Enclosure 9

The 2019 ICRANet Newsletters

ICRANet Newsletter

December 2018 – January 2019

SUMMARY

1. On the ultra-relativistic Prompt Emission (UPE), the Hard and Soft X-ray Flares, and the extended thermal emission (ETE) in GRB 151027A

The paper with this title co-authored by R. Ruffini, L. Becerra, C.L. Bianco et al., has been published by the Astrophysical Journal on 20 of December 2018.

A new study by ICRANet group led by prof. Ruffini published in prestigious Astrophysical Journal on 20 of December 2018 sheds light on the time sequence of emission from binary-driven hypernova (BdHN), with progenitor a carbon-oxygen core on the verge of a supernova (SN) explosion and a binary companion neutron star (NS). The GRB 151027A is selected as a prototype and its emission is characterized by the following episodes: the Ultra-relativistic Prompt emission (UPE) and the Flare-Plateau-Afterglow phase (FPA). The model is applied to study a multiple component in the UPE phase observed in the range of 10–1000 keV as well as the Hard X-ray Flares observed in the range of 0.3–150 keV, the extended-thermal-emission (ETE), and finally the soft X-ray flare observed in the range of 0.3–10 keV.

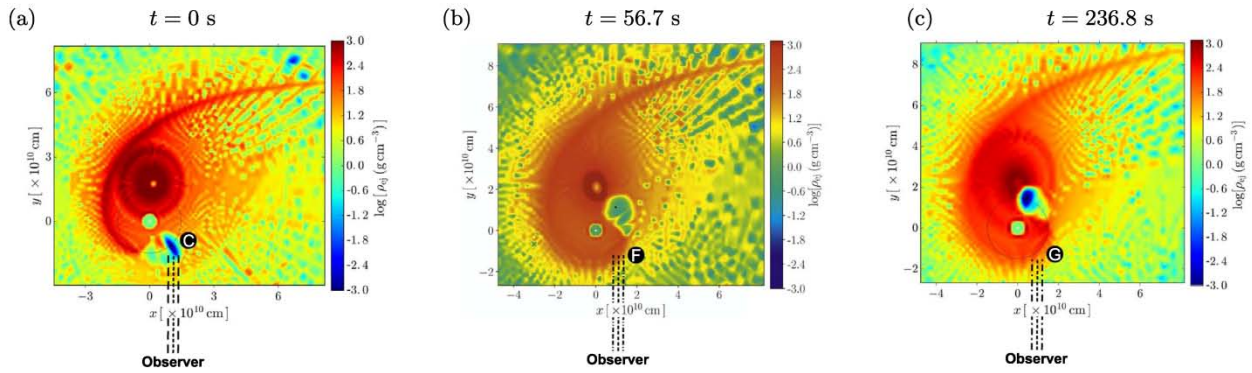


Fig. 1. Snapshots of the density distribution of the SN ejecta in the equatorial plane of the progenitor binary system at selected instants of time.

Fig. 1 shows three snapshots of the density distribution of the SN ejecta in the equatorial plane of the progenitor binary system composed initially of a FeCO core and a neutron star. After the SN explosion the ejecta reaches the NS companion and accretion onto NS starts. Panel (a) shows the snapshot at the time t=0 when the NS companion reaches the critical mass and leads to the formation of a BH (black dot). At point C, the NS companion collapses into a BH, and an e^+e^- plasma — the dyadosphere—is formed (Ruffini 1999). The remaining part of the plasma impacts with the high-density portion of the SN ejecta (point E), propagates inside the ejecta encountering a baryon load of $B \sim 10^1$–10^2, and finally reaches transparency, leading to the hard X-ray flare emission (point F) in gamma-rays with an effective Lorentz factor of Γ=10 and to soft X-ray flare emission (point G) with an effective Γ=4, which are then followed by the late afterglow phases.

The main conclusion of the paper is that the UPE, the hard X-ray flare and the soft X-ray flare do not form a causally connected sequence: within the BdHN model they are the manifestation of the same physical process of the BH formation as seen through different viewing angles, implied by the morphology and the ~300 s rotation period of the HN ejecta.

The paper is available here: https://doi.org/10.3847/1538-4357/aaee68

2. In memory of Riccardo Giacconi, 6 October 1931 –9 December 2018

Riccardo Giacconi, the scientist who allowed humanity to access the images of our Universe in all wavelengths from visible light to X-rays, passed away on Sunday, 9 December 2018. Founding member of ICRA and ICRANet, he has been the first President of ICRANet Scientific Committee.

Figure 1: ICRANet Scientific Committee 2008.

Figure 2: ICRANet Scientific Committee 2010.

Figure 3: Group Picture ICRANet Scientific Committee 2010.

