurs at t = 21.6 min.

Link to the press release on ICRANet website: http://www.icranet.org/communication/

Link to the press release on INAF website: http://www.inaf.it/it/notizie-inaf/morphology-afterglows-jetted-ge-emission-long-grb

6. ICRA-ICRANet press release *"The newborn black hole in GRB 191014C proves that it is alive"*, May 27, 2021

A new theory explains the high-energy (photon energies of gigaelectronvolts — GeV) observed in the energetic long-duration gamma-ray bursts (GRBs) as originated in the vicinity of the black hole horizon. The theory, published today in Astronomy & Astrophysics [1], led by an ICRA-ICRANet research team (INAF associates), is based on the "*inner engine*" previously introduced by the team [2, 3]. The theory, which is also shown to work in active galactic nuclei (AGN), proofs that the rotational energy of a black hole can indeed be extracted from the horizon of the black hole, and efficiently used to power the most energetic and powerful objects in the Universe.

Rotating black holes were initially conceptualized either as "dead" objects or as sinks of energy. Subsequently, it was realized that much as the thermodynamical systems, black holes may interact with their surroundings exchanging energy [4, 5]. This result led to one of the most important concepts in black hole physics and astrophysics: the Christodoulou-Ruffini-Hawking black hole mass-energy formula [4–6]. In its most general form, for a rotating charged black hole, it relates the black hole mass-energy to three independent pieces: its "irreducible mass, its charge, and its angular momentum. It led to a corollary of paramount importance in astrophysics: up to 50% of the mass-energy of a charged black hole, and up to 29% of the one of a rotating black hole, could be in principle extracted!. This extraordinary result led to the alternative view of "alive" black holes, and since then it has permeated, for fifty years as of this writing, relativistic astrophysics both theoretically and experimentally.

The most energetic astrophysical sources, GRBs and AGN, were soon identified as primary candidates to be powered by black holes. GRBs, the most powerful transient objects in the sky, release energies of up to a few 1054 erg in just a few seconds! Their luminosity in the gamma-rays, in the time interval of the event, is as large as the luminosity of all the stars of the observable Universe! GRBs have been thought to be powered, by an up-to-now unknown mechanism, by stellar-mass black holes. AGN, releasing 10^{46} erg s^{-1} for billion years, must be powered by supermassive black holes of up to a few billion solar masses. However, every theoretical effort to find a mechanism to extract the black hole energy has been vanified by the implausibility of their realization in nature (see, e.g. [7]).

There was the urgency of new physics!. The novel engine presented in the new publication makes the job through a purely general relativistic, gravito-electrodynamical process: a rotating black hole, interacting with a surrounding magnetic field, creates an electric field (see Fig. 1) that accelerates ambient electrons to ultrahigh-energies leading to high-energy radiation (see Fig. 2) and ultrahigh-energy cosmic rays (UHECRs). Aspects of this novel machine worth to be outlined are: (1) the

nature of the emission results from the physical process leading to the electric and magnetic fields and the black hole formation. (2) The emission process is not continuous but discrete, it repeats over and over, releasing in every characteristic time a well-established *"blackholic quantum"* of energy [2], extracted from the black hole horizon thanks to the presence of a surrounding magnetic field. (3) Such a timescale, for GRBs, is as short as femtoseconds, making it difficult to be probed directly by current observational facilities. Direct evidence of the process discreteness might come out, instead, from AGN. In the case of M87*, the authors have predicted a high-energy (GeV) luminosity of a few 10^{43} erg s^{-1}, released in a timescale of up to tenths of seconds, while the timescale for UHECRs emission is of the order of half a day!

All the above results are important. The proof that we can use the extractable rotational energy of a black hole to explain the high-energy jetted emissions of GRBs and AGN stands alone. The jetted emission does not originate from an ultra-relativistic acceleration of matter in bulk (massive jets), but from very special energy-saving general relativistic and electrodynamical processes leading to the emission of blackholic quanta of energy [2]. A long march of successive theoretical progress and new physics discovered using observations of GRBs has brought to this result which has been waited for about fifty years of relativistic astrophysics.

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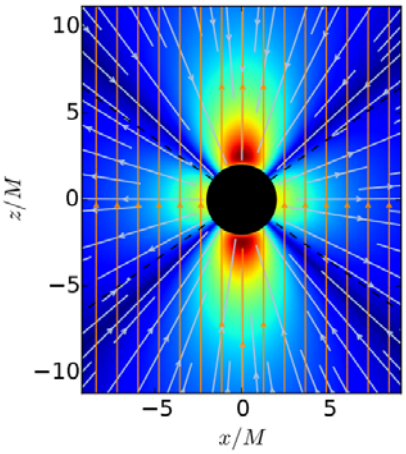


FIG. 1. Figure taken from [1] with the kind permission of the authors. Electric (blue lines) and magnetic (golden lines) field lines surrounding the rotating black hole. Electrons located in these northern and southern hemisphere cones of semi-aperture angle of≈ 60° are outwardly accelerated leading to GeV photons (see Fig. 2).

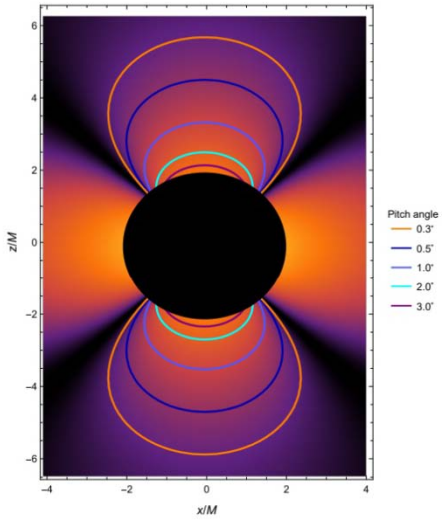


FIG. 2. Figure taken from [1] with the kind permission of the authors. Electrons are accelerated and emit GeV photons in the conical region with a semi-aperture angle $\theta\pm \approx 60°$ (dark boundary). This "jetted" emission is essential to infer the BdHN I morphology from the GeV emission data of long GRBs [8].

Link to the press release on ICRANet website: http://www.icranet.org/communication/

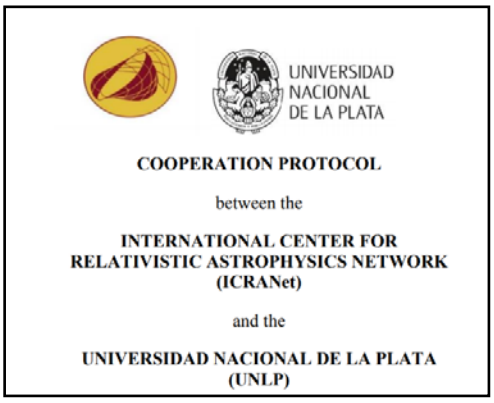
Link to the press release on A&A website: https://www.aanda.org/component/content/article/190-press-releases/2021-press-releases/2191-the-newborn-black-hole-in-grb-191014c-proves-that-it-isalive

7. Renewal of the Cooperation Agreement ICRANet – University of Ferrara, Italy, May 28, 2021

On May 28, 2021, the Cooperation Agreement between ICRANet and the University of Ferrara (UNIFE) has been renewed. The renewal was signed by Prof. Vincenzo Guidi (Director of the Physic Department of UNIFE) and by Prof. Remo Ruffini (Director of ICRANet). This agreement will be valid for further 5 years and the main joint activities to be developed under its framework 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, 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/index.php?option=com_content&task=view&id=1097

8. New Cooperation protocol and specific Agreement ICRANet- Universidad Nacional de La Plata (UNLP), Argentina, March 18, 2021


UNIVERSIDAD NACIONAL DE LA PLATA

COOPERATION PROTOCOL

between the

INTERNATIONAL CENTER FOR RELATIVISTIC ASTROPHYSICS NETWORK (ICRANet)

and the

UNIVERSIDAD NACIONAL DE LA PLATA (UNLP)


UNIVERSIDAD NACIONAL DE LA PLATA

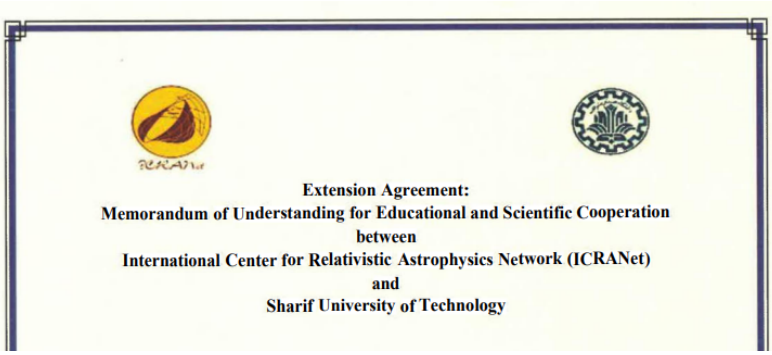
SPECIFIC AGREEMENT BETWEEN UNIVERSIDAD NACIONAL DE LA PLATA AND THE INTERNATIONAL CENTER FOR RELATIVISTIC ASTROPHYSICS NETWORK. JOINT WORK PLAN FROM FEBRUARY 2021 TO MARCH 2025

On May 2021, ICRANet has received the official confirmation that a new Cooperation protocol as well a specific agreement between ICRANet and the Universidad Nacional De La Plata (UNLP) in Argentina have been signed. The Cooperation Protocol has been signed on March 18, 2021 (both in English and in Spanish) by Dr Fernando Alfredo Tauber (President of UNLP) and by Prof. Remo Ruffini (Director of ICRANet), while the Specific Agreement has been signed by EngD Marcos Daniel Actis (UNLP Vice President for Institutional Affairs), by Lic. Raúl Anìbal Perdomo (UNLP Faculty of Astronomy and Geophysics) as well as by Prof. Remo Ruffini.

Both the agreements will be valid for 4 years and the main joint activities to be developed under their framework 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, the development of inter-institutional research areas associated to local graduate programs and joint publications.

For the texts of the Cooperation Protocol as well as of the Specific Agreement: http://www.icranet.org/index.php?option=com_content&task=view&id=1369

9. Renewal of the Cooperation Protocol ICRANet - Sharif University of Technology, Iran, March 9, 2021

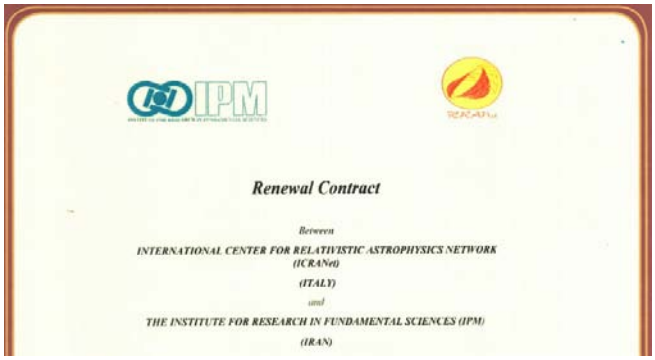

Extension Agreement:
Memorandum of Understanding for Educational and Scientific Cooperation
between
International Center for Relativistic Astrophysics Network (ICRANet)
and
Sharif University of Technology

On April 2021, ICRANet has received the official confirmation that the Cooperation protocol between ICRANet and Sharif University of Technology (Iran) was renewed. The renewal was signed on March 9, 2021 by Prof. Mahmoud Fotouhi Firoozabad (President of Sharif University of Technology) and by Prof. Remo Ruffini (Director of ICRANet). This agreement will be valid for further 5 years and the main joint activities to be developed under its framework 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, 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/index.php?option=com_content&task=view&id=1061

10. Renewal of the Cooperation Protocol ICRANet - Institute for Research in Fundamental Sciences (IPM), Iran, April 12, 2021



On April 12, 2021 the Cooperation Protocol between ICRANet and the Institute for Research in Fundamental Sciences (IPM) has been renewed. The renewal has been signed by Prof. Mohammad Javad A. Larijani (Director of IPM) and by Prof. Remo Ruffini (Director of ICRANet). This agreement will be valid for further 5 years and the main joint activities to be developed under its framework 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, 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/index.php?option=com_content&task=view&id=1060

11. "Gerbertus 2021. Astrophysics and new technologies", online meeting, May 12, 2021

The annual congress in honor of Gerbert of Aurillac, scientist, scholastic astronomer and Pope, took place virtually on May 12, 2021 and has been coordinated, as the previous ones, by and in the ICRANet center in Pescara at international level.

Gerbert d'Aurillac (circa 938 - 12.5.1003) was a Benedictine monk in his home town in France, he studied mathematics and astronomy in Vic (Catalonia) and was known for the music already by Pope Johannes XIII in 971 in Rome. From there, he left for Reims, where he served as a teacher at the cathedral school and as secretary of the Archbishop Adalberone until his death. He was elected Bishop of Reims in 991, after the deposition of Arnolfo, which the Pope didn't recognize as valid, and in 995 he withdrawn in Saasbach to be the tutor of the young Emperor Otto III. He wrote several treaties on the organ pipes (980), on the Astrolabe and on the Abaco, he introduced the indo-Arab digits (983, *Carme Figurato a Ottone II*) on the *De Rationali et ratione uti* (997 a Ottone III) and his epistolary was the richest we received in the X century. In 998, Pope Gregory V appointed him as Bishop of Ravenna and on April 9, 999, on the Easter day, he was crowned Pope in Rome *"da R in R in R"*, assuming the name of Sylvester II. According to a legend, Gerbert, considered as the most duct man of his times, built an automaton in binary logic.

Astrophysics and new technologies is the title of the 2021 edition of the meeting and the idea is to maintain the contact with the historical tradition, also by using new technologies. The invited speakers included also undergraduate students, in order to be more efficient in hitting the audience of high school students and addressing them on the opportunities offered to them in computer science, electronics, automation, robotic, environment and territory in relation to the field of observational astronomy and/or theoretical astrophysics.

The virtual meeting started at 4:00 PM on May 12, with the opening remarks made by Prof. Remo Ruffini (Director of ICRANet) and by Prof. Cosimo Palagiano (Accademia nazionale dei Lincei). Those have been followed by presentations on "Science, astrophysics and new technologies" by Prof. Francesco Berrilli (Tor Vergata and Accademia nazionale dei Lincei – physicist of the Sun), on "Interferometry in astronomy: from the Hanbury Brown and Twiss interferometer to the global very long baseline array" by Prof. Paolo Ochner (Astrophysical Observatory of Asiago and University of Padua, astronomer), by Daniele Impellizzeri (ITA G. Garibaldi, IT specialist), on the "study of the photoluminescence of the hybrid Perovskiti" by Paolo De Vincenzi (University of Roma La Sapienza, Physics, student), on the "computer science in the study of the phenomena" by Andrea Brucato (University of Roma La Sapienza, Physics, student), on the "Computer science in the school" by Fabio Zaccagnini (University of Roma La Sapienza, Physics, student), on "The role of computer science in astronomy" by Lorenzo Ricciardi (University Roma Tre, Computer science, student), on the "total station" by Prof. Paola Spera (IIS Caffè, CAT instructor), on the "survey campaign for the sundial of Santa Maria degli Angeli" by Prof. Giuseppe Cultrera (IIS Caffè, CAT teacher), on "Technology for astrophysics" by Prof. Runa Briguglio (INAF – Astrophysical Observatory of Arcetri) and on the "comment to the digital edition of Lo Scontro della Cometa (G. Artom, 1910)" by Prof. Federico Manzini (Astronomical station IAU A12).

During the conference, 2 digitalized booklets were presented: *"Lo Scontro della Cometa"* (1911) and *"Mars in 1896/97"*, the last one also with an experiment to see through a telescope a coin at 30 m far, with the same angular diameter of Mars in January 1897. It has been also presented by Prof. Sigismondi, the volume n. 14 of *Gerbertus* (2021) - http://www.icra.it/gerbertus/2021/Gerb-14-2021-totale.pdf.

Both the program of the event, as well the recording of the talks are available on the webpage of the meeting: http://www.icranet.org/index.php?option=com_content&task=view&id=1366

On that occasion, Prof. Sigismondi has also prepared a press release (in Italian) available at this link: http://www.icranet.org/scuola_lavoro/2020-2021/12052021/press_release.pdf

For the history of the previous meetings since 2003: http://www.icra.it/gerbertus

12. World Astronomy week virtual meeting, ICRANet Isfahan (Iran), May 11-12, 2021

International Astronomy Week is a public annual event, intended to inform students and general audience about Astronomy and Astrophysics, and to provide an active atmosphere for public scientific discussions about astronomy between professionals, scholars and students to interact and exchange new ideas in this field.