The close collaboration between Prof. Ruffini and Prof. Giacconi, went on throughout their lives, and led to the observation and identification of Cignus X-1, the first Black Hole in our Galaxy, conceptually introduced by Remo Ruffini, together with John Wheeler (https://physicstoday.scitation.org/doi/10.1063/1.3022513).

For this important work, Prof. Giacconi received the 2002 Nobel Prize in Physics (https://www.nobelprize.org/prizes/physics/2002/summary) and Prof. Ruffini received in 1973 the Cressy-Morrison Award from the New York Academy of Sciences (http://www.icranet.org/documents/Ruffini-CMorrison-award.jpg).

Figure 4: Prof. Remo Ruffini, Prof. Riccardo Giacconi and the three volumes of the ICRANet Scientific report 2010.

Prof. Giacconi realized UHURU (https://heasarc.gsfc.nasa.gov/docs/uhuru/uhuru.html), the first satellite that observed the Universe in X-Rays, launched from the Italian space station "San Marco" in Kenya, and followed by the great observatories EINSTEIN (https://heasarc.gsfc.nasa.gov/docs/einstein/heao2_about.html) and CHANDRA (http://chandra.harvard.edu/), always in X-Rays. This allowed also the subsequent development, during his mission as ESO Director, of the biggest optical telescope in the world, the VLT in Chile (https://www.eso.org/public/teles-instr/paranal-observatory/vlt/).

In Beijing, Professor Ruffini, commemorating Riccardo Giacconi, presented in a series of conferences, the most recent results on Gamma Ray Bursts (the GRBs), that, after almost 40 years of study and thanks to several observatories created by Riccardo in the USA and in Europe, are been revealed in all their beauty: cosmological objects that thanks to their extreme luminosity equal for a hundred of seconds to the integrated luminosity of all billions of galaxies of our Universe, each one composed of a hundred of billions of stars.

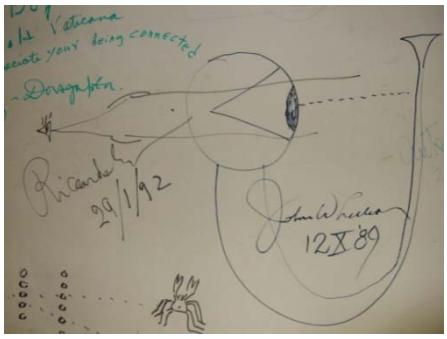


Figure 5: Riccardo Giacconi and John Wheeler dated signatures at G9.

Prof. Giacconi is survived by his wife Mirella, daughters Anna and Guia, and grandchildren Alexandra and Colburn. He was pre-deceased by his son Mark.

Prof. Giacconi and John Wheeler left their dated signatures on the wall (see Fig. 5) located in the G9 room of ICRA, in the Physics Department of University of Rome "La Sapienza": the Universe becomes conscious of its existence with the presence of the Human eye (Wheeler), improved by the lenses of the X-Rays Satellites (Giacconi).

3. Professor Ruffini visit to Tsinghua University (Beijing), 8 -15 December 2018

From 8 to 15 December 2018, Professor Ruffini visited Tsinghua University in Beijing (China) together with Prof. Jorge Rueda, Prof. Shesheng Xue, Dr Yu Wang and Rahim Moradi. The ICRANet delegation was invited by Professor Shing-Tung Yau, Director of the Yau Mathematical Science Center, to deliver a series of 4 Chia-Chiao Lin distinguished lectures at Tsinghua University, one of the most important Chinese universities.

Announcement of the CC Lin Lectures at Tsinghua University, Beijing.

The first CC Lin Lecture "*On the Relativistic Astrophysics domains*" was presented by Prof. Remo Ruffini (https://youtu.be/hkEOt-kaWZI), the second CC Lin Lecture "*The eight different GRB families*" was presented by Prof. Rueda (https://youtu.be/2dSkvsznL5w), the third CC Lin Lecture "*The long march toward the understanding of the fundamental nature of GRBs*" was presented by Dr. Yu Wang (https://youtu.be/6TT9BiR9o4g) and the forth CC Lin Lecture "*The GeV radiation and the "inner engine" of Gamma Ray Bursts*" was presented by Prof. Xue and Rahim Moradi (https://youtu.be/-UJr6EKq3cY).
During his visit, Professor Ruffini took also part at the 11th Shing-Tung Yau High School Science Award Ceremony, founded in 2008 by Prof. Shing-Tung Yau with the desire to inspire scientific innovations among Chinese high school students all over the world.

Professor Ruffini was also invited to participate to the 2nd S.T. Yau Science Forum. Founded in 2017 by Professor Shing-Tung Yau, the forum aimed at establishing a platform for dialogue between young Chinese students and outstanding scientists and scholars with notable contributions in their respective fields, encouraging students to foster their passion for scientific research, expanding their scientific capacities and visions, and cultivating their innovative mindsets. On that occasion, Professor Ruffini delivered the lecture, titled "*From the earliest visions of the Cosmos to the detection of Black Holes in our Universe*" (video: https://youtu.be/vpICywnsGds).

From left to right: Rahim Moradi, Dr. Wang Yu, Prof. Remo Ruffini, Prof. Shude Mao, Prof. Jorge Rueda and Prof. She-Sheng Xue.

From left to right: Prof. Jorge Rueda, Prof. Remo Ruffini, Prof. Shing-Tung Yau, Prof. She-Sheng Xue and Dr Wang Yu.

4. New collaboration Agreement between INAF and ICRANet, 18 December 2018

On the 18 of December 2018 a cooperation agreement between ICRANet and INAF was signed in the INAF headquarters in Rome. The main joint activities to be developed under the framework of this agreement will include the promotion of theoretical and observational activities within the field of Relativistic Astrophysics; the joint collaboration of faculty members, researchers, post-doctorate fellows and students; the organization of training and teaching courses, seminars, conferences, workshops or short courses, and the joint work on scientific publications.

5. Professor Ruffini visit to Brazil, 16 – 18 January 2019

From left to right: Prof. Clovis Maia, Prof. Anderson Ribeiro Correia (President of CAPES), Prof. Remo Ruffini, Concepta Pimentel (DRI CAPES) and Prof. Manuel Malheiro.

From 16 to 18 January 2019, Professor Ruffini, Director of ICRANet, visited the capital of Brazil, where he had a series of meeting with Brazilian representatives, accompanied by Prof. Manuel Malheiro and Prof. Clovis Maia. On Thursday, January 17, he had a meeting at CAPES with its new President, Anderson Ribeiro Correia, in presence of the Director of International Relations: on this occasion, they had discussed the reopening of the ICRANet-Capes agreement and the President of Capes, former Rector of ITA, recognized once again the relevance of ICRANet, and the activities at ITA and the University of Brasilia. In the afternoon, Prof. Ruffini, at the Brazilian Ministery of Science, Technology, Innovation and Communication (MCTIC) met one of its main secretaries, Air Force Colonel Carlos Alberto Baptistucci. They discussed the appointment of a diplomat for the board of ICRANet, as well as a representative for the new Ministry of Finances and a member of the scientific community. Prof. Ruffini also met the Rector of the University of Brasilia, Prof. Marcia Abrahao, in presence of Prof. Clovis Maia, Prof. Vanessa Andrade, Prof. Marcos Maia, and Prof. Adalene Silva (in charge of the International Graduate Program division), and discussed about the possibility to implement ICRANet activities at her University.

6. Professor Ruffini intervention at "*Science by Night*", Liceo Scientifico Galileo Galilei of Pescara, 19 January 2019

On January 19, 2019, the Liceo Scientifico Galileo Galilei of Pescara, organized an important event titled "Science by Night". This event represented a nice occasion for discussion among students, citizens and researchers, and attracted a lot of people, offering visitors a unique opportunity to take part in science activities aiming to showcase both the fascination of research as a career and its significant societal impact. On that occasion, an ICRANet delegation composed by Prof. Remo Ruffini, Prof. Gregory Vereshchagin and Prof. She-Sheng Xue was invited to participate, and Prof. Ruffini deliver an important talk, titled "*La fisica di Einstein applicata all'Universo. Aspetti concettuali, aspetti morali e sviluppi tecnologici*".

See the interview of Professor Ruffini to TV channel Rete 8:
https://www.youtube.com/watch?v=XjL2cA50LMk

7. Prof. Ruffini meeting with ICTP Director and TWAS Executive Director, Trieste, 31 January 2019

From left to right: Prof. Fernando Quevedo (ICTP Director), Prof. Remo Ruffini (Director of ICRANet), Prof. Romain Murenzi (TWAS Executive Director) and Prof. Sandro Scandolo (ICTP).

On January 31, 2019, Professor Remo Ruffini visited ICTP in Trieste and met the ICTP Director, Prof. Fernando Quevedo, and the TWAS Executive Director, Prof. Romain Murenzi. This visit was an important opportunity for them to discuss about the increase of the existing synergies for the performance of their duties and for the implementation of activities related to projects of common interest. The longstanding collaboration among ICRANet and ICTP, and ICRANet and TWAS, will continue to ensure multi-year stability to the research activity in the field of relativistic astrophysics, exploration and observation of the universe from underground, the ground and space, finding means of coordination for better implementation of national and international scientific programs.

8. Scientific visits to ICRANet

From the 10 December 2018, Dr Li Liang, a Chinese researcher, is visiting ICRANet center in Pescara. During his visit, he is discussing his scientific researches and having fruitful exchange of ideas with other ICRANet researchers from different parts of the world. He is also working with them on the preparation of scientific papers.