This event has been organized by Dr. Soroush Shakeri, from ICRANet-Isfahan, and the Department of Physics at IUT on May 11-12, 2021 as a virtual meeting. In this meeting, several scientists from Germany and Iran have been brought together to discuss about different topics in astronomy. The meeting started on May 11 at 16:30 (IRST), with an interesting talk given by Dr. Behnam Javanmardi from University of Bonn, Germany, about *"Cosmological inconsistencies and Hubble*

Constant", and continued with an extensive discussion by Dr. Javad Taghizadeh Firouzjaee from K.N. Toosi University of Technology, Tehran, about *"The Mystery of Black Holes"* and the recent Nobel Prize in physics. In the second day of the meeting, Dr. Sedighe Sajadian from the Department of Physics of IUT, Isfahan, talked about different methods of detecting extrasolar planets and about the possibility to have life beyond our solar system. At the end, Dr. Mahdi Kord Zangeneh from Shahid Chamran University of Ahvaz, presented an extensive overview about Cosmology and the recent achievements in astrophysics, where he had an interactive discussion with students about various ongoing researches in the field.

For the news on the IUT newsletter: https://iscoweb.iut.ac.ir/sites/iscoweb/files/u758/nl-no.18-_may_2021.pdf

13. Recent publications

Becerra-Vergara, E. A.; Argüelles, C. R.; Krut, A.; Rueda, J. A.; Ruffini, R., *Hinting a dark matter nature of Sgr A* via the S-stars*, to be published in Monthly Notices of the Royal Astronomical Society Letters.

The motion data of the S-stars around the Galactic center gathered in the last 28 yr imply that Sgr A* hosts a supermassive compact object of about 4×10^6 M$\odot$, a result awarded with the Nobel Prize in Physics 2020. A non-rotating black hole (BH) nature of Sgr A* has been uncritically adopted since the S-star orbits agree with Schwarzschild geometry geodesics. The orbit of S2 has served as a test of General Relativity predictions such as the gravitational redshift and the relativistic precession. The central BH model is, however, challenged by the G2 post-peripassage motion and by the lack of observations on event-horizon-scale distances robustly pointing to its univocal presence. We have recently shown that the S2 and G2 astrometry data are better fitted by geodesics in the spacetime of a self-gravitating dark matter (DM) core - halo distribution of 56 keV-fermions, "darkinos", which also explains the outer halo Galactic rotation curves. This Letter confirms and extends this conclusion using the astrometry data of the 17 best-resolved S-stars, thereby strengthening the alternative nature of Sgr A* as a dense core of darkinos.

ArXiv: https://arxiv.org/abs/2105.06301

J. A. Rueda and R. Ruffini, *The Quantum Emission of an Alive Black Hole*, Third Award-Winning Essay of the *"Gravity Research Foundation 2021 awards for essays on Gravitation"*, to be published in a special issue of IJMPD in October 2021.

A long march of fifty years of successive theoretical progress and new physics discovered using observations of gamma-ray bursts, has finally led to the formulation of an efficient mechanism able to extract the rotational energy of a Kerr black hole to power these most energetic astrophysical sources and active galactic nuclei. We here present the salient features of this long-sought

mechanism, based on gravito-electrodynamics, and which represents an authentic shift of paradigm of black holes as forever "alive" astrophysical objects.

GRF Award Announcement website: https://www.gravityresearchfoundation.org/announcement

ArXiv: https://arxiv.org/abs/2105.07890

Moradi, R.; Rueda, J. A.; Ruffini, R.; Wang, Y., *The newborn black hole in GRB 191014C proves that it is alive*, to be published in A&A on May 27, 2021.

A multi-decade theoretical effort has been devoted to finding an efficient mechanism to use the rotational and electrodynamical extractable energy of a Kerr-Newman black hole (BH), to power the most energetic astrophysical sources such as gamma-ray bursts (GRBs) and active galactic nuclei (AGN). We show an efficient general relativistic electrodynamical process which occurs in the "inner engine" of a binary driven hypernova (BdHN). The inner engine is composed of a rotating Kerr BH of mass M and dimensionless spin parameter α, a magnetic field of strength B_0 aligned and parallel to the rotation axis, and a very low-density ionized plasma. Here, we show that the gravitomagnetic interaction between the BH and the magnetic field induces an electric field that accelerates electrons and protons from the environment to ultrarelativistic energies emitting synchrotron radiation. We show that in GRB 190114C the BH of mass $M=4.4\ M_\odot$, $\alpha=0.4$, and $B_0 \approx 4\times10^{10}$ G can lead to a high-energy ($\gtrsim$GeV) luminosity of 10^{51} erg s^{-1}. The inner engine parameters are determined by requiring 1) that the BH extractable energy explains the GeV and ultrahigh-energy emission energetics, 2) that the emitted photons are not subjected to magnetic-pair production, and 3) that the synchrotron radiation timescale agrees with the observed high-energy timescale. We find for GRB 190114C a clear jetted emission of GeV energies with a semi-aperture angle of approximately 60° with respect to the BH rotation axis.

A&A forthcoming article: https://doi.org/10.1051/0004-6361/201937135

ArXiv: https://arxiv.org/abs/1911.07552

Sahakyan, N., *Modeling the broadband emission of 3C 454.3*, published in Monthly Notices of the Royal Astronomical Society on April 22, 2021.

The results of a long-term multiwavelength study of the powerful flat spectrum radio quasar 3C 454.3 using Fermi-LAT and Swift XRT/UVOT data are reported. In the γ-ray band, Fermi-LAT observations show several major flares when the source flux was $>10^{-5}$ photon cm^{-2} s^{-1}; the peak γ-ray flux above 141.6 MeV, $(9.22\pm1.96) \times 10^{-5}$ photon cm^{-2} s^{-1} observed on MJD 55519.33, corresponds to 2.15×10^{50} erg s^{-1} isotropic γ-ray luminosity. The analysis of Swift XRT and UVOT data revealed a flux increase, although with smaller amplitudes, also in the X-ray and optical/UV bands. The X-ray emission of 3C 454.3 is with a hard spectral index of $\Gamma X = 1.16–1.75$, and the flux in the flaring states increased up to $(1.80\pm0.18) \times 10^{-10}$erg cm^{-2} s^{-1}. Through combining the analysed data, it was possible to assemble 362 high-quality and quasi-simultaneous spectral energy distributions of 3C 454.3 in 2008–2018, which all were modelled within a one-zone leptonic scenario assuming the emission region is within the broad-line region, involving synchrotron, synchrotron self-Compton, and external Compton mechanisms. Such an extensive modelling is the key for constraining the underlying emission mechanisms in the 3C 454.3 jet and allows to derive the physical parameters of the jet and investigate their evolution in time. The modelling suggests that during the flares, along with the variation of emitting electron parameters, the Doppler boosting factor increased substantially, implying that the emission in these periods has most likely originated in a faster moving region.

DOI: https://doi.org/10.1093/mnras/stab1135

MAGIC collaboration, *H.E.S.S. and MAGIC observations of a sudden cessation of a very-high-energy γ-ray flare in PKS 1510−089 in May 2016* , Astronomy & Astrophysics, Volume 648, id.A23, 22 pp.

The flat spectrum radio quasar (FSRQ) PKS 1510−089 is known for its complex multiwavelength behaviour and it is one of only a few FSRQs detected in very-high-energy (VHE, $E > 100$ GeV) γ rays. The VHE γ-ray observations with H.E.S.S. and MAGIC in late May and early June 2016 resulted in the detection of an unprecedented flare, which revealed, for the first time, VHE γ-ray intranight variability for this source. While a common variability timescale of 1.5 h has been found, there is a significant deviation near the end of the flare, with a timescale of ∼20 min marking the cessation of the event. The peak flux is nearly two orders of magnitude above the low-level emission. For the first time, a curvature was detected in the VHE γ-ray spectrum of PKS 1510–089, which can be fully explained by the absorption on the part of the extragalactic background light. Optical *R*-band observations with ATOM revealed a counterpart of the γ-ray flare, even though the detailed flux evolution differs from the VHE γ-ray light curve. Interestingly, a steep flux decrease was observed at the same time as the cessation of the VHE γ-ray flare. In the high-energy (HE, $E >$ 100 MeV) γ-ray band, only a moderate flux increase was observed with *Fermi*-LAT, while the HE γ-ray spectrum significantly hardens up to a photon index of 1.6. A search for broad-line region (BLR) absorption features in the γ-ray spectrum indicates that the emission region is located outside of the BLR. Radio very-long-baseline interferometry observations reveal a fast-moving knot interacting with a standing jet feature around the time of the flare. As the standing feature is located ∼50 pc from the black hole, the emission region of the flare may have been located at a significant distance from the black hole. If this is indeed a true correlation, the VHE γ rays must have been produced far down in the jet, where turbulent plasma crosses a standing shock.

DOI: https://doi.org/10.1051/0004-6361/202038949

MAGIC collaboration, *Broadband Multi-wavelength Properties of M87 during the 2017 Event Horizon Telescope Campaign*, The Astrophysical Journal Letters, Volume 911, Issue 1, id.L11, 43 pp.

In 2017, the Event Horizon Telescope (EHT) Collaboration succeeded in capturing the first direct image of the center of the M87 galaxy. The asymmetric ring morphology and size are consistent with theoretical expectations for a weakly accreting supermassive black hole of mass $\sim 6.5 \times 10^9$ $M_\odot$. The EHTC also partnered with several international facilities in space and on the ground, to arrange an extensive, quasi-simultaneous multi-wavelength campaign. This Letter presents the results and analysis of this campaign, as well as the multi-wavelength data as a legacy data repository. We captured M87 in a historically low state, and the core flux dominates over HST-1 at high energies, making it possible to combine core flux constraints with the more spatially precise very long baseline interferometry data. We present the most complete simultaneous multi-wavelength spectrum of the active nucleus to date, and discuss the complexity and caveats of combining data from different spatial scales into one broadband spectrum. We apply two heuristic, isotropic leptonic single-zone models to provide insight into the basic source properties, but conclude that a structured jet is necessary to explain M87's spectrum. We can exclude that the simultaneous γ-ray emission is produced via inverse Compton emission in the same region producing the EHT mm-band emission, and further conclude that the γ-rays can only be produced in

the inner jets (inward of HST-1) if there are strongly particle-dominated regions. Direct synchrotron emission from accelerated protons and secondaries cannot yet be excluded.

DOI: https://doi.org/10.3847/2041-8213/abef71

Li-Yang Gao, Ze-Wei Zhao, She-Sheng Xue, Xin Zhang, *Relieving the H0 tension with a new interacting dark energy model*, accepted for publication in JCAP.

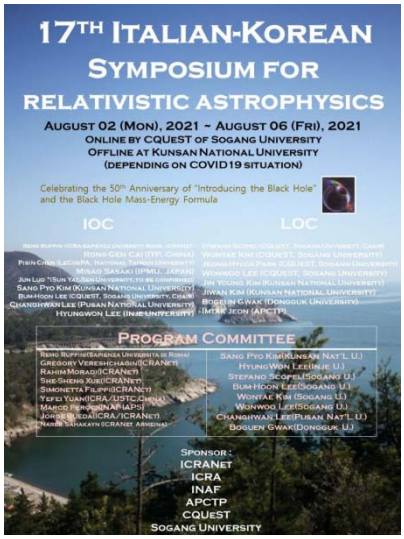
We investigate an extended cosmological model motivated by the asymptotic safety of gravitational field theory, in which the matter and radiation densities and the cosmological constant receive a correction parametrized by the parameters δ_G and δ_Λ, leading to that both the evolutions of the matter and radiation densities and the cosmological constant slightly deviate from the standard forms. Here we explain this model as a scenario of vacuum energy interacting with matter and radiation. We consider two cases of the model: {(i) ΛCDM with one additional free parameter δ_G, with δ_G and δ_Λ related by a low-redshift limit relation and (ii) e ΛCDM with two additional free parameters δ_G and δ_Λ that are independent of each other.} We use two data combinations, CMB+BAO+SN (CBS) and CMB+BAO+SN+H_0 (CBSH), to constrain the models. We find that, in the case of using the CBS data, neither ΛCDM nor eΛ CDM can effectively alleviate the H0 tension. However, it is found that using the CBSH data the H0 tension can be greatly relieved by the models. In particular, in the case of eΛCDM, the H_0 tension can be resolved to 0.71σ. We conclude that as an interacting dark energy model, ΛCDM is much better than Λ(t)CDM in the sense of both relieving the H_0 tension and fitting to the current observational data.

ArXiv: https://arxiv.org/abs/2101.10714

ICRANet Newsletter

June – July 2021

SUMMARY



1. The Sixteenth Marcel Grossmann virtual Meeting (MG16), July 5 - 10, 2021

The Sixteenth Marcel Grossmann Meeting on Recent Developments in Theoretical and Experimental General Relativity, Astrophysics and Relativistic Field Theories (MG16) took place online from July 5 to 10, 2021. 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.

More than 1200 participants from 51 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 virtual format, a lot of scientists from developing countries had also the possibility to attend the conference. The rich program of the conference was articulated in 46 plenary presentations, 3 public lectures, 5 round tables and 81 parallel session, each one with about 9 speakers.

The meeting started on Monday morning, July 5 with the opening remarks by Prof. Remo Ruffini (Director of ICRANet), immediately followed by the MG16 Awards ceremony, presented by Prof. Roy P. Kerr. This year, the MG16 Individual Awards went to:

- Prof. Demetrios Christodoulou (ETH Zurich) *"For his many lasting contributions to the foundation of mathematical physics including the dynamics of relativistic gravitational fields. Notably for: contributing in 1971, at the age of 19, to derive with Remo Ruffini the mass-energy formula of black holes as a function of their angular momentum, charge and irreducible mass. Christodoulou turned then to the study of partial differential equations and mathematical physics, to which he remained dedicated for the rest of his career. Highlights in this area include the theoretical discovery of the nonlinear memory effect of gravitational waves (Phys. Rev. Letters 1991), the monograph (1993) in collaboration with Sergiu Klainerman on the global nonlinear stability of the Minkowski spacetime, the monograph (2009) on the formation of black holes in pure general relativity by imploding gravitational waves, and the monographs (2007 and 2019) on the formation and further development of shocks in fluids"*
- Prof. Gerard 't Hooft (Utrecht University) *"for his persistent devotion to the study of the quantum field theory boundary conditions at the black hole horizon";*
- Prof. Tsvi Piran (Hebrew University of Jerusalem) *"for extending Relativistic Astrophysics across international frontiers, a true companion in the search for the deeper meaning of Einstein's great theory";*
- Prof. Steven Weinberg (University of Texas at Austin) *"for unwavering support for the MG meetings since their inception, a true companion in the search for the deeper meaning of Einstein's great theory".*

Prof. Demetrios Christodoulou

Prof. Gerard 't Hooft

Prof. Tsvi Piran

Prof. Steven Weinberg

The MG16 Institution Awards to the SRG mission *"for the creation of the world's best X-ray map of the entire sky, for the discovery of millions of previously unknown accreting supermassive black holes at cosmological redshifts, for the detection of X-rays from tens of thousands of galaxy clusters, filled mainly with dark matter, and for permitting the detailed investigation of the growth of the large-scale structure of the universe during the era of dark energy dominance"* went to:

- Prof. Alexander Shirshakov (on behalf of S.A. Lavochkin Association);
- Prof. Peter Predehl (on behalf of Max Planck Institute for Extraterrestrial Physics - MPE);
- Prof. Rashid Sunyaev (on behalf of Space Research Institute IKI of the Russian Academy of Sciences).