9. ICRANet publications up to 2018

We are pleased to inform that according to the SAO/NASA Astrophysics Data System (which is a digital library portal for researchers in astronomy and physics, operated by the Smithsonian Astrophysical Observatory (SAO) under a NASA grant) the publications with affiliation to ICRANet has reached in 2018 the number of 559. With the total number of citation of 8845, it results in a very high impact measured by the H-index of 45. Among the top cited papers there is a review paper "*Electron-positron pairs in physics and astrophysics: From heavy nuclei to black holes*" published in Physics Reports in 2010 with 253 citations. This information is now available at ICRANet website:
http://www.icranet.org/index.php?option=com_content&task=view&id=304&Itemid=780.

Publications of ICRANet Faculty members (both within NASA ADS and ArXiv databases) are available here:
http://www.icranet.org/index.php?option=com_content&task=view&id=332&Itemid=806.

10. Russian translation of the book “Relativistic kinetic theory” published in Moscow

In December 2018, has been published the Russian translation of the monograph "*Relativistic Kinetic Theory With Applications in Astrophysics and Cosmology*" written by ICRANet faculty member prof. Gregory Vereshchagin in co-authorship with Alexey Aksenov from Institute of Computer Aided Design of the Russian Aacademy of Sciences, published by Cambridge University Press in 2017,. The publication of this Russian edition is supported by the grant of the Russian Foundation for Basic Research, project ID: 18-12-00027. The book is published with the leading Russian publishing house "Nauka" in Moscow.

The book is available at:
https://naukabooks.ru/knigi/katalog/relyativistskaya_kineticheskaya_teoriya_s_prilozheniyami_v_astrofizike_i_kosmologii-_2018/

11. Recent publications

Published

Becerra, L.; Ellinger, C. L.; Fryer, C. L.; Rueda, J. A.; Ruffini, R., *SPH simulations of the induced gravitational collapse scenario of long gamma-ray bursts associated with supernovae*, The Astrophysical Journal, Volume 871, Issue 1, article id. 14, published on 18 January 2019.

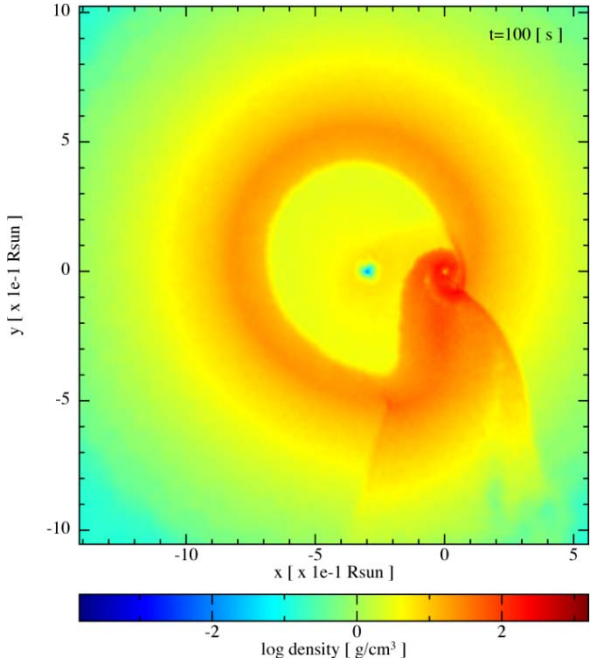


Fig. 2. Surface density on the equatorial binary plane of the SN expansion under the presence of its NS companion at different times. These plots correspond to the SPH simulation of the IGC scenario for an initial binary system composed by a NS of 2 M_{sun} and the COcore of a M_{zams}=25 M_{sun} progenitor with an initial orbital period of about 5 mins. The NS companion is at the origin and the nu-NS is along the -x-axis.

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

Link: https://doi.org/10.3847/1538-4357/aaf6b3

M. A. Prakapenia, I. A. Siutsou, G. V. Vereshchagin, *Thermalization of electron–positron plasma with quantum degeneracy*, Physics Letters A Volume 383, Issue 4, p. 306, published on 17 January 2019.

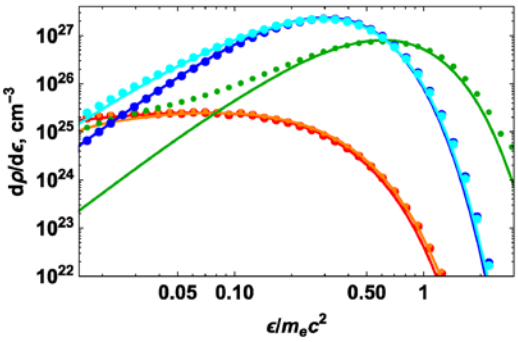


Fig. 3. Energy density spectra at selected time moments for photon (Boltzmann: blue; Planck: cyan; Bose–Einstein: green) and pairs (Boltzmann: orange; Fermi–Dirac: red).