Prof. Alexander Shirshakov

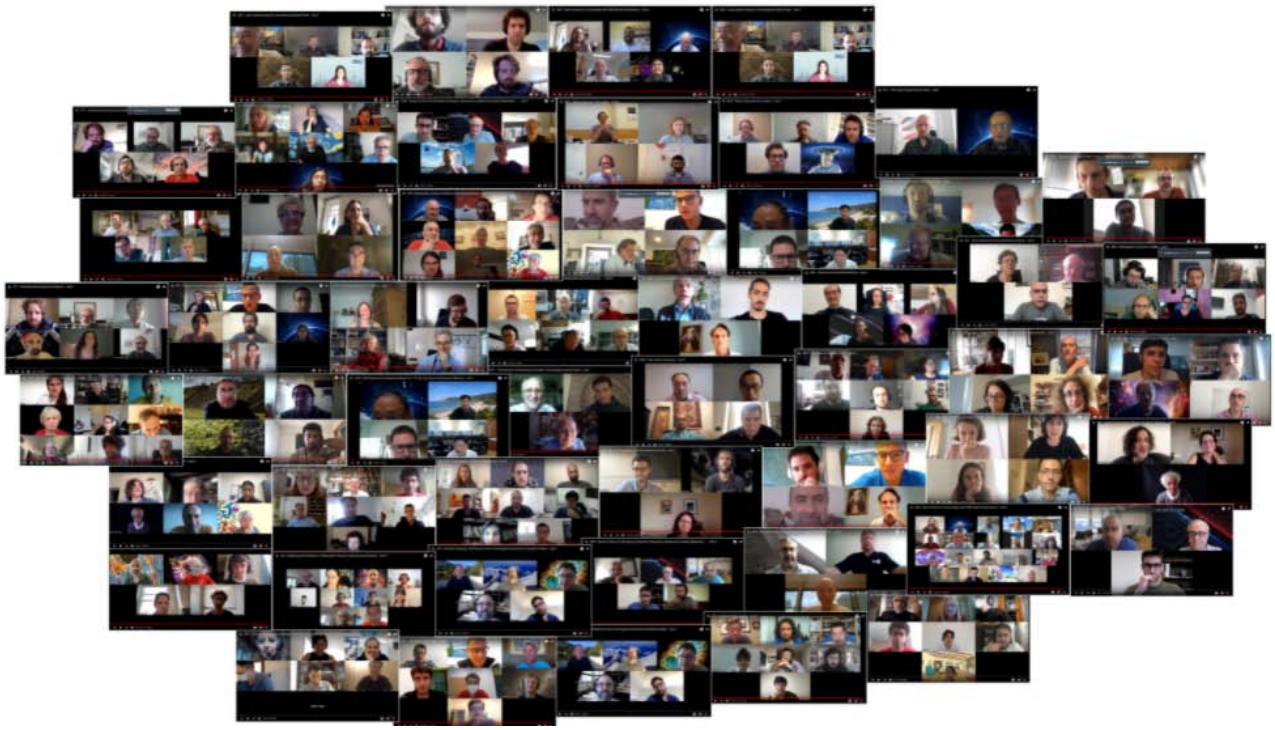
Prof. Peter Predehl

Prof. Rashid Sunyaev

The MG16 Awards booklet is available here: http://www.icra.it/mg/mg16/mg16_awards.pdf

During this six day conference, a variety of topics were discussed in the plenary sessions, beginning with events in relativistic astrophysics on Monday, Black holes and the Quantum on Tuesday, Lambda CDM tensions on Wednesday, Black holes in GRBs and Precision tests on Thursday, Massive stars and Physics behind stellar collapse on Friday and Current and future missions on Saturday.

Up to 30 parallel sessions per days took place in every parallel sessions block, covering the following topics: Accretion, Active Galactic Nuclei, Alternative Theories, Black Holes, Binaries, Boson Stars, Cosmic Microwave background, Cosmic Strings, Dark Energy and Large Scale Structure, Dark Matter, Education, Exact solutions, Early Universe, Fundamental interactions and Stellar evolution, Fast transient, Gravitational Waves, High Energy, History of Relativity, Neutron Stars, Precision Tests, Quantum Gravity, Strong Field and White Dwarfs. All the abstracts submitted for the parallel sessions have been collected in the book of abstracts, available on the Indico platform for MG16 at the following link: https://indico.icranet.org/event/1/book-of-abstracts.pdf



Collection of screenshots from parallel sessions at MG16, July 5-10, 2021

Three public lectures have been presented by Razmik Mirzoyan, Asghar Qadir and Mohammad Bagheri (Ulugh Beg lectures) and Francis Halzen. Five roundtables have been organized by Andrea Merloni on the new results from SRG/eRosita, by Wick Haxton and Gianpaolo Bellini on Solar neutrinos and Borexino, by Marc Kamionkowski, Piero Rosati and Licia Verde on Precision cosmology, by Eleonora Troja, Jorge Rueda, Liang Li and Rahim Moradi on GRB 170817A and by Reinhard Genzel (A 40-Year Journey), Carlos Arguelles (A dark matter nature of SgrA*?), Eduar Becerra, Andreas Krut and Jorge Rueda on what is in our Galactic center.

The electronic proceedings of the 16th Marcel Grossmann meeting held on July 5-10, 2021 in virtual format, will be published by World Scientific. As done previously, the contributions from plenary speakers will be published in IJMPD. The proceedings submission is now started. Please consult Instructions for authors: http://www.icra.it/mg/mg16/doc/instructions_for_authors.pdf. The page limit is 20 pages and the deadline for submission has been scheduled on September 30, 2021.

The recordings of the different sessions (plenary and parallel session, official award ceremony, public lectures and round tables) are now available on the ICRANet YouTube channel at the following link: http://www.icranet.org/video_mg16

3 satellite meetings to MG16, celebrating the 50th anniversary of "Introducing the Black Hole" are going to be organized by ICRANet:

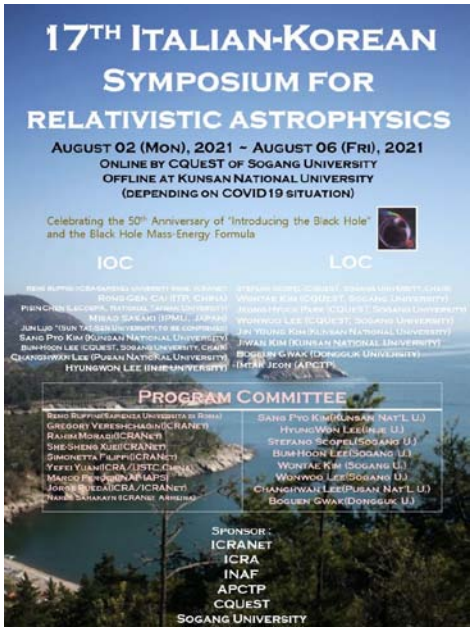
- the 17th Italian-Korean Symposium on Relativistic Astrophysics (IK17), August 2 - 6, 2021, Kunsan National University (Korea) and online (https://www.apctp.org/plan.php/kis2021);
- the ICRANet – Isfahan Astronomy Meeting "From the ancient Persian Astronomy to recent developments in theoretical and experimental general relativity and Astrophysics", November 3 - 5, 2021, Isfahan University of Technology (IUT - Iran) and online;
- the 3rd Julio Garavito Armero Meeting, December 1 - 3, 2021, Colombia.

For more information on MG16 meeting, please consult MG16 official website (http://www.icra.it/mg/mg16/) and MG16 meeting on Indico (https://indico.icranet.org/event/1/).

The meeting has been also advertised:

- on ICRANet website: http://www.icranet.org/communication/
- on Hyperspace: https://hyperspace.uni-frankfurt.de/?s=MG16&submit=Search
- on INSPIRE: https://inspirehep.net/conferences/1861415
- on 3DNews Daily Digital Digest (in Russian): https://3dnews.ru/1043464/observatoriya-spektrrg-udostoena-prestignoy-premii-v-oblasti-astrofiziki
- on the Canadian Astronomy Data center: https://www.cadc-ccda.hia-iha.nrc-cnrc.gc.ca/en/meetings/getMeetings.html?number=6564

2. The 17th Italian- Korean Symposium (IK17), August 2 - 6, 2021



It gives us great pleasure to announce the 17th Italian-Korean Symposium on Relativistic Astrophysics, that will be held from August 2 to 6, 2021 in person at Kunsan National University (Gunsan, Korea) and online. The meeting has been co organized by Kunsan National University, CQUeST and Sogang University (on the Korean side) and, on the italian side, by ICRANet. Members of IK17 International Organizing Committee (IOC) are Remo Ruffini (ICRA-Sapienza University Rome/ICRANet, Co-Chair), Rong-Gen Cai (ITP, China), Pisin Chen(LeCosPA, National Taiwan University), Misao Sasaki(IPMU, Japan), Jun Luo (Sun Yat-Sen University), Sang Pyo Kim (Kunsan National University), Bum-Hoon Lee (CQUeST, Sogang University, Chair), Changhwan Lee (Pusan National University) and Hyungwon Lee (Inje University). Members of IK17 Local Organizing Committee (LOC) are Stefano Scopel (CQUeST, Sogang University, Chair), Wontae Kim (CQUeST, Sogang University), Jeong-Hyuck Park (CQUeST, Sogang University), Wonwoo Lee (CQUeST, Sogang University), Jin Young Kim (Kunsan National University), Jiwan Kim (Kunsan National University), Bogeun Gwak (Dongguk University) and Imtak Jeon (APCTP). The IK17 Program Committee is composed by Remo Ruffini (ICRA-Sapienza University Rome/ICRANet), Gregory Vereshchagin (ICRANet), Jorge A Rueda (ICRANet), Rahim Moradi (ICRANet), She-Sheng Xue (ICRANet), Simonetta Filippi (ICRANet), Yefei Yuan (ICRA/USTC, China), Marco Feroci (INFN IAPS), Narek Sahakyan (ICRANet Armeria), Sang Pyo Kim (Kunsan National University), Hyungwon Lee (Inje University), Stefano Scopel (CQUeST, Sogang University), Bum-Hoon Lee (CQUeST, Sogang University), Wontae Kim (CQUeST, Sogang University), Wonwoo Lee (CQUeST, Sogang University), Changhwan Lee (Pusan National University) and Bogeun Gwak (Dongguk University).

The Italian-Korean Symposia on Relativistic Astrophysics is a series of biannual meetings, alternatively organized in Italy and in Korea since 1987. The symposia discussions cover topics in astrophysics and cosmology, such as gamma-ray bursts and compact stars, high energy cosmic rays, dark energy and dark matter, general relativity, black holes, and new physics related to cosmology. The scientific program is under preparation, and more details about the event will be published on its webpage (http://45.120.69.181/plan.php/kis2021) as soon as available.

3. Annular solar eclipse, June 10, 2021

A special event on the occasion of the annular solar eclipse on June 10, 2021 took place virtually on that day, coordinated, as the previous ones, by and in the ICRANet center in Pescara at international level. During the eclipse, from h 12:00 to 13:00 (CEST), Prof. Costantino Sigismondi, ICRANet collaborator, in teleconference between Pescara and the astrophysical Observatory of Asiago, presented the opening lecture of the Summer School ASYAGO, speaking about the astrometric length of the solar diameter as well as about the importance of those data for the comprehension of the solar physics. The diameter will be measured starting from the 4 times of contact between the lunar and the solar disk: this opportunity occurs only on the occasion of those astronomical phenomena.

The eclipse will be an annular one in Greenland and partial, almost very low in northern Italy. A similar situation occurred on June 21, 2020 even in the center of Italy. The images with an accurate timing per second (data from the astrophysical Observatory of Asiago) will be used to extrapolate the contact times.

An exhaustive video, from the starting to the end, as the one taken on June 21, 2020 in Rome, has allowed to obtain a final resolution of 0.1", so 100 km on the solar diameter, equivalent to almost 1 million and a half km. This video is on YouTube and the relevant publication is in the online review Gerbertus. It is essential that a standard clock could be filmed during the video and that we could study how it evolves to then extrapolate the timing UTC (for example, on the website http://rime.inrim.it/labtf/tempo-legale-italiano/). In an eclipse, even if partial like this one is in northern Italy, with a duration of 1 hour, an accurate timing of few tenths of a second offers a relative precision of 1 part on 36000, equivalent to almost 40 km on the whole solar diameter.

During this eclipse, we will try to caught the phenomenon in all its technical and historical aspects, with particular attention to the scientific objective of the accurate measurement of the sola diameter. In particular, is has been clarified how, through the angular measurement of the length of the underlying rope between the intersection points in-between the two circles of the sun and of the moon (radical rope), it describes a parabolic function of the time, and the 2 zeros correspond to the first and to the last contact.

In presence of a sun slightly larger of its standard value equal to 1,392 millions of km, the eclipse started a bit before and ended a bit later compared to the ephemerides, calculated with regard to a standard sun. Vice versa if the sun is minor.

Implications in solar astrophysics

The high-resolution measurement of the solar diameter is very difficult already when we reach a scale of 1000 km, which is the smallest one discernable from the Earth, due to the turbulence of the atmosphere. The solar granulation is visible through the best telescopes only when the atmosphere is calm and has this dimension: those are the dimensions to the surface of the convective cells which bring the sun core energy towards the photosphere. The convective region concerns the internal part of the sun above the 70% of the sun ray, therefore the last 400.000 km. The standard solar model works, but we can't still predict exactly the trend of solar cycles, connected to the magnetism inside the sun, even if their recurrence each 11 years is well known. Even today, nobody

can predict exactly when and how the maximum solar activity will be with regard to the cycle started in 2020. These kind of problems are common in the field of the stellar variability, where, for example, we have the same uncertainty for the Mira type variables.

The global oscillations of the sun or of its oblateness are extremely difficult to measure both on the ground and from the satellites: on the ground the difficulty is due to the continuous agitation of the atmosphere, while from the satellites it is difficult for the optic, limited in the size and by the systematic errors of the visual field.

The eclipse gives us the opportunity to use another celestial body, the Moon, its profile and its movement, as a term of comparison. Possible variations of the solar diameter on the scales less than 10 km would imply anyway some mechanism of redistribution of the energy between the magnetic one, the gravitational one and the thermal one, which could help to better define our knowledge of the nearest star to us (the only one of which we know quite well the surface details and whose activity directly affects the life and the climate on earth).

During the event of June 10, Prof. Sigismondi has clarified, together with the experts in this field, those technical aspects of the solar models and of the measurement of the solar diameter thanks to the eclipse. Prof. Sigismondi is an expert in the study of the high resolution measurement of the solar diameter, its astrophysics and relativistic implications; he has guided the observational campaign of 2 annular eclipses: in Valoria la Buena (Spain) on October 3, 200 and in Kourou (French Guyana) on September 22, 2006. The first observed annular eclipse was the one on May 30, 1984 in its initial phases at the sunset time in Rome. The partial and total eclipses observed or studied, for astrometrical purposes, have been dozens. One of the most important one is the annular-total eclipses (hybrid) of May 9, 1567 observed in Rome by Padre Cristoforo Clavio. This branch of the solar physics started in 1978 from that analysis.

The program, recording and podcast material on that event could be found on the webpage of the meeting: http://www.icranet.org/index.php?option=com_content&task=view&id=1375

On that occasion, Prof. Sigismondi has also prepared a press release (in Italian) available at this link: http://www.icranet.org/index.php?option=com_content&task=view&id=1032&Itemid=920

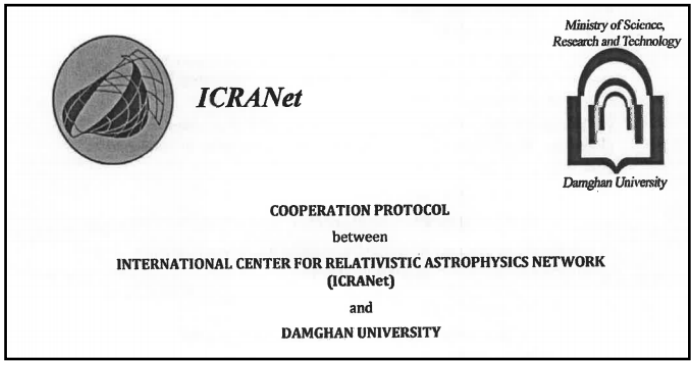
4. Renewal of the cooperation agreement ICRANet-UDEA (Colombia), June 9, 2021

On June 9, 2021, the Cooperation Agreement between ICRANet and the Universidad de Antioquia (UDEA) has been renewed. The renewal was signed by Prof. Adriana Echavarria Isaza (Dean of the Faculty of exact and natural sciences of UDEA) and by Prof. Remo Ruffini (Director of ICRANet). This agreement will be valid for further 5 years and the main joint activities to be developed under its framework 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, 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/index.php?option=com_content&task=view&id=1038

5. New cooperation Protocol ICRANet - Damghan University (Iran), June 23, 2021



On June 23, 2021, ICRANet has signed a new Cooperation protocol with the Damghan University in Iran. The Cooperation Protocol has been signed (both in English and in Persian) by Dr. Abdolali Basiri (President of the Damghan University), by Dr. Shahab Shahidi (School of Physics, Damghan University), by Prof. Remo Ruffini (Director of ICRANet) and by Prof. Narek Sahakyan (Director of ICRANet Seat in Yerevan).

The cooperation protocol will be valid for 5 years and the main joint activities to be developed under their framework 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, the development of inter-institutional research areas associated to local graduate programs and joint publications.

For the text of the Cooperation Protocol: http://www.icranet.org/index.php?option=com_content&task=view&id=1380

6. Scientific visits to ICRANet

- Carlos Raul Arguelles (Universidad Nacional de La Plata), from July 2, 2021 – ongoing
- Krzysztof Belczynski (Polish Academy of Sciences), July 1-16, 2021
- Yunlong Zheng (University of Sciences and Technology of China – USTC), from July 9, 2021 - ongoing

During their visit, those scientists have the opportunity to discuss their scientific research and to have fruitful exchange of ideas with other researchers from ICRANet and from different parts of the world. Prior and/or during their visit, those scientists had also the opportunity to participate to the 116th Marcel Grossmann meeting (online) from ICRANet Hq.

Prof. Carlos Raul Arguelles

Prof. Krzysztof Belczynski

Dr Yunlong Zheng

7. Recent publications

Yen Chen Chen, *Classifying Seyfert galaxies with deep learning*, accepted for publication in ApJS.

Traditional classification for subclass of the Seyfert galaxies is visual inspection or using a quantity defined as a flux ratio between the Balmer line and forbidden line. One algorithm of deep learning is Convolution Neural Network (CNN) and has shown successful classification results. We building a 1-dimension CNN model to distinguish Seyfert 1.9 spectra from Seyfert 2 galaxies. We find our model can recognize Seyfert 1.9 and Seyfert 2 spectra with an accuracy over 80% and pick out an additional Seyfert 1.9 sample which was missed by visual inspection. We use the new Seyfert 1.9 sample to improve performance of our model and obtain a 91% precision of Seyfert 1.9. These results indicate our model can pick out Seyfert 1.9 spectra among Seyfert 2 spectra. We decompose H{\alpha} emission line of our Seyfert 1.9 galaxies by fitting 2 Gaussian components and derive line width and flux. We find velocity distribution of broad H{\alpha} component of the new Seyfert 1.9 sample has an extending tail toward the higher end and luminosity of the new Seyfert 1.9 sample is slightly weaker than the original Seyfert 1.9 sample. This result indicates that our model can pick out the sources that have relatively weak broad H{\alpha} component. Besides, we check distributions of the host galaxy morphology of our Seyfert 1.9 samples and find the distribution of the host galaxy morphology is dominant by large bulge galaxy. In the end, we present an online catalog of 1297 Seyfert 1.9 galaxies with measurement of H{\alpha} emission line.

ArXiv: https://arxiv.org/abs/2107.06653

Li-Yang Gao, Ze-Wei Zhao, She-Sheng Xue, Xin Zhang, *Relieving the H_0 tension with a new interacting dark energy model*, JCAP 07 (2021) 005.

We investigate an extended cosmological model motivated by the asymptotic safety of gravitational field theory, in which the matter and radiation densities and the cosmological constant receive a correction parametrized by the parameters δG and $\delta \Lambda$, leading to that both the evolutions of the matter and radiation densities and the cosmological constant slightly deviate from the standard forms. Here we explain this model as a scenario of vacuum energy interacting with matter and radiation. We consider two cases of the model: (i) $\tilde{\Lambda}$CDM with one additional free parameter δG, with δG and $\delta \Lambda$ related by a low-redshift limit relation and (ii) e $\tilde{\Lambda}$CDM with two additional free parameters δG and $\delta \Lambda$ that are independent of each other. We use two data combinations, CMB+BAO+SN (CBS) and CMB+BAO+SN+H_0 (CBSH), to constrain the models. We find that, in

the case of using the CBS data, neither $\tilde{\Lambda}$CDM nor e$\tilde{\Lambda}$CDM can effectively alleviate the H_0 tension. However, it is found that using the CBSH data the H_0 tension can be greatly relieved by the models. In particular, in the case of e$\tilde{\Lambda}$CDM, the H_0 tension can be resolved to 0.71σ. We conclude that as an interacting dark energy model, $\tilde{\Lambda}$CDM is much better than Λ(t)CDM in the sense of both relieving the H_0 tension and fitting to the current observational data.

DOI: https://doi.org/10.1088/1475-7516/2021/07/005

MAGIC collaboration, *Multiwavelength variability and correlation studies of Mrk 421 during historically low X-ray and γ-ray activity in 2015–2016*, MNRAS, Volume 504, Issue 1, June 2021.

We report a characterization of the multiband flux variability and correlations of the nearby ($z = 0.031$) blazar Markarian 421 (Mrk 421) using data from Metsähovi, *Swift*, *Fermi*-LAT, MAGIC, FACT, and other collaborations and instruments from 2014 November till 2016 June. Mrk 421 did not show any prominent flaring activity, but exhibited periods of historically low activity above 1 TeV ($F_{>1\ \mathrm{TeV}} < 1.7 \times 10^{-12}$ ph cm^{-2} s^{-1}) and in the 2–10 keV (X-ray) band ($F_{2-10\mathrm{keV}}<3.6\times10^{-11}$ erg cm^{-2} s^{-1}), during which the *Swift*-BAT data suggest an additional spectral component beyond the regular synchrotron emission. The highest flux variability occurs in X-rays and very high-energy ($E > 0.1$TeV) γ-rays, which, despite the low activity, show a significant positive correlation with no time lag. The HR_{keV} and HR_{TeV} show the *harder-when-brighter* trend observed in many blazars, but the trend flattens at the highest fluxes, which suggests a change in the processes dominating the blazar variability. Enlarging our data set with data from years 2007 to 2014, we measured a positive correlation between the optical and the GeV emission over a range of about 60 d centred at time lag zero, and a positive correlation between the optical/GeV and the radio emission over a range of about 60 d centred at a time lag of 43^{+9-6} d. This observation is consistent with the radio-bright zone being located about 0.2 parsec downstream from the optical/GeV emission regions of the jet. The flux distributions are better described with a lognormal function in most of the energy bands probed, indicating that the variability in Mrk 421 is likely produced by a multiplicative process.

DOI: https://doi.org/10.1093/mnras/staa3727

MAGIC collaboration, *First detection of VHE gamma-ray emission from TXS 1515–273, study of its X-ray variability and spectral energy distribution*, MNRAS, Stab1994, July 21, 2021.

We report here on the first multi-wavelength (MWL) campaign on the blazar TXS 1515–273, undertaken in 2019 and extending from radio to very-high-energy gamma rays (VHE). Up until now, this blazar had not been the subject of any detailed MWL observations. It has a rather hard photon index at GeV energies and was considered a candidate extreme high-synchrotron-peaked source. MAGIC observations resulted in the first-time detection of the source in VHE with a statistical significance of 7.6σ. The average integral VHE flux of the source is 6±1 per cent of the Crab nebula flux above 400 GeV. X-ray coverage was provided by Swift-XRT, XMM-Newton, and NuSTAR. The long continuous X-ray observations were separated by ∼9 h, both showing clear hour scale flares. In the XMM-Newton data, both the rise and decay timescales are longer in the soft X-ray than in the hard X-ray band, indicating the presence of a particle cooling regime. The X-ray variability timescales were used to constrain the size of the emission region and the strength of the magnetic field. The data allowed us to determine the synchrotron peak frequency and classify the source as a flaring high, but not extreme, synchrotron peaked object. Considering the constraints

and variability patterns from the X-ray data, we model the broad-band spectral energy distribution. We applied a simple one-zone model, which could not reproduce the radio emission and the shape of the optical emission, and a two-component leptonic model with two interacting components, enabling us to reproduce the emission from radio to VHE band.

DOI: https://doi.org/10.1093/mnras/stab1994

Kh. Jafarzade, J. Sadeghi, B. Eslam Panah, S. H. Hendi, *Geometrical thermodynamics and P-V criticality of charged accelerating AdS black holes*, accepted for publication in Annals of Physics.

The unusual asymptotic structure of the accelerating black holes led to ambiguity in their geometric characteristics and thermodynamic behavior. Motivated by the interesting properties of such black holes and the significant role of electric charge and string tension on their structure, we study the thermodynamic behavior of these black holes by two methods and examine the changes of free parameters on the thermal behavior of the black holes. First, we investigate phase transition and thermal stability of the system through the use of heat capacity in the non-extended phase space. We examine the effects of electric charge, string tension and the cosmological constant on the phase transition and stability of the system. We also find that to have a phase transition, we have to apply some constraints on the free parameters. Then, we employ the geometrical thermodynamic (GT) method to study phase transition and compare the obtained results with those of the heat capacity. Next, we work in the extended phase space by considering the cosmological constant as a dynamical pressure and evaluate the existence of van der Waals like phase transition. We obtain critical quantities and study the effective role of electric charge and string tension on these quantities. Finally, we make use of the GT method in the extended phase space and find that the results of the GT method, heat capacity and P−V diagram lead to a consistent conclusion.

ArXiv: https://arxiv.org/abs/1711.04522

ICRANet Newsletter

August – September 2021

SUMMARY

1. ICRA – ICRANet press release *"Classifying Seyfert galaxies with deep learning"*

Scientist uses deep learning to identify low luminous Seyfert 1.9 galaxies that are usually missed by human inspection among ten thousands of spectra. These results are published in the Astrophysical Journal Supplement Series on 28 September 2021 by a PhD student, Yen Chen Chen, in the department of physics at Sapienza University of Rome and the International Center for Relativistic Astrophysics Network (ICRANet).

Seyfert 1 and Seyfert 2 galaxies have distinct features on their spectra and the difference is explained by different viewing angles in the unification model of active galactic nuclei. However, a few Seyfert galaxies called intermediate Seyfert (Seyfert 1.2, 1.5, 1.8, 1.9) share spectral features from Seyfert 1 and Seyfert 2 and these two-component sources are hard to be explained by the unification model. At early time, these sources were picked out by vision inspection and hard to be picked out from amount observation data. Recently, astronomers usually fit candidate spectra to find these two-component sources. However, the fitting process usually spends a lot of time and the classification results are dependent on fitting results. Now, this classification process can be done by deep learning. Scientist builds a convolution neural network (CNN) model and feeds the model with a known sample of Seyfert 1.9 galaxies. The result shows that the trained CNN model has a high ability to recognize Seyfert 1.9 galaxies and the trained model finds new Seyfert 1.9 sources.

The novel point is that this method only needs a few known sources for training model and the training process is fast. Besides, the trained model can obtain more new sources in a faster way ever. This work shows a practical method in identifying sources and can be applied in the future. These new Seyfert 1.9 sources have obscure characteristic on its spectra and are usually missed in classification process by visual inspection. Scientist finds this machine-selected Seyfert 1.9 sample is fainter than the human selected one. This work provides astronomers more Seyfert 1.9 sources to low luminous end and will help astronomers understand the origin of the two components on its emission lines with multiple wavelength follow-up observation.

NGC 2992 (right) and NGC 2993 (left). Credit Line and Copyright Adam Block/ Mount Lemmon SkyCenter/University of Arizona.

Link to the press release on INAF website: http://www.inaf.it/en/inaf-news/seyfert-galaxies-dl

Link to the press release on ICRANet website: http://www.icranet.org/communication/28092021/eng.pdf

Reference:

Yen Chen Chen, Classifying Seyfert Galaxies with Deep Learning ApJS **256** 34.

https://iopscience.iop.org/article/10.3847/1538-4365/ac13aa

2. The 17th Italian-Korean Symposium (IK17), August 2-6, 2021

The Italian-Korean Symposia on Relativistic Astrophysics is a series of biannual meetings, alternatively organized in Italy and in Korea since 1987. The 17th Italian-Korean Symposium on Relativistic Astrophysics has been held from August 2 to 6, 2021 in a mixed format: in person at Kunsan National University (Gunsan, Korea) and online.

Fig. 1: H.E. Amb. Federico Failla (Ambassador of Italy in Korea) on the occasion of the official opening ceremony of IK17 meeting, August 2, 2021.

The opening remarks have been presented by Prof. Byeong-Sun Kwak (President of the Kunsan National University), by H.E. Amb. Federico Failla (Ambassador of Italy in Korea) and by Prof. Remo Ruffini (Director of ICRANet and President of ICRA).

During this five days conference, a variety of topics in astrophysics and cosmology were discussed, such as gamma-ray bursts and compact stars, high energy cosmic rays, dark energy and dark matter, general relativity, black holes, and new physics related to cosmology. The most recent scientific developments were presented by eminent Professors and researchers. The speakers for the Korean part were Prof. Sang Pyo Kim and Prof. Jin Young Kim (Kunsan National University), Prof. Stefano Scopel, Prof. Mu-In Park, Prof. Lu Yin, Prof. Eoin O Colgain, Prof. Wontae Kim, Prof. Wonwoo Lee and Prof. Hochoel Lee (Sogang University), Prof. Pisin Chen (National Taiwan University & Stanford University), Prof. Hyun Kyu Lee (Hanyang University), Prof. Dong-Hoon Kim (Seoul National University), Prof. Lang Liu (Institute of Theoretical Physics), Prof. Chen-Te Ma and Prof. Mahdis Ghodrati (APCTP), prof. Daniele Gregoris (Jiangsu University of Science and Technology), Prof. Bogeun Gwak (Dongguk University), Prof. Chan Park (NIMS), Prof. Chang-Hwan Lee and Prof. Dong-han Yeom (Pusan National University), Prof. Myeonghwan Oh (Kyungpook National University) and Prof. Sung-Won Kim (Ewha Womans University). The ICRANet speakers were Prof. Remo Ruffini, Prof. Jorge A. Rueda H., Prof. Narek Sahakyan, Prof. Soroush Shakeri, Prof. Shesheng Xue, Prof. Carlos Arguelles, Prof. Rahim Moradi, Prof. Liang Li, Prof. Maria Giovanna Dainotti and Prof. Kuantay Boshkayev.

Fig. 2: Prof. Remo Ruffini, Prof. Rahim Moradi and Prof. Soroush Shakeri presenting their lecture at the IK17 meeting.

The IK17 proceedings will collect all the presentations of the meeting, which will be published in the Journal of the Korean Physical Society (JKPS). The deadline for the submission is October 31, 2021.

For more information about the meeting, please see: http://45.120.69.181/plan.php/kis2021

3. 23 RAGtime meeting Opava, Czech Republic, September 6-10, 2021

From September 6 to 10, 2021, Professor Ruffini, Director of ICRANet, visited Silesian University in Opava (Czech Republic). Together with Prof. Jorge Rueda (ICRANet Faculty Professor), they have been invited to deliver 2 lectures on the occasion of the 23rd RAGtime meeting. Prof. Ruffini presented a lecture titled *"Derivation of the existence of the Black Holic Quantum from GRBs"* while Prof. Rueda presented a lecture titled *"Quantifying the blackholic quantum in GRBs and AGN"*.

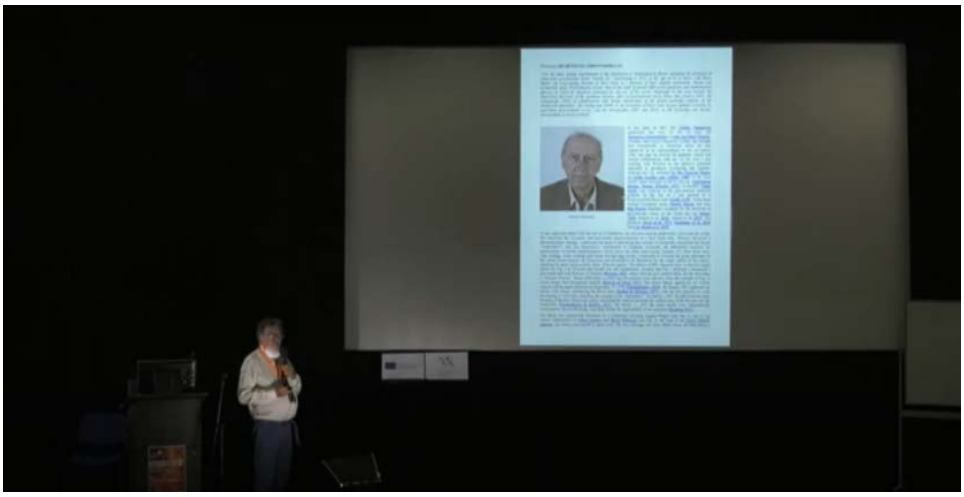


Fig. 3: Prof. Remo Ruffini presenting his talk at the 23rd RAGtime meeting in Opava, September 7, 2021.