The non-equilibrium electron–positron–photon plasma thermalization process is studied using relativistic Boltzmann solver, taking into account quantum corrections both in non-relativistic and relativistic cases. Collision integrals are computed from exact QED matrix elements for all binary and triple interactions in the plasma. It is shown that in non-relativistic case (temperatures $k_BT \leq 0.3\ m_ec^2$) binary interaction rates dominate over triple ones, resulting in establishment of the kinetic equilibrium prior to final relaxation towards the thermal equilibrium, in agreement with the previous studies. On the contrary, in relativistic case (final temperatures $k_BT \geq 0.3\ m_ec^2$) triple interaction rates are fast enough to prevent the establishment of kinetic equilibrium. It is shown that thermalization process strongly depends on quantum degeneracy in initial state, but does not depend on plasma composition.

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

Punsly, Brian; Tramacere, Andrea; Kharb, Preeti; Marziani, Paola, *The Powerful Jet and Gamma-Ray Flare of the Quasar PKS 0438–436*, The Astrophysical Journal, Volume 869, Issue 2, article id. 174, published on 26 December 2018.

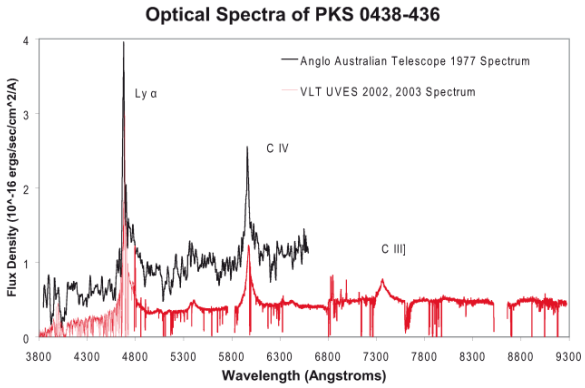


Fig. 4. Comparison of the two spectra.

PKS 0438−436 at a redshift of z=2.856 has been previously recognized as possessing perhaps the most luminous known synchrotron jet. Little is known about this source since the maximum elevation above the horizon is low for the Very Large Array (VLA). We present the first VLA radio image that detects the radio lobes. We use both the 151 MHz luminosity, as a surrogate for the isotropic radio lobe luminosity, and the lobe flux density from the radio image to estimate a long term, time averaged, jet power $1.5\pm0.7\times10^{47}$ergs s^{-}. We analyze two deep optical spectra with strong broad emission lines and estimate the thermal bolometric luminosity of the accretion flow, $L_{bol}=6.7\pm3.0\times10^{46}$ergs s^{-}. The ratio 3.3±2.6, is at the limit of this empirical metric of jet dominance seen in radio loud quasars and this is the most luminous accretion flow to have this limiting behavior. Despite being a very luminous blazar, it previously had no γ-ray detections (EGRET, AGILE or FERMI) until December 11 - 13 2016 (54 hours) when FERMI detected a flare that we analyze here. The isotropic apparent luminosity from 100 MeV - 100 GeV rivals the most luminous detected blazar flares (averaged over 18 hours), $\sim5-6\times10^{49}$ ergs s^{-1}. The γ-ray luminosity varies over time by two orders of magnitude, highlighting the extreme role of Doppler abberation and geometric alignment in producing the inverse Compton emission.

Link: https://doi.org/10.3847/1538-4357/aaefe7

Ruffini, R.; Becerra, L.; Bianco, C. L.; Chen, Y. C.; Karlica, M.; Kovacevic, M.; Melon Fuksman, J. D.; Moradi, R.; Muccino, M.; Pisani, G. B.; Primorac, D.; Rueda, J. A.; Vereshchagin, G. V.; Wang, Y.; Xue, S.-S., *On the ultra-relativistic Prompt Emission (UPE), the Hard and Soft X-ray Flares, and the extended thermal emission (ETE) in GRB 151027A*, The Astrophysical Journal Volume 869, Issue 2, article id. 151, published on 20 December 2018.

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

Link: https://doi.org/10.3847/1538-4357/aaee68

Punsly, Brian; Marziani, Paola; Bennert, Vardha N.; Nagai, Hiroshi; Gurwell, Mark A., *Revealing the Broad Line Region of NGC 1275: The Relationship to Jet Power 2018*, The Astrophysical Journal, Volume 869, Issue 2, article id. 143, published on 19 December 2018.