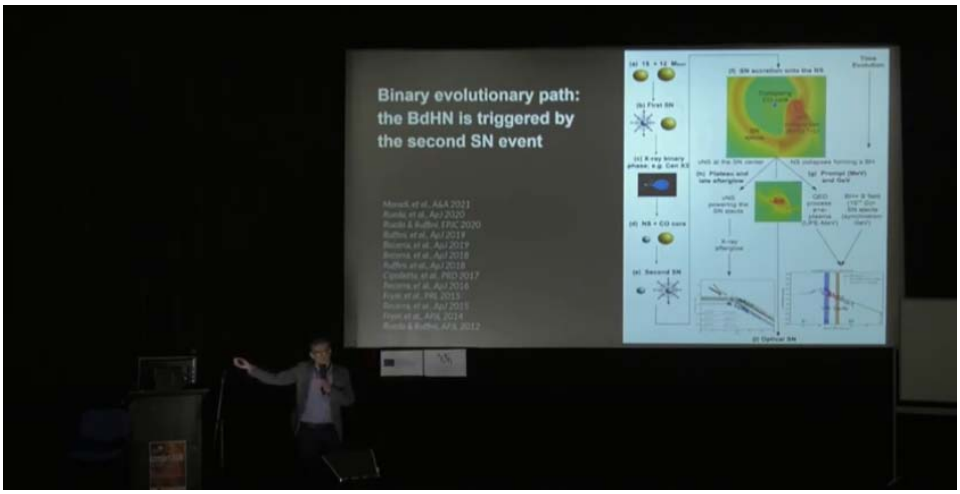


Fig. 4: Prof. Jorge Rueda presenting his talk at the 23rd RAGtime meeting in Opava, September 7, 2021.

For the video of Prof. Ruffini on ICRANet YouTube channel: https://youtu.be/G9BEgdvJSVU

For the video of Prof. Rueda on ICRANet YouTube channel: https://youtu.be/fUtBWlCFQvg

4. 107th SIF National Congress, September 13 – 17, 2021

From September 13 to 17, 2021, the Italian Physical Society (Società Italiana di Fisica, SIF) held its online 107th National Congress. Prof. Remo Ruffini (Director of ICRANet), Prof. Jorge Rueda (ICRANet Faculty Professor), Prof. Gregory Vereshchagin (ICRANet Faculty Professor), Prof. Rahim Moradi (ICRANet Faculty Professor) and Dr Stefano Campion, were invited to participate and present their talk through a video presentation reporting on their latest scientific results. Prof. Ruffini presented a talk titled *"GRB 180720B: a BDHNI prototype"*, Prof. Rueda presented a talk titled *"The long GRB afterglow from the radio to the X-rays in the binary-driven hypernova scenario"*, Prof. Vereshchagin presented a talk titled "*Kinetic effects in nonequilibrium electron-positron plasmas*", Prof. Moradi presented a talk titled "GRB-SNe connection within the binary-driven hypernova (BdHN) model" and Dr Campion presented a talk titled "*Magnetic field screening in strong crossed electromagnetic fields"*.

For more information, please check the conference website: https://www.sif.it/attivita/congresso/107

5. Upcoming meeting: ICRANet - Isfahan Astronomy Meeting, Iran and online, November 3-5, 2021

It gives us great pleasure to announce the *"ICRANet - Isfahan Astronomy Meeting. From the Ancient Persian Astronomy to Recent Developments in Theoretical and Experimental Physics, Astrophysics and General Relativity"*. Isfahan, as an historical city in the center of Iran and as one of the world's most beautiful cities, will host the first series of this meeting, which will be held from 3 to 5 November 2021 at the Isfahan University of Technology (IUT - Iran) and online.

This meeting, co organized by ICRANet and IUT, will provide a great opportunity for discussing about topics ranging from the ancient Persian astronomy to recent developments in observational astronomy, high energy astrophysical phenomena such as Gamma-Ray Bursts (GRBs) and Active Galactic Nuclei (AGNs), Theories of Gravity, General Relativity and its Mathematical Foundation, Black Holes, Dark matter and Early Universe Cosmology. A workshop on Data Science in Astrophysics will be also held during the meeting.

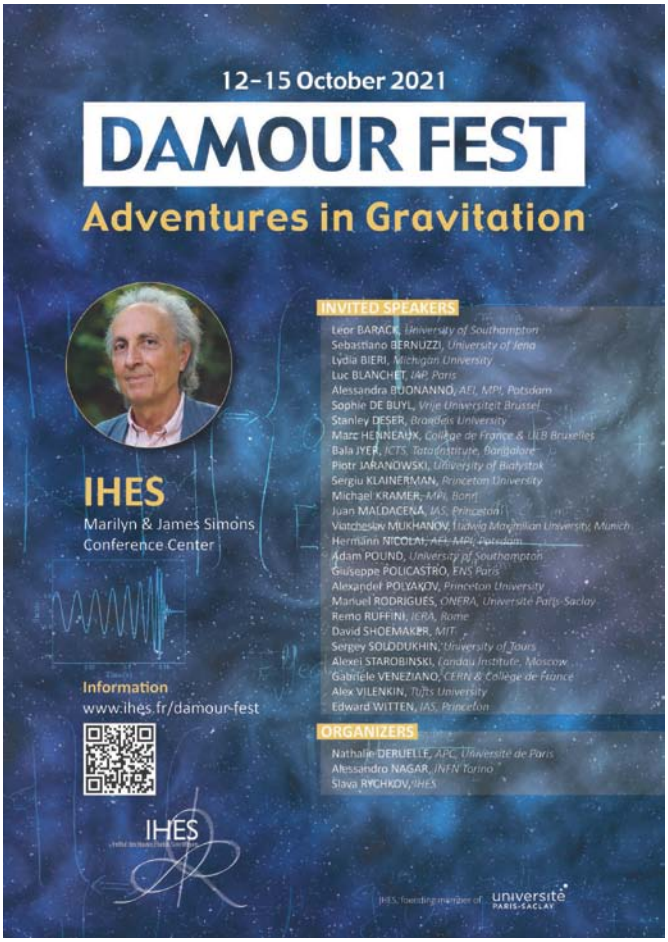
Members of the meeting Scientific Committee are the chair, Prof. Remo Ruffini (ICRANet/ICRA), the co-chair, Prof. Yousef Sobouti (ISABS, Iran), Prof. Hassan Firouzjahi (IPM, Iran), Prof. Shahram Khosravi (KHU, Iran), Prof. Habib Khosroshahi (IPM), Prof. Kourosh Nozari (UMZ, Iran), Prof. Sohrab Rahvar (SUT, Iran), Prof. Soroush Shakeri (IUT), Prof. Shadi Tahvildar-Zadeh (Rutgers, USA) and Prof. She-Sheng Xue (ICRANet). Members of the meeting Organizing Committee are the Chair, Prof. Soroush Shakeri (IUT), Prof. Amin Farhang (IPM and IUT), Prof. Fazlollah Hajkarim (UNIPD, Italy), Prof. Rahim Moradi

(ICRANet), Prof. Sedigheh Sajadian (IUT), Prof. Shahab Shahidi (DU, Iran), Prof. Wang Yu (ICRANet) and Prof. M. H. Zhollideh Haghighi (IPM,KNTU, Iran).

The scientific program is in preparation, and more details about the event will be published on its webpage: https://indico.icranet.org/event/2/. We kindly encourage you to register to the meeting at the following link: https://indico.icranet.org/event/2/registrations/4/

For more information about the ICRANet-Isfahan collaboration, please see: http://www.icranet.org/index.php?option=com_content&task=view&id=1059 - https://indico.icranet.org/event/2/page/9-icranet-isfahan

6. Upcoming meeting: Damour Fest meeting, IHES Paris, October 12-15, 2021



It gives us great pleasure to announce the meeting *"Damour Fest: Adventures in Gravitation"*, which will be held on October 12 - 15, 2021 at the Institut des Hautes Études Scientifiques (IHES, France) and online. The event will be held in a blended form, with talks given on site at IHES and others remotely through Zoom.

This conference, organized by Nathalie Deruelle (APC, Université de Paris), Alessandro Nagar (INFN Torino), and Slava Rychkov (IHES), would be a tribute on the occasion of the 70th anniversary of Prof. Thibault Damour. Prof. Damour is a permanent professor at IHES since 1989. He is a theoretical physicist specializing in general relativity and string theory. He is known worldwide for his innovative work on black holes, gravitational waves, and quantum cosmology. Throughout his career, he has received numerous international awards, such as the prestigious Einstein Medal and the CNRS Gold Medal, and more recently (in 2021) the Galileo Galilei Medal, the ICTP Dirac medal, and the Balzan Prize.

The confirmed invited speakers are: Prof. Leor Barack (University of Southampton), Prof. Sebastiano Bernuzzi (University of Jena), Prof. Lydia Bieri (Michigan University), Prof. Luc Blanchet (IAP, Paris), Prof. Alessandra Buonanno (AEI, MPI, Potsdam), Prof. Sophie De Buyl (Vrije Universiteit Brussel), Prof. Stanley Deser (Brandeis University), Prof. Marc Henneaux (Collège de France & ULB Bruxelles), Prof. Bala Iyer (ICTS, Tata institute, Bangalore), Prof. Piotr Jaranowski (University of Białystok), Prof. Sergiu Klainerman (Princeton University), Prof. Michael Kramer (MPI, Bonn), Prof. Juan Maldacena (IAS, Princeton), Prof. Viatcheslav Mukhanov (Ludwig Maximilian University, Munich), Prof. Hermann Nicolai (AEI, MPI, Potsdam), Prof. Adam Pound (University of Southampton), Prof. Giuseppe Policastro (ENS Paris), Prof. Alexander Polyakov (Princeton University), Prof. Manuel Rodrigues (ONERA, Université Paris-Saclay), Prof.

Remo Ruffini (ICRA, ICRANet), Prof. David Shoemaker (MIT), Prof. Sergey Solodukhin (University of Tours), Prof. Alexei Starobinski (Landau Institute, Moscow), Prof. Gabriele Veneziano (CERN & Collège de France), Prof. Alex Vilenkin (Tufts University) and Prof. Edward Witten (IAS, Princeton).

The programme is in preparation and will be available on the conference website at the following link: https://indico.math.cnrs.fr/event/6802/

We kindly encourage you to register to the meeting at the following link: https://indico.math.cnrs.fr/event/6802/registrations/557/

For more information, please contact Elisabeth Jasserand, the IHES scientific activities coordinator: jasserand@ihes.fr (email), +33 (0)160926604 (phone).

7. Seminar of Prof. Ivan Rybak at ICRANet center, September 22, 2021

On Wednesday, September 22, 2021, Dr. Ivan Rybak (Centro de Astrofísica da Universidade do Porto - Portugal) presented a seminar titled *"Cosmic (super/superconducting) strings as a probe of high energy physics"* with the following abstract:

The theoretical possibility of cosmic strings existence was suggested in the 1970s. Since that time, these hypothetical objects have passed through the ups and downs of scientific community attention. Cosmic strings evoked particular interest in the 2000s, whereby implementing superstring theory to the early universe description, we "have discovered cosmic strings lurking everywhere in the undergrowth", as was expressed by Tom Kibble. Nowadays, many scenarios that extend the Standard Model of particles physics suggest the production of cosmic string. Future missions, such as LISA, with improved observational facilities, will probe models where cosmic strings occur, thereby shedding light on possible early universe scenarios. In this talk, I will make a short overview of models where cosmic strings take place. I will provide state of the art methods to study the evolution of cosmic strings and explain why we should pay attention to cosmic superconducting and (super)strings. I will conclude with current and future observational constraints on cosmic strings.

The announcement of the seminar has also been published on ICRANet website: http://www.icranet.org/index.php?option=com_content&task=blogcategory&id=89&Itemid=781

The video of the seminar is available on ICRANet YouTube channel at the following link: https://youtu.be/sZr1LKzDIvw

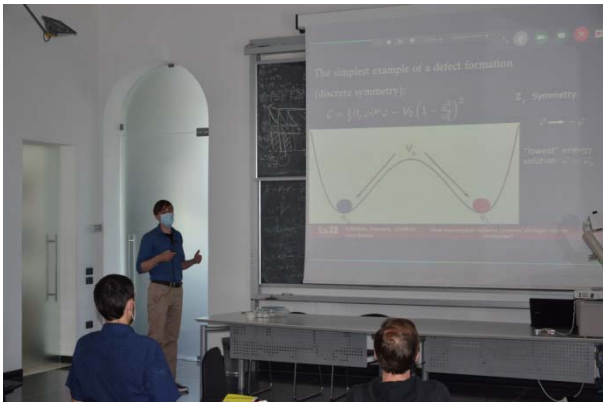


Fig. 5 and 6: Dr Ivan Rybak giving his seminar at ICRANet center in Pescara, September 22, 2021.

8. Visit of Prof. Vladimír Karas, Director of the Astronomical Institute of the Czech Academy of Sciences, at ICRA Seat, Rome, September 27, 2021

On September 27, 2021, Prof. Vladimír Karas, Director of the Astronomical Institute of the Czech Academy of Sciences, came to Italy and visited the ICRA Seat in Sapienza University of Rome. On that occasion, he had the possibility to visit the Seat and to sign the ICRA wall, as previously done by eminent scientists and Nobel laureates who collaborated with ICRA and gave their significant support to its activities. On that occasion, Prof. Ruffini discussed many scientific issues with Prof. Karas and had also the possibility to propose him a possible collaboration agreement between ICRANet and his center in Prague.

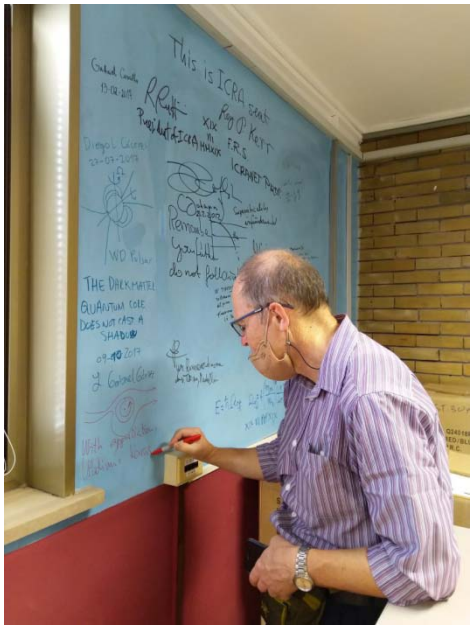


Fig. 7: Prof. Vladimír Karas, Director of the Astronomical Institute of the Czech Academy of Sciences, signing ICRA wall at the Sapienza University of Rome, September 27, 2021.

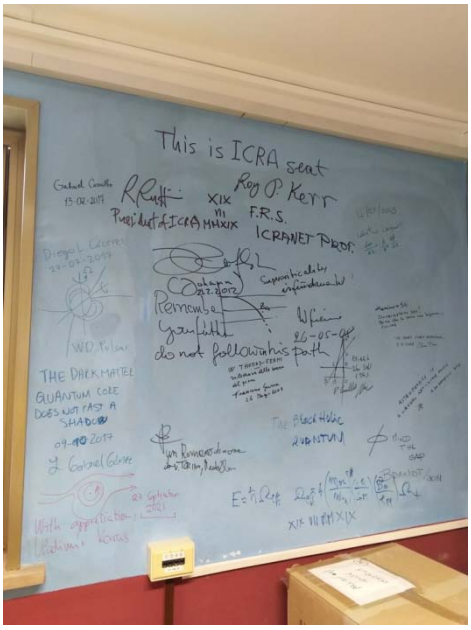
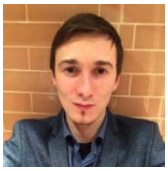


Fig. 8: ICRA wall at Sapienza University of Rome.

9. Scientific visits to ICRANet



- Dr. Ivan Rybak (Centro de Astrofísica da Universidade do Porto - Portugal), September 22-23, 2021
- Prof. Narek Sahakyan (Director of ICRANet Armenia), September 24 – 25, 2021

During their visit, those scientists had an opportunity to discuss their scientific research and to have fruitful exchange of ideas with other researchers from ICRANet and from different parts of the world.