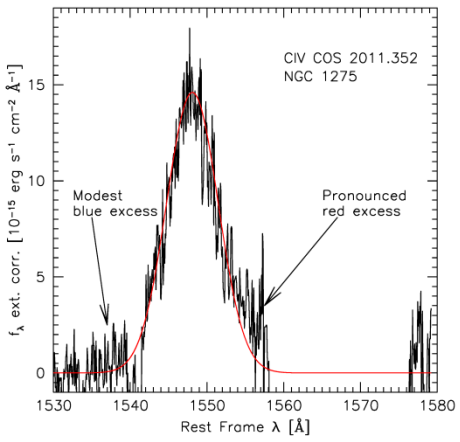


Fig. 5. The widest plausible NL fit to CIV in 2011.352 still results in a significant redwing residual.

NGC 1275 is one of the most conspicuous active galactic nuclei (AGN) in the local Universe. The radio jet currently emits a flux density of 10 Jy at 1 mm wavelengths, down from the historic high of 65 Jy in 1980. Yet, the nature of the AGN in NGC 1275 is still controversial. It has been debated whether this is a broad emission line (BEL) Seyfert galaxy, an obscured Seyfert galaxy, a narrow line radio galaxy or a BL-Lac object. We clearly demonstrate a persistent Hβ BEL over the last 35 years with a full width half maximum (FWHM) of 4150 - 6000 km/s. We also find a prominent Pα BEL (FWHM = 4770km/s) and a weak CIV BEL (FWHM = 4000 km/s), Hβ/CIV = 2. A far UV HST observation during suppressed jet activity reveals a low luminosity continuum. The Hβ BEL luminosity is typical of broad line Seyfert galaxies with similar far UV luminosity. X-ray observations indicate a softer ionizing continuum than expected for a broad line Seyfert galaxy with similar far UV luminosity. This is opposite of the expectation of advection dominated accretion. The AGN continuum appears to be thermal emission from a low luminosity, optically thick, accretion flow with a low Eddington ratio, = 0.0001. The soft, weak ionizing continuum is consistent with the relatively weak CIV BEL. Evidence that the BEL luminosity is correlated with the jet mm wave luminosity is presented. Apparently, the accretion rate regulates jet power.

Link: https://doi.org/10.3847/1538-4357/aaec75

Ruffini, R.; Karlica, M.; Sahakyan, N.; Rueda, J. A.; Wang, Y.; Mathews, G. J.; Bianco, C. L.; Muccino, M., *On a GRB afterglow model consistent with hypernovae observations*, The Astrophysical Journal, Volume 869, Issue 2, article id. 101, published on 14 December 2018.

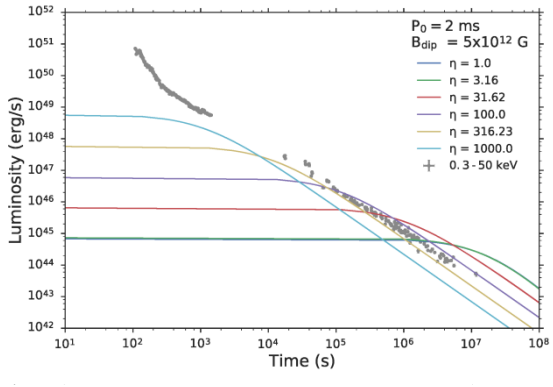


Fig. 6. The observed luminosity of GRB 130427A in the 0.3–50 keV band (gray points), and the theoretical luminosity from a pulsar for selected quadrupole to dipole magnetic field ratio and quadrupole angles in color lines.

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

Link: https://doi.org/10.3847/1538-4357/aaeac8

Damien Bégué, Clément Stahl, She-ShengXue, *A model of interacting dark fluids tested with supernovae and Baryon Acoustic Oscillations data*, published inNuclear Physics B 940 (2019) 312–320.

We compare supernovae and Baryon Acoustic Oscillations data to the predictions of a cosmological model of interacting dark matter and dark energy. This theoretical model can be derived from the effective field theory of Einstein–Cartan gravity with two scaling exponents δG and δΛ, related to the interaction between dark matter and dark energy. We perform a χ2 fit to the data to compare and contrast it with the standard ΛCDM model.
We then explore the range of parameter of the model which gives a better χ2 than the standard cosmological model. All those results lead to tight constraints on the scaling exponents of the model. Our conclusion is that this class of models, provides a decent alternative to the CDM model.

Link: https://www.sciencedirect.com/science/article/pii/S0550321319300033

Accepted for publication

Sahakyan, N., *The Origin of the Multiwavelength Emission of PKS 0502+049*, accepted for publication in Astronomy & Astrophysics.

The origin of the multiwavelength emission from PKS 0502+049 neighboring the first cosmic neutrino source TXS 0506+056 is studied using the data observed by Fermi-LAT and Swift UVOT/XRT. This source

was in a flaring state in the considered bands before and after the neutrino observations in 2014-2015, characterized by hard emission spectra in the X-ray and gamma-ray bands, 1.5-1.8 and <2.0, respectively. During the neutrino observations, the gamma-ray spectrum shows a deviation from a simple power-law shape, indicating a spectral cutoff at E_c =8.50 GeV. The spectral energy distributions of PKS 0502+049 are modeled within a one-zone leptonic scenario assuming that high energy γ-ray emission is produced either by IC scattering of synchrotron or dusty torus photons by the electron population that produce the radio-to-optical emission. Alternatively, the observed γ-rays are modeled considering inelastic interaction of protons, when the jet interacts with a dense gaseous target. During the neutrino observations, the gamma-ray data are best described when the proton energy distribution is $E_p^{-2.61}$ and if the protons are effectively accelerated up to 10 PeV, the expected neutrino rate is 1.1 events within 110 days. In principle, if the gamma-ray emission with a hard photon index observed during the flaring periods extends up to TeV, the expected rate can be somewhat higher, but such conditions are hardly possible. Within the hadronic interpretation, the gamma-ray data can be reproduced only when the accretion rate of PKS 0502+049 is in the supper-Eddington regime, as opposed to the leptonic scenario. From the point of view of the necessary energetics as well as considering that the required parameters are physically reasonable, when the neutrinos were observed, the broadband emission from PKS 0502+049 is most likely of a leptonic origin.

Link: http://adsabs.harvard.edu/abs/2018arXiv181206338S

Suzana Bedić, Gregory Vereshchagin, *Probability of inflation in Loop Quantum Cosmology*, accepted for publication in Phys. Rev. D.

We discuss how initial conditions for cosmological evolution can be defined in Loop Quantum Cosmology with massive scalar field and how the presence of the bounce influences the probability of inflation in this theory, compared with General Relativity. The main finding of the paper is existence of an attractor in the contracting phase of the universe, which results in special conditions at the bounce, quite independent on the measure of initial conditions in the remote past, and hence very specific duration of inflationary stage with the number of e-foldings about 140.

Link: https://arxiv.org/abs/1807.06554

ICRANet Newsletter

February – March 2019

SUMMARY

1. ICRANet press release *"On the Supernova breakout in the BdHN GRB 190114C"*, March 2019

In March 2019, ICRANet has prepared an important press release on the Supernova breakout in the BdHN GRB 190114C, which will be sent out for publication. On January 14, 2019, GRB 190114C was announced by the team of the Swift satellite (GCN 23688). Its distance (redshift z=0.42) was determined a few hours later by the Nordic Optical Telescope located at the Canary Islands – Spain (GCN 23695). Soon after we recognized that this source was a BdHN I, ICRANet sent the GCN 23715 (see full text below) anticipating the possibility of the appearance of an associated Supernova. The Supernova was indeed detected at the exactly predicted time, as reported by A. Melandri et al. on 19 March 2019 (GCN 23983). We herby illusrate the relevance of this ephocal observations, by evidencing the universal role of the Supernova mass both in BdHN I and BdHN II.

One of the largest multimessenger Observational effort in the history of Astrophysics

The detection and follow-up of GRB 190114C has been made possible thanks to a worldwide effort of many satellites and telescopes with a very strong participation of Italy through the International satellites Swift (NASA-DOE mission with the participation of Italy and the UK) and Fermi (NASA-DOE mission with the participation of ASI, INFN and INAF), and with the Italian satellite AGILE. Specifically, this GRB has been observed in the X-ray and gamma-ray energy domain by the satellites Swift, Fermi, AGILE, INTEGRAL, Insight-HXMT/HE (a Chinese X-ray satellite of IHEP, Tsinghua University-China), Konus-Wind (Russia); also, in the highest gamma-ray energy domain by Fermi-LAT (USA and Italy) and the MAGIC telescopes, located at the Roque de los Muchachos Observatory, Canary Islands – Spain (with the collaboration of institutions in Germany, Armenia, Bulgaria, Croatia, Finland, Italy, Poland, Spain and Switzerland); finally in the optical domain by the telescopes MASTER-IAC (Russia), Pan-STARRS (Haleakala Observatory, Hawaii - USA), the Nordic Optical Telescope-NOT, located at Canary Islands – Spain (owned by the Nordic Optical Telescope Scientific Association, and funded by Denmark, Finland, Iceland, Norway and Sweden), MPG+GROND (La Silla Observatory, Chilean Atacama Desert-Chile), GCT+OSIRIS (Canary Islands - Spain), Osservatorio Astronomico S. Di Giacomo (Agerola - Italy), VLT+FORS2, the NTT+EFOSC2 and the REM+ROS2 at the European Southern Observatory - ESO (Chile), the TNG+DOLORES (INAF), the LBT+MODS2 (INAF) located at Mount Graham (Arizona - USA), the WHT+ACAM located at the Roque de los Muchachos Observatory (Canary Islands - Spain), McDonald Observatory (USA), SNU Observatory (Seoul - South Korea), AZT-33IK located at the Sayan Observatory (Russia), LSGT at the Siding Spring Observatory (Australia), GROWTH-India telescope at the Indian Astronomical Observatory (India), KMTnet in the South African Astronomical Observatory (South Africa), UKIRT, RC-1000 of the CHILESCOPE Observatory (Chile), HCT located at the Indian astronomical observatory (India), COATLI and the Harold Johnson Telescope at Osservatorio Astronomico Nacional on the Sierra de San Pedro Martir (Mexico), RTT150 at the TUBITAK National Observatory (Turkey); in the radio band domain by the Karl G. Jansky Very large Array (VLA), the Atacama LargeMillimeter/Submillimeter Array (ALMA), the Australia Telescope Compact Array (ATCA), the Sardinia Radio Telescope (INAF), the MeerKAT radio telescope (South Africa) and the Giant Meterwave Radio Telescope – GMRT (India).