10. Recent publications

Yen Chen Chen, *Classifying* ***Seyfert Galaxies with Deep Learning*** **ApJS 256** 34.

The traditional classification for a subclass of the Seyfert galaxies is visual inspection or using a quantity defined as a flux ratio between the Balmer line and forbidden line. One algorithm of deep learning is the convolution neural network (CNN), which has shown successful classification results. We build a one-dimensional CNN model to distinguish Seyfert 1.9 spectra from Seyfert 2 galaxies. We find that our model can recognize Seyfert 1.9 and Seyfert 2 spectra with an accuracy of over 80% and pick out an additional Seyfert 1.9 sample that was missed by visual inspection. We use the new Seyfert 1.9 sample to improve the performance of our model and obtain a 91% precision of Seyfert 1.9. These results indicate that our model can pick out Seyfert 1.9 spectra among Seyfert 2 spectra. We decompose the Hα emission line of our Seyfert 1.9 galaxies by fitting two Gaussian components and derive the line width and flux. We find that the velocity distribution of the broad Hα component of the new Seyfert 1.9 sample has an extending tail toward the higher end, and the luminosity of the new Seyfert 1.9 sample is slightly weaker than the original Seyfert 1.9 sample. This result indicates that our model can pick out the sources that have a relatively weak broad Hα component. In addition, we check the distributions of the host galaxy morphology of our Seyfert 1.9 samples and find that the distribution of the host galaxy morphology is dominated by a large bulge galaxy. In the end, we present an online catalog of 1297 Seyfert 1.9 galaxies with measurements of the Hα emission line.

DOI: 10.3847/1538-4365/ac13aa

Giommi P., Perri M., Capalbi M., D'Elia V., Barres de Almeida U., Brandt C.H., Pollock A.M.T., et al., ***X-ray spectra, light curves and SEDs of blazars frequently observed by Swift,*** **MNRAS, Volume 507, Issue 4, November 2021, Pages 5690–5702.**

Blazars research is one of the hot topics of contemporary extragalactic astrophysics. That is because these sources are the most abundant type of extragalactic γ-ray sources and are suspected to play a central role in multimessenger astrophysics. We have used Swift_xrtproc, a tool to carry out an accurate spectral and photometric analysis of the Swift-XRT data of all blazars observed by Swift at least 50 times between December 2004 and the end of 2020. We present a database of X-ray spectra, best-fit parameter values, count rates and flux estimations in several energy bands of over 31 000 X-ray observations and single snapshots of 65 blazars. The results of the X-ray analysis have been combined with other multifrequency archival data to assemble the broad-band Spectral Energy Distributions (SEDs) and the long-term light curves of all sources in the sample. Our study shows that large X-ray luminosity variability on different time-scales is present in all objects. Spectral changes are also frequently observed with a 'harder-when-brighter' or 'softer-when-brighter' behaviour depending on the SED type of the blazars. The peak energy of the synchrotron component (ν_{peak}) in the SED of HBL blazars, estimated from the log-parabolic shape of their X-ray spectra, also exhibits very large changes in the same source, spanning a range of over two orders of magnitude in Mrk421 and Mrk501, the objects with the best data sets in our sample.

DOI: https://doi.org/10.1093/mnras/stab2425

Fraga B.M.O., Barres de Almeida U., Bom C.R., Brandt C.H., Giommi P., Schubert P., de Albuquerque M.P., ***Deep learning Blazar classification based on multifrequency spectral energy distribution data,*** **MNRAS, Volume 505, Issue 1, July 2021, Pages 1268–1279.**

Blazars are among the most studied sources in high-energy astrophysics as they form the largest fraction of extragalactic gamma-ray sources and are considered prime candidates for being the counterparts of high-energy astrophysical neutrinos. Their reliable identification amid the many faint radio sources is a crucial step for multimessenger counterpart associations. As the astronomical community prepares for the coming of a number of new facilities able to survey the non-thermal sky at unprecedented depths, from radio to gamma-rays, machine-learning techniques for fast and reliable source identification are ever more relevant. The purpose of this work was to develop a deep learning architecture to identify Blazar within a population of active galactic nucleus (AGN) based solely on non-contemporaneous spectral energy distribution information, collected from publicly available multifrequency catalogues. This study uses an unprecedented amount of data, with spectral energy distributions (SEDs) of 14 000 sources collected with the Open Universe VOU-Blazars tool. It uses a convolutional long short-term memory neural network purposefully built for the problem of SED classification, which we describe in detail and validate. The network was able to distinguish Blazars from other types of active galactic nuclei (AGNs) to a satisfying degree (achieving a receiver operating characteristic area under curve of 0.98), even when trained on a reduced subset of the whole sample. This initial study does not attempt to classify Blazars among their different sub-classes, or quantify the likelihood of any multifrequency or multimessenger association, but is presented as a step towards these more practically oriented applications.

DOI: https://doi.org/10.1093/mnras/stab1349

S. Campion, J.A. Rueda, R. Ruffini, S.S. Xue, *Magnetic field screening in strong crossed electromagnetic fields*, Physics Letters B, Volume 820, 10 September 2021, 136562.

We consider crossed electric and a magnetic fields $\left(\vec{B} = B\,\hat{z},\ \vec{E} = E\,\hat{y}\right)$, with $E/B < 1$, in presence of some initial number of $e^{\pm}$ pairs. We do not discuss here the mechanism of generation of these initial pairs. The electric field accelerates the pairs to high-energies thereby radiating high-energy synchrotron photons. These photons interact with the magnetic field via magnetic pair production process (MPP), i.e. $\gamma + B \rightarrow e^{+} + e^{-}$, producing additional pairs. We here show that the motion of all the pairs around the magnetic field lines generates a current that induces a magnetic field that shields the initial one. For instance, for an initial number of pairs $N_{\pm},0=10^{10}$, an initial magnetic field of 10^{12}G can be reduced of a few percent. The screening occurs in the short timescales $10^{-21} \leq t \leq 10^{-15}$s, i.e. before the particle acceleration timescale equals the synchrotron cooling timescale. The present simplified model indicates the physical conditions leading to the screening of strong magnetic fields. To assess the occurrence of this phenomenon in specific astrophysical sources, e.g. pulsars or gamma-ray bursts, the model can be extended to evaluate different geometries of the electric and magnetic fields, quantum effects in overcritical fields, and specific mechanisms for the production, distribution, and multiplicity of the $e^{-}e^{+}$ pairs.

DOI: https://doi.org/10.1016/j.physletb.2021.136562

ICRANet Newsletter

October – November 2021

SUMMARY

1. The forth successful prediction of a supernova following a GRB by ICRANet scientists

On October 23rd, 2021, the Gamma-Ray Burst GRB 211023A was detected by the Fermi satellite (GCN 30958), both by the GBM instrument (GCN 30965), operating in keV-MeV energy range, and by the LAT instrument (GCN 30961), operating in the GeV energy range. GRB 211023A was detected as well by the AGILE satellite (GCN 30969) and by Konus/WIND (GCN 31022). The MASTER network of robotic telescopes detected the optical counterpart (GCN 30977). A large observational campaign followed this detection.

On November 8th, 2021, after 16 days of the detection of this GRB, the measurement of its spectroscopic redshift was reported by Pozanenko et al., (GCN 31053) thanks to the data of the BTA telescope of the SAO RAS.

Just 4 hours after the publication of GCN 31053 with the announcement of the redshift measurement, our groups at ICRANet and ICRA-USTC published GCN 31056 offering a theoretical interpretation of this event:

- computed an isotropic energy E_{iso}~$6x10^{52}$ erg for GRB 211023A from known distance thanks to to the measurement of the redshift and from prompt phase observations of the Fermi satellite;
- since its energy is between 10^{52} and 10^{54} ergs identified GRB 211023A as a type I BdHN;
- predicted the appearance of the peak of associated optical supernova emission at (18.4+/-2.6) days after the trigger (November 10th 2021, uncertainty from November 8th 2021 to November 12th 2021), with a bolometric optical luminosity of $L=(9.0+/-2.7)x10^{42}$ erg/s based on the statistics of 26 supernovae associated with GRBs (Della Valle et al., 2021).

On November 20th, 2021 the supernova was observed, see Fig. 1, as reported by Belkin et al. 2021 (GCN 31098), making it the fourth successful prediction of a supernova associated with GRB made by ICRANet scientists.

Large observational campaign in optical band is still ongoing, and as of today the lightcurve of this GRB is represented in Fig. 2.

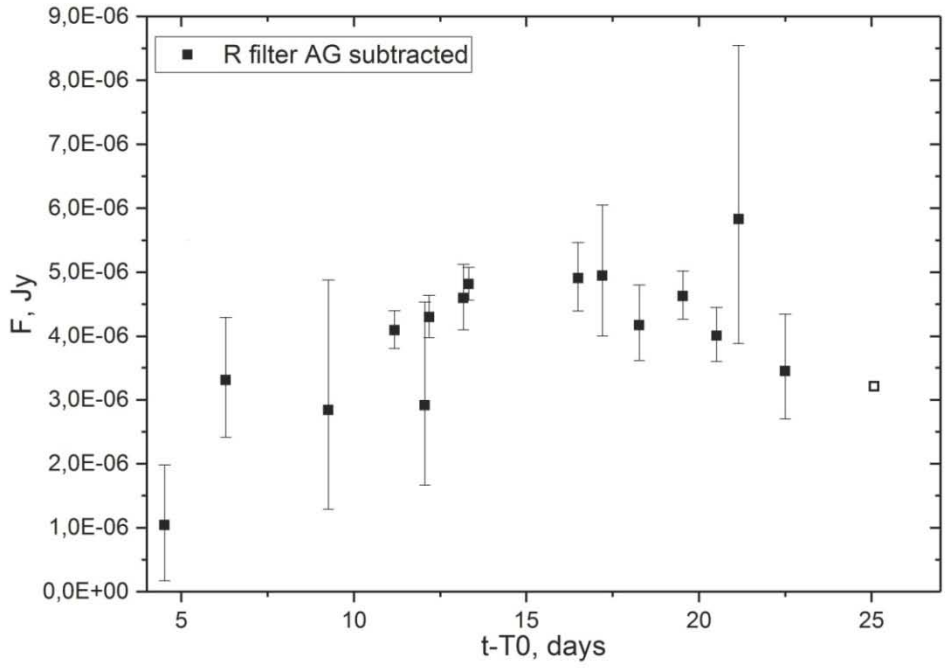


Fig. 1. Optical supernova following the GRB 211023A, predicted by the ICRANet team. Source: http://grb.rssi.ru/GRB211023A/GRB211023A_AG_subtracted_LC.png

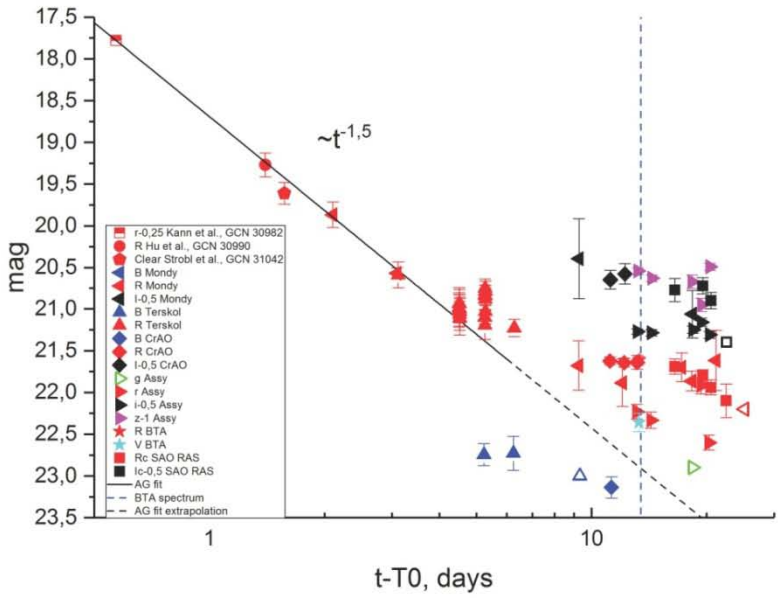


Fig. 2. The lightcurve of GRB 211023A as observed by different optical instruments.

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TITLE: GCN CIRCULAR
NUMBER: 31056
SUBJECT: GRB 211023A: A BdHN of type I
DATE: 21/11/08 19:17:11 GMT
FROM: Remo Ruffini at ICRA <ruffini@icra.it>

Y. Aimuratov, L. Becerra, C.L. Bianco, Y-C. Chen, C. Cherubini, S. Eslamzadeh, S. Filippi, M. Karlica, Liang Li, G.J. Mathews, R. Moradi, M. Muccino, G.B, Pisani, F. Rastegar Nia, J.A. Rueda, R. Ruffini, N. Sahakyan, Y. Wang, S.S. Xue, on behalf of the ICRANet and ICRA-USTC team, report:

The identification of the redshift z=0.36 of GRB 211023A (A. Pozanenko et al. 2021, GCN 31053), with the isotropic energy of E_{iso}~6x10^{52} erg in 10-1000 keV (S. Lesage et al. 2021, GCN 30965, S. Poolakkil et al. 2021, GCN 30998), qualify GRB 211023A as a BdHN I, confirmed by the observation of the GeV emission (N. Di Lalla et al. 2021, GCN 30961), originated from the black hole (R. Ruffini et al. 2019 ApJ 886 82, Moradi et al 2021. Phys. Rev. D 104, 063043) and the afterglow emission (Jan Strobl et al. 2021 GCN 31042) originated from the newborn neutron star (J.A. Rueda et al. 2020 ApJ 893 148).

Following Ruffini et al. 2021 (MNRAS, 504, 5301, doi:10.1093/mnras/stab724) we indicate the appearance of the peak of optical supernova to be observed at (18.4+/-2.6) days after the trigger (November 10th 2021, uncertainty from November 8th 2021 to November 12th 2021), with the bolometric optical luminosity of L=(9.0+/-2.7)x10^{42} erg/s.

The follow-up optical observations for the SN are recommended.

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TITLE: GCN CIRCULAR

NUMBER: 31098
SUBJECT: GRB 211023A: optical observations and photometric evidence of supernova
DATE: 21/11/20 14:54:34 GMT
FROM: Alexei Pozanenko at IKI, Moscow apozanen@iki.rssi.ru

S. Belkin (IKI), A. Pozanenko (IKI), I. Sokolov (INASAN, KIAM), E. Klunko (ISTP), A. S. Moskvitin (SAO RAS), V. Kim (HSE, FAI), V. Rumyantsev (CrAO), R. Ya. Inasaridze (AbAO), M. Krugov (FAI), D. Berezin (IC AMER NASU), G. Butenko (IC AMER NASU), N. Pankov (HSE), D. Datashvili (AbAO), V. R. Ayvazian (AbAO), G. V. Kapanadze (AbAO) report on behalf of GRB IKI FuN:
We observed the field of the GRB 211023A (Fermi GBM team, GCN 30958; Di Lalla et al., GCN 30961; Lesage et al, GCN 30965; Ursi et al, GCN 30969; Poolakkil, GCN 30998; Ridnaia et al., GCN 31022) with Zeiss-2000 and Zeiss-600 telescopes of Terskol observatory, AZT-33IK telescope of Sayan observatory (Mondy), AZT-20 telescope of Assy-Turgen observatory, ZTSh 2.6m-telescope of CrAO observatory, AS-32 telescope of AbAO observatory, and Zeiss-1000 1-m telescope of SAO RAS. The optical counterpart (Lipunov et al., GCN 30970; Zhirkov et al, GCN 30977; Kann et al, GCN 30982; Hu et al, GCN 30990; Belkin et al, GCN 31004; Vinko et al, GCN 31008; Belkin et al, GCN 31018; Belkin et al, GCN 31020; Kumar et al, GCN 31023; Gupta et al., GCN 31041; Strobl et al., GCN 31042; Pozanenko et al., GCN 31053; Moskvitin et al., GCN 31066) was detected in most of the stacked images. A preliminary light curve based on our observations and GCN Circulars cited above can cab be found at

http://grb.rssi.ru/GRB211023A/GRB211023A_LC.png

Starting from the fifth day, a systematic flux excess over the approximation of the afterglow by a single power law is observed. After subtraction of the afterglow approximated by the light curve with a power law (Belkin et al, GCN 31020), and neglecting a contribution of the host galaxy we determine a preliminary light curve of possible SN, see

http://grb.rssi.ru/GRB211023A/GRB211023A_AG_subtracted_LC.png

Using redshift of GRB 211023A (Pozanenko et al., GCN 31053) we calculated an absolute magnitude at the maximum of the supposed supernova (M_R=-19.9 +0.40 -0.29; adjusted by a Galactic extinction (Schlafly & Finkbeiner, 2011)) and a time since the burst trigger in the observer frame (t-T0 = 16.9+/-1.5). These parameters are in agreement with parameters of known SN-GRB (e.g. see Figure 12 from Belkin et al., Astronomy Letters, 2020). The supernova associated with GRB 211012A is in agreement with early predictions (Kann et al, GCN 30982; Aimuratov et al., GCN 31056; Minaev et al., GCN 31081).

2. ICRANet - Isfahan Astronomy Meeting, IUT (Iran) and online, November 3-5, 2021

The *"ICRANet - Isfahan Astronomy Meeting. From the Ancient Persian Astronomy to Recent Developments in Theoretical and Experimental Physics, Astrophysics and General Relativity"* took place from 3 to 5 November 2021. Isfahan, an historical city in the center of Iran and one of the world's most beautiful cities, hosted the first series of this meeting at the Isfahan University of Technology (IUT - Iran) and online.

The meeting, organized under the aegis of the H.E. Mohammad Ali Zolfigol, Minister of Science, Research and Technology of the Islamic Republic of Iran, exceeded every expectation with more than 190 registered participants and attendees. This meeting, by inviting more than 33 prominent speakers from more than 16 countries, provided a great opportunity for discussing about topics ranging from the ancient Persian astronomy to recent developments in observational astronomy, high energy astrophysical phenomena such as Gamma-Ray Bursts (GRBs) and Active Galactic Nuclei (AGNs), Theories of Gravity, General Relativity and its mathematical foundation, Black Holes, Dark matter and Early Universe Cosmology. The rich program of the conference included 33 talks and a workshop on Data Science in Astrophysics.

Members of the meeting Scientific Committee were Prof. Remo Ruffini (ICRANet/ICRA), co-chair with Prof. Yousef Sobouti (ISABS, Iran), Prof. Hassan Firouzjahi (IPM, Iran), Prof. Shahram Khosravi (KHU, Iran), Prof. Habib Khosroshahi (IPM), Prof. Kourosh Nozari (UMZ, Iran), Prof. Sohrab Rahvar (SUT, Iran), Prof. Soroush Shakeri (IUT), Prof. Shadi Tahvildar-Zadeh (Rutgers, USA) and Prof. She-Sheng Xue (ICRANet).

Members of the meeting Organizing Committee were the Chair, Prof. Soroush Shakeri (IUT), Prof. Amin Farhang (IPM and IUT), Prof. Fazlollah Hajkarim (UNIPD, Italy), Prof. Rahim Moradi (ICRANet), Prof. Sedigheh Sajadian (IUT), Prof. Shahab Shahidi (DU, Iran), Prof. Wang Yu (ICRANet) and Prof. M. H. Zhollideh Haghighi (IPM,KNTU, Iran).

The opening remarks of the meeting have been presented by H.E. Mohammad Ali Zolfigol, Minister of Science, Research and Technology of the Islamic Republic of Iran, who sent a special thanks to IUT and ICRANet (the organizers) as well as to the Scientific and Organizing Committee of the meeting. He also gave a very warm welcome to all the participants, highlighting his strong

support to this significant event, which marked the continuation of a longstanding, active and fruitful collaboration between ICRANet and the Islamic Republic of Iran and, more generally, between Italy and the Islamic Republic of Iran. The speech of the Minister has been presented to the participants by Prof. Yousef Sobouti (founder of IASBS).

Prof. Mohammad Ali Zolfigol, Minister of Science, Research and Technology of the Islamic Republic of Iran.

Prof. S. M. Abtahi, President of the Isfahan University of Technology (IUT).

Prof. Yousef Sobouti (founder of IASBS).

Following this speech, Prof. Sobouti also gave a talk about the development of the modern astronomy in Iranian universities in the morning session. This continued by a presentation from Prof. Remo Ruffini about the 50th anniversary of *"Introducing the Black Hole"* and his non-stop efforts during past decades to understand the physical nature of Gamma Ray Bursts (GRBs) as the most luminous explosions in the Universe. After the lecture by prof. Ruffini, Prof. Habib Khosroshahi (Iranian National Observatory – INO - Project Director) presented an extensive overview about the Iranian National Observatory and its 3.4m optical telescope. He also drew the attention to the unique potential of INO to follow the transient sources such as GRBs. During the meeting, a series of talks have been presented about the physics of GRBs, GRBs in the optical domain, GRB - Supernovae connection and the use of GRBs as a cosmological tool which led to many interactive discussions. The first day of the meeting finished with a presentation by Prof. Shadi Tahvildar-Zadeh about the dream of Einstein to arrive at a quantum theory of atomistic matter , which included electrodynamics phenomena.

The second day of the meeting started with a presentation by Prof. Roy Patrick Kerr: he discussed about the nature of singularities and his Kerr metric, which was among hot topics in most of the scientific discussions around General Relativity (GR) in the past 50 years. Afterwards, Prof. Shing-Tang Yau talked about the notion of angular momentum in GR. There were several talks in the morning session about some European missions in astrophysics, such as New high precision tests of GR presented by Prof. Claus Lammerzahl, Mercury and the Bepi Colombo mission presented by Prof. Roberto Peron and also about Square Kilometre Array (SKA) project presented by Prof. Fatemeh Tabatabaei. This day finished with a workshop on *"Data Science and Machine Learning in Relative Astrophysics"* in the afternoon session, chaired by Prof. Wang Yu and Prof. Rahim Moradi.

The last day of the meeting started with a talk given by Prof. Hossein Masoumi Hamedani about the similarities and the differences of the methods of Ibn al-Haytham and that of the Galileo discussing about the Light of the Moon. Then, Prof. Richard Kerner presented an historical talk from a European perspective about Astronomy in Islamic World. There were also several talks about the Dark Matter, Modified Gravity and Early Universe Cosmology in the morning and afternoon sessions, which made the program of the meeting more richer.

The recordings of the different sessions are available on the ICRANet YouTube channel at the following link: https://www.youtube.com/watch?v=6nM0WwpawdM&list=PLr5RLbSWSonuzZt0K4CkKjbHuKcYgpSZl&index=2

For more information about the meeting and about the proceedings publication, please check the official webpage of the meeting: https://indico.icranet.org/event/2/

For the IUT newsletter issue on this meeting and the speeches delivered in the opening session of ICRANet-Isfahan Astronomy Meeting, please see: http://english.iut.ac.ir/newsletter

3. Visit of H.E. Alfonso Di Riso, Ambassador of Italy in Armenia, to the ICRANet Armenia Seat, November 30, 2021

Fig. 3: H.E. Alfonso Di Riso, Ambassador of Italy in Armenia with Prof. Narek Sahakyan, Director of ICRANet Seat in Armenia, visiting the center on Tuesday November 30, 2021.

On November 30, 2021, the Ambassador Extraordinary and Plenipotentiary of Italy to Armenia, H.E. Alfonso Di Riso and the Head of the Consular and Administrative Department, Dr Annarosa Colangelo, visited the ICRANet Armenia Seat, located at the National Academy of Sciences of the Republic of Armenia.

Prof. Narek Sahakyan, Director of the ICRANet Seat in Armenia, presented the center and its current activities as well as the main research topics and the obtained results. Also, the current projects implemented with the ICRANet center in Pescara have been presented and discussed. The importance of the ICRANet Armenia center to expand the activities of ICRANet in the regional countries was highlighted and discussed.

Both parties strongly highlighted the importance of the Armenian-Italian scientific cooperation in the field of astrophysics and discussed the possibilities of further develop and expand the Armenian-Italian scientific cooperation.

Press Release by the National Academy of Sciences of Armenia (in Armenian): https://www.sci.am/newsview.php?id=454&arch=&langid=2

4. New cooperation protocol between ICRANet and Peoples' Friendship University of Russia (RUDN), October 27, 2021

On October 27, 2021 ICRANet has signed a new Cooperation protocol with the Peoples' Friendship University of Russia (RUDN). The Cooperation Protocol has been signed by Prof. Oleg Yastrebov (Rector of RUDN), by Prof. Yefremov Alexander Petrovich (President IGC of RUDN), by Prof. Remo Ruffini (Director of ICRANet) and By Prof. Narek Sahakyan (Director of ICRANet Seat in Armenia).

The agreement will be valid for 5 years and the main joint activities to be developed under their framework 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, the development of inter-institutional research areas associated to local graduate programs and joint publications.

For the text of the Cooperation Protocol: http://www.icranet.org/index.php?option=com_content&task=view&id=1398

5. ICRANet scientists are among the top 2 per cent of most cited authors, according to Elsevier

Recent update of the publicly available database of over 100,000 top-scientists listed by Elsevier, show that Prof. Remo Ruffini (Director of ICRANet), Prof. Thibault Damour (IHES, Paris), Prof. Paolo Giommi (ASI, Rome), Prof. Behzad Eslam Panah (ICRANet-Mazandaran, Iran), Prof. Thomas Buchert (Centre de Recherche Astrophysique de Lyon, UCBL1, ENS-L, CNRS, France), Prof. Donato Bini (CNR), Prof. Chris L. Fryer (University of Arizona, Tucson), Prof. Hagen Kleinert (Richard Feynmann - ICRANet Chair, Freie Universitat Berlin), Prof. Hernando Quevedo (Institute of Nuclear Science, UNAM) and several other ICRANet scientists are in this list.

Prof. Remo Ruffini

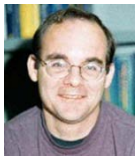
Prof. Thibault Damour

Prof. Paolo Giommi

Prof. Behzad Eslam Panah

Prof. Thomas Buchert

Prof. Donato Bini



Prof. Chris L. Fryer

Prof. Hagen Kleinert

Prof. Hernando Quevedo

Reference:

Baas, Jeroen; Boyack, Kevin; Ioannidis, John P.A. (2021), *"August 2021 data-update for "Updated science-wide author databases of standardized citation indicators"*, Mendeley Data, V3, DOI: https://doi.org/10.17632/btchxktzyw.2

6. Italian Knowledge Leaders meeting, November 24, 2021

Fig. 4: Prof. Remo Ruffini receiving his prize on the occasion of the Italian Knowledge Leaders meeting, November 24, 2021

On November 24, 2021, Prof. Ruffini, Director of ICRANet has been invited to participate to the Italian Knowledge Leaders. This project, organized under the aegis of the Italian Ministry of tourism, aims to start a path which will bring together the support of the italian Institutions and firms as well as the scientific and cultural competences of the most relevant "knowledge leaders" of our country. This meeting was attended by relevant representatives of the national and local Institutions, as well as by a delegation of the main 'Italian Knowledge Leaders', prominent members of the international scientific and professional Institutions.

This event initiated a series of meetings, which will provide a nice occasion to organize networking activities, training courses and conferences aiming at to improve the awareness of the scientific and cultural development at national and international level. The main goal of the project is to give the right recognition to these "intellectual leaders" as ambassadors of the italian intellectual capital, involving them in the promotion of Italy as a "destination of knowledge" and encouraging the opinion leader to be even more active at international level, in order to promote the scientific and cultural knowledge of our country.

At the end of the meeting, Prof. Ruffini has also received an award recognizing his fundamental role in this field as an "Italian Knowledge leader".

7. Visit of Prof. Remo Ruffini to Bremen (Germany), October 31-November 2, 2021

Fig. 5: From left to right: Dr. Claudia Schilling (Senator for Science and Ports), Marco Fuchs (Honorary Consul of Italy in Bremen and OHB), and Dr. Vincenzo Fiorentini (Italian Embassy in Berlin) during the meeting with Prof. Remo Ruffini.

From October 31 to November 2, 2021, Prof. Remo Ruffini, Director of ICRANet, visited Bremen (Germany). On November 1, he participated to a very important meeting concerning the collaboration ICRANet – Bremen, the proposal of a collaboration project and the possible entrance of Germany to ICRANet as a Member State. Several eminent representatives joined the meeting, such as Dr. Claudia Schilling (Senator for Science and Ports), Marco Fuchs (Honorary Consul of Italy in Bremen and OHB), Dr. Arianna Pascoli (Honorary Consulate of Italy in Bremen), Marco Eggert (Honorary Consulate of Italy in Bremen), Dr. Vincenzo Fiorentini (Italian Embassy in Berlin), Prof. Dr. Hansjörg Dittus (University of Bremen), Priv.-Doz. Dr. Eva Hackmann (University of Bremen), Dr. Meike List (University of Bremen) and Prof. Claus Laemmerzahl (University of Bremen). After that strategic meeting, a joint German – Italian cooperation project, with a leading role played by Bremen and ICRANet, is in preparation.

8. Damour fest meeting, IHES Paris (France), October 12 – 15, 2021

Fig. 6: from the left to the right: Prof. Thibault Damour, Prof. Remo Ruffini and Prof. Nathalie Deruelle.

From October 12 to 15, 2021 Professor Ruffini, Director of ICRANet, visited Institut des Hautes Études Scientifiques (IHES) in Paris (France). Prof Ruffini was invited to deliver a plenary lecture on the occasion of the Damour fest meeting. This conference, organized by Nathalie Deruelle (APC, Université de Paris), Alessandro Nagar (INFN Torino), and Slava Rychkov (IHES), has been a tribute on the occasion of the 70th anniversary of Prof. Thibault Damour.

Prof. Ruffini presented a lecture titled *"On the nature of the ultrarelativistic prompt emission phase of GRB 190114C and GRB 180720B"*, here below the abstract:

We address the physical origin of the ultra-relativistic prompt emission (UPE) phase of GRB 190114C and GRB 180720B. We assume that during the UPE phase, the "inner engine" of the GRB, composed of a Kerr black hole (BH) and a uniform test magnetic field B_0, aligned with the BH rotation axis, a Wald - Papapetrou solution operates in an overcritical field $|E| \geq E_c$, where $E_c = m^2_e c^3/(e\hbar)$, being m_e and $-e$ the mass and charge of the electron. We infer an e^+e^- pair electromagnetic plasma in presence of a baryon

load, a PEMB pulse, originating from a vacuum polarization quantum process in the inner engine. This modifies both the boundary conditions and the physics interpretation of the pioneering work of Damour-Ruffini 1975. The new process determine the time varying mass and spin of the Kerr BH in the inner engine, fulfilling the Christodoulou-Hawking-Ruffini mass-energy formula of a Kerr BH. For the first time, we quantitatively show how the inner engine, by extracting the rotational energy of the Kerr BH, produces a series of PEMB pulses and the overall GRBs MeV emissions (detailed in Phys. Rev. D: https://doi.org/10.1103/PhysRevD.104.063043).

Fig. 7: Prof. Ruffini delivering his plenary lecture on the occasion of the Damour Fest meeting at IHES (Paris).

For the website of the meeting: https://indico.math.cnrs.fr/event/6802/overview

For the video of Prof. Ruffini presentation on YouTube: https://www.youtube.com/watch?v=V50aJ5UQx_w

9. Armenian Summit of Minds, Dilijan (Armenia), October 23-24, 2021

Fig. 8: Group photo of the Armenian Summit of Minds 2021, Dilijan

From October 23 to 24, 2021, Professor Ruffini, Director of ICRANet, was invited by the President of the Republic of Armenia, H. E. Armen Sarkissian, to participate to the Armenian Summit of Minds 2021. This meeting united famous figures of the world's political, economic, scientific, and cultural circles. It was a unique platform for exchanging ideas, knowledge and experience, the main goals of which are to present new ideas on most significant issues of global interest and establish mutually reliable partnerships through direct discussions. High level representatives in the field of international politics and economy were present.

On Sunday, October 24, Prof. Ruffini was also invited to participate to the gala dinner and official reception hosted by H.E. Armen Sarkissian at the Presidential Palace.

For video and photos of the meeting: https://www.president.am/en/press-release/search/?search_q=summit+of+minds

10.Space Tech expo Europe, Bremen (Germany), November 16-18, 2021

Fig. 9: H.E. Armando Varricchio, Ambassador of Italy in Berlin, during the Space Tech Expo meeting in Bremen.

From November 16 to 18, 2021, Professor Ruffini, Director of ICRANet, participated to the meeting Space Tech Expo Europe, organized in Bremen (Germany). Comprising of 75+ high-level speakers focusing on key topics including investment, launch, sustainability, space exploration and downstream applications, the conference provided a very critical insights into the most exciting innovations and developments in the European (and beyond) space industry. It brought together professionals in the space industry in Europe and beyond, high-level industry experts from space agencies, prime integrators, New Space start-ups and suppliers, in order to discuss current trends, developments and challenges in the market, as well as innovative and ground-breaking technologies.

On Tuesday November 16, Prof. Ruffini was also invited to participate to the gala dinner organized by OHB, one of the leading aerospace industries in Europe, located in Bremen. OHB has been also collaborating with participated highly qualified italian companies in important space missions.

For more information about the meeting: https://www.spacetechexpo.eu/

11.USTC Global Vista - Europe Day, November 17, 2021

The USTC Global Vista - Europe Day took place at the University of Sciences and Technology of China (USTC) and online from November 16 to 17, 2021. On that occasion, around 20 Universities and Colleges from Germany (RWTH Aachen University, University of Jena, University of Cologne, Technical University of Munich), France (French Higher Education Agency, Paris Technical School of Engineering, Nantes Centrale, EPITA French Higher School of Information Engineers, Tours and Orleans School of Engineering, ISEP Paris School of Electronics and

Computer Information Engineers, Toulouse First University, French SKEMA Business School, Lyon Business School, France, ESSEC Business School), the Netherlands (University of Twente), Belgium (Dutch Free University of Brussels - VUB), Ghent University), Italy (ICRANet and the University of Ferrara - UNIFE), and Poland (University of Warsaw) jointly launched an online presentation of their PhD active programs.

Wednesday, November 17 was totally devoted to Astrophysics. On that occasion, Prof. Remo Ruffini (Director of ICRANet), followed by Prof. Jorge Rueda (ICRANet Faculty Professor, UNIFE) and Prof. Piero Rosati (UNIFE), have been invited to give a plenary lecture presentation. The day started with the opening remarks by Prof. Ruffini, Prof. Rosati and Prof. Rueda. The first lecture was presented by Prof. Ruffini on the occasion of the 50th anniversary of the article "Introducing the Black Hole" by Remo Ruffini and John A. Wheeler. The second lecture was presented by Prof. Rosati about the structure of the University of Ferrara and the new joint PhD program on Relativistic Astrophysics (JIRA PhD) established by USTC and UNIFE, with the participation of ICRANet and ICRA. The last lecture, on ICRANet Seats and structures, has been presented by Prof. Jorge Rueda.

https://mp.weixin.qq.com/s/NG-FewMlj9zF2trS0re90A

12. *"From the Sundial to the Relativity"*, online meeting, October 1, 2021

Fig. 10: Prof. Sigismondi chairing the online event "From the Sundial to the Relativity" on October 1, 2021.

The event *"From the Sundial to the Relativity"* has been held virtually on October 1, 2021. Prof. Costantino Sigismondi, ICRANet collaborator and chair of the event, thanks also to the support of ICRANet and many other scientists from all over the world, organized this virtual meeting as well as a podcast meeting in order to create a nice occasion for discussion among students and researchers. This event is part of the series "School and Research" coordinated as well by Prof. Sigismondi.

The virtual meeting started at 10 AM on Friday October 1, with the opening remarks made by Prof. Sigismondi and went on with some important contributions by Lorenzo Ricciardi, Diego Guglielmi and G. Dragut. The main topics discussed during the meeting went from the history and the

alignment of the Vatican obelisk, to the limit between special and general relativity, the planet Earth and the light's aberration, the figure of James Bradley and the aberration of Gamma Draconis, the work of Le Verrier on the orbit of Mercury, the meridian of Saint Peter and the day observation of the Stars. Other topics were also discussed, such as the Comets grazing the Sun, the interaction between the Earth, the Sun and the climate, the main difference concerning the climate in the past and in the future, the Calderone of Gran Sasso, the well of Monte Amaro, the Terminillo, the Velino and the date of disappearance of the snow.

This theoretical section was also integrated with the podcast materials prepared by Prof. Sigismondi. The program of the event and all the relevant podcast materials, can be found at the following link: http://www.icranet.org/index.php?option=com_content&task=view&id=1390

A recording of the meeting can also be found on ICRANet YouTube channel: https://www.youtube.com/watch?v=_INBWTo2s78&t=418s

13.Scientific visits to ICRANet

- Dr Yerlan Aimuratov

Fesenkov Astrophysical Institute – Kazakhstan
October 8 – 31, 2021

- Sareh Eslamzadeh Askestani

University of Mazandaran – Iran
October 8, 2021 – ongoing

- Prof. Massimo Della Valle

Osservatorio di Capodimonte – Italy
November 24 – 25, 2021

Dr Yerlan Aimuratov

Sareh Eslamzadeh Askestani

Prof. Massimo Della Valle

During their visit, those scientists had an opportunity to discuss their scientific research and to have fruitful exchange of ideas with other researchers from ICRANet and from different parts of the world.

14. Recent publications

C. R. Argüelles, M. F. Mestre, E. A. Becerra-Vergara, V. Crespi, A. Krut, J. A. Rueda, R. Ruffini, *What does lie at the Milky Way centre? Insights from the S2 star orbit precession*, ref. MN-21-3399-L.R2, accepted for publication in Monthly Notices of the Royal Astronomical Society Letters.

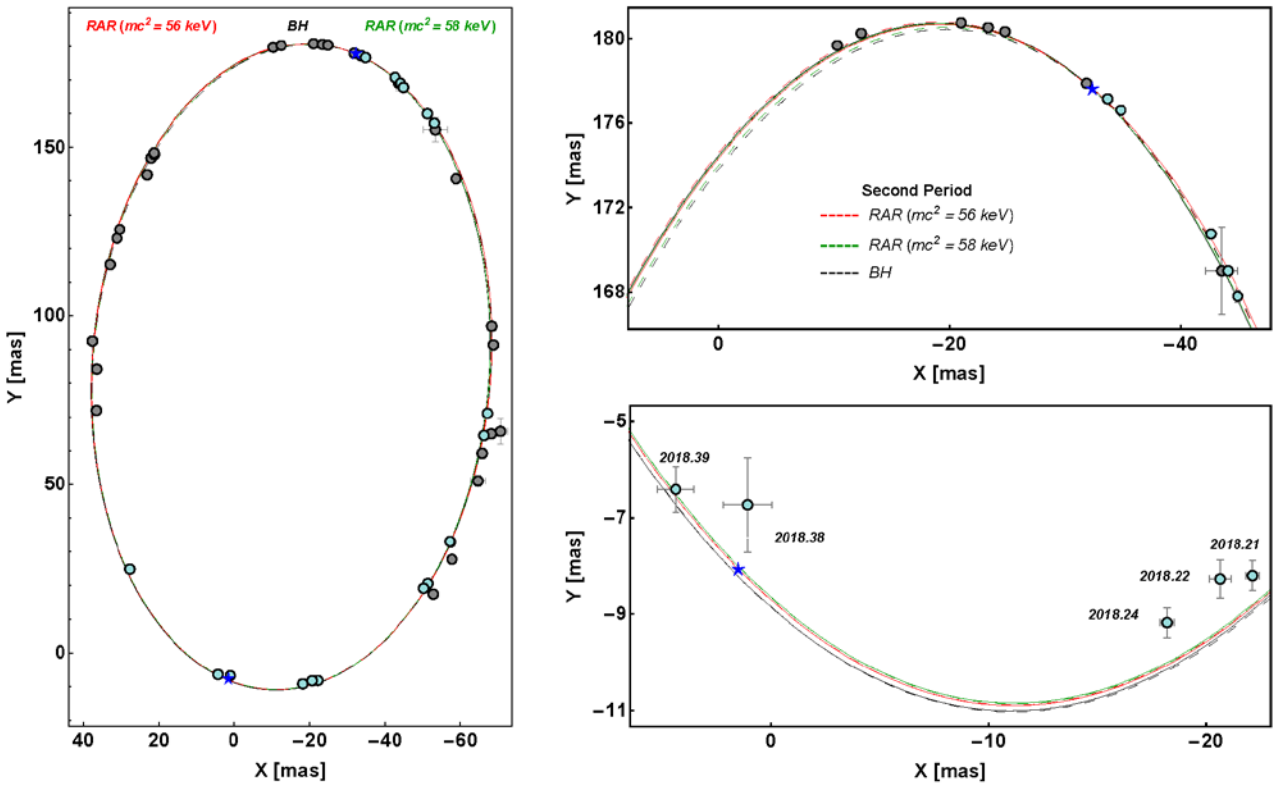


Fig. 11: Relativistic precession of S2 in the projected orbit on the plane of the sky as predicted in the BH and RAR DM models. While it is prograde for the BH and RAR (m = 58 keV/c^2) (in dashed black and green respectively), it is retrograde for the RAR DM model (m = 56 keV/c^2) (in dashed red). The solid (theoretical) curves and gray (data) points correspond to the first period (1994–2010) while the dashed (theoretical) curves and cyan (data) points to the second period (2010–2026). Right panels: zoom of the region around apocentre (top panel) and pericentre (bottom panel). The astrometric measurements are taken from Do et al. (2019).

It has been recently demonstrated that both, a classical Schwarzschild black hole (BH), and a dense concentration of self-gravitating fermionic dark matter (DM) placed at the Galaxy centre, can explain the precise astrometric data (positions and radial velocities) of the S-stars orbiting SgrA*. This result encompasses the 17 best resolved S-stars, and includes the test of general relativistic effects such as the gravitational redshift in the S2-star. In addition, the DM model features another remarkable result: the dense core of fermions is the central region of a continuous density distribution of DM whose diluted halo explains the Galactic rotation curve. In this Letter, we complement the above findings by analyzing in both models the relativistic periapsis precession of the S2-star orbit. While the Schwarzschild BH scenario predicts a unique prograde precession for S2, in the DM scenario it can be either retrograde or prograde, depending on the amount of DM mass enclosed within the S2 orbit, which in turn is a function of the DM fermion mass, see Fig. 7. We show that all the current and publicly available data of S2 cannot discriminate between the two models, but upcoming S2 astrometry close to next apocentre passage could potentially establish if SgrA* is governed by a classical BH or by a quantum DM system.

ArXiv: https://arxiv.org/abs/2109.10729

Zhu, M., Zheng, Y., *Improved DHOST Genesis*, published on November 22, 2021 on J. High Energ. Phys. 2021, 163 (2021).

We improve the DHOST Genesis proposed in [1], such that the near scale invariant scalar power spectrum can be generated from the model itself, without invoking extra mechanism like a string gas. Besides, the superluminality problem of scalar perturbation plagued in [1] can be rescued by choosing proper DHOST action.

DOI: https://doi.org/10.1007/JHEP11(2021)163

Mian Zhu, Amara Ilyas, Yunlong Zheng, Yi-Fu Cai, Emmanuel N. Saridakis, *Scalar and tensor perturbations in DHOST bounce cosmology*, published on November 2021 on JCAP11(2021)045.

We investigate the bounce realization in the framework of DHOST cosmology, focusing on the relation with observables. We perform a detailed analysis of the scalar and tensor perturbations during the Ekpyrotic contraction phase, the bounce phase, and the fast-roll expansion phase, calculating the power spectra, the spectral indices and the tensor-to-scalar ratio. Furthermore, we study the initial conditions, incorporating perturbations generated by Ekpyrotic vacuum fluctuations, by matter vacuum fluctuations, and by thermal fluctuations. The scale invariance of the scalar power spectrum can be acquired introducing a matter contraction phase before the Ekpyrotic phase, or invoking a thermal gas as the source. The DHOST bounce scenario with cosmological perturbations generated by thermal fluctuations proves to be the most efficient one, and the corresponding predictions are in perfect agreement with observational bounds. Especially the tensor-to-scalar ratio is many orders of magnitude within the allowed region, since it is suppressed by the Hubble parameter at the beginning of the bounce phase.

DOI: https://doi.org/10.1088/1475-7516/2021/11/045

Gasparyan, S; Bégué, D.; Sahakyan, N., *Time-dependent lepto-hadronic modeling of the emission from blazar jets with SOPRANO: the case of TXS 0506+056, 3HSP J095507.9+355101 and 3C 279*, accepted for publication in MNRAS.

The observation of a very-high-energy neutrino by IceCube (IceCube-170922A) and its association with the flaring blazar TXS 0506+056 provided the first multimessenger observations of blazar jets, demonstrating the important role of protons in their dynamics and emission. In this paper, we present SOPRANO (https://www.amsdc.am/soprano), a new conservative implicit kinetic code which follows the time evolution of the isotropic distribution functions of protons, neutrons and the secondaries produced in photo-pion and photo-pair interactions, alongside with the evolution of photon and electron/positron distribution functions. SOPRANO is designed to study leptonic and hadronic processes in relativistic sources such as blazars and gamma-ray bursts. Here, we use SOPRANO to model the broadband spectrum of TXS 0506+056 and 3HSP J095507.9+355101, which are associated with neutrino events, and of the extreme flaring blazar 3C 279. The SEDs are interpreted within the guise of both a hadronic and a hybrid model. We discuss the implications of our assumptions in terms of jet power and neutrino flux.

ArXiv: https://arxiv.org/abs/2110.01549

MAGIC collaboration, *First detection of VHE gamma-ray emission from TXS 1515-273, study of its X-ray variability and spectral energy distribution*, published in MNRAS, Volume 507, Issue 1, October 2021, pp.1528-1545.

We report here on the first multiwavelength (MWL) campaign on the blazar 1ES 1515–273, undertaken in 2019 and extending from radio to very-high-energy gamma-rays (VHE). Up until now, this blazar had not been the subject of any detailed MWL observations. It has a rather hard photon index at GeV energies and was considered a candidate extreme high-synchrotron-peaked source. MAGIC observations resulted in the first-time detection of the source in VHE with a statistical significance of 7.6σ. The average integral VHE flux of the source is 6 ± 1 per cent of the Crab nebula flux above 400 GeV. X-ray coverage was provided by Swift-XRT, XMM–Newton, and NuSTAR. The long continuous X-ray observations were separated by ∼9 h, both showing clear hour scale flares. In the XMM–Newton data, both the rise and decay time-scales are longer in the soft X-ray than in the hard X-ray band, indicating the presence of a particle cooling regime. The X-ray variability time-scales were used to constrain the size of the emission region and the strength of the magnetic field. The data allowed us to determine the synchrotron peak frequency and classify the source as a flaring high, but not extreme synchrotron-peaked object. Considering the constraints and variability patterns from the X-ray data, we model the broad-band spectral energy distribution. We applied a simple one-zone model, which could not reproduce the radio emission and the shape of the optical emission, and a two-component leptonic model with two interacting components, enabling us to reproduce the emission from radio to VHE band.

DOI: https://doi.org/10.1093/mnras/stab1994

Fan Xu, Jin-Jun Geng, Xu Wang, Liang Li, Yong-Feng Huang, *Is the Birth of PSR J0538+2817 Accompanied by a Gamma-ray Burst?*, accepted for publication in MNRAS.

Recently, the Five-hundred-meter Aperture Spherical radio Telescope (FAST) measured the three-dimensional velocity of PSR J0538+2817 in its associated supernova remnant S147 and found a possible spin-velocity alignment in this pulsar. Here we show that the high velocity and the spin-velocity alignment in this pulsar can be explained by the so-called electromagnetic rocket mechanism. In this framework, the pulsar is kicked in the direction of the spin axis, which naturally explains the spin-velocity alignment. We scrutinize the evolution of this pulsar and show that the pulsar kick can create a highly relativistic jet at the opposite direction of the kick velocity. The lifetime and energetics of the jet is estimated. It is argued that the jet can generate a Gamma-ray Burst (GRB). The long term dynamical evolution of the jet is calculated. It is found that the shock radius of the jet should expand to about 32 pc at present, which is well consistent with the observed radius of the supernova remnant S147 (32.1±4.8 pc). Additionally, our calculations indicate that the current velocity of the GRB remnant should be about 440 km s^{-1}, which is also consistent with the observed blast wave velocity of the remnant of S147 (500 km s^{-1}).

ArXiv: https://arxiv.org/abs/2109.11485