What is a BdHN?

ICRANet has been following the study of GRBs since the earliest discovery time to the latest observations by a theoretical analysis, which has led, among others, to the classification of all GRBs in nine different subclasses. Binary driven Hypernovae (BdHN) are the most numerous of such subclass. Their progenitor is a binary system composed of carbon-oxygen (CO) core and a magnetized neutron star (NS) companion in a very compact orbit of binary period of the order of minutes. The CO core collapses at its center forming a new NS (νNS), but the external layers are ejected in form of a Supernova (SN) explosion, see figure enclosed. The SN ejecta produces a massive and rapid accretion process onto the NS companion leading to its gravitational collapse forming a black hole (BH). Meanwhile, the Supernova ejecta continues to expand but still matter remain around of both the νNS and the BH. The background magnetic field (B) collapse, together with the rotation of the BH, triggers the "Wald" process by which an electric field is induced. This

E-field explains both the ultra relativistic prompt emission phase (UPE) in the gamma-rays through the transparency of the self-accelerating electron-positron pair plasma created by quantum electrodynamic process of vacuum breakdown, and the GeV emission through synchrotron emission of accelerated protons in the B-field. The interaction of the νNS pulsar emission with the SN ejecta explains the X-ray afterglow. Finally, after about 15 days, the optical emission of the SN produced by the energy release of the decay of Nickel, is observed.

What is exceptional in GRB 190114C

Truly exceptional is that all phases of the BdHN starting from the onset of the SN break-out, to the accretion process, to the moment of formation of the Black Hole, to the observation of the GeV emission and afterglow to the final identification of the optical Supernova have become observable with enormous precision in this most unique source.

GCN CIRCULAR

NUMBER: 23715
SUBJECT: GRB 190114C: A type 1 BdHN with TeV emission
DATE: 19/01/15 15:29:54 GMT
FROM: Remo Rufinni at ICRA ruffini@icra.it

R. Ruffini, R. Moradi, Y. Aimuratov, U. Barres de Almeida, C. L. Bianco, Y. C. Chen, C. Cherubini, S. Filippi, D. M. Fuksman, M. Karlica, Liang Li, D. Primorac, J.A. Rueda, N. Sahakyan, Y. Wang, S.S. Xue on behalf of the ICRANet team, report:

GRB 190114C with T90=116 s (50-300 keV), Epeak = 998.6 +/- 11.9 keV, isotropic energy release in gamma-rays Eiso = 3 E53 erg, and the isotropic peak luminosity Liso = 1 E53 erg/s (R. Hamburg et al., CGN 23707) presents the typical characteristics of type I binary-driven hypernova (BdHN) (Y. Wang et al., submitted to Astrophysical Journal arXiv:1811.05433v2). The most significant ever Fermi-LAT GeV emission (D. Kocevski et al., GCN 23709) with test statistic value TS>2500 implies that this GRB is seen from the normal to the orbital plane of the progenitor binary system composed of a carbon-oxygen core and a neutron star companion (R. Ruffini et al., submitted to Astrophysical Journal arXiv:1803.05476). The TeV emission (R. Mirzoyan et al., GCN 23701), a first in GRBs, has been recently predicted, as originating from the Wald solution, within the new inner engine approach of the long GRBs recently introduced in Ruffini et al (submitted to Physical Review Letter: arXiv:1811.01839) and Ruffini et al (submitted to Astrophysical Journal: arXiv:1812.00354). Most interesting this system being at z=0.4245 (A. J. Castro-Tirado et al., GCN 23708), can give a strong support to our BdHN approach by Observing a Supernova. Using the averaged appearance time of the SNe associated to GRBs (Cano et al., 2016), and considering the redshift z=0.42 (J. Selsing et al., GCN 23695, A. J. Castro-Tirado et al., GCN 23708), a bright optical signal will peak at 18.8 +/- 3.7 days after the trigger (February 2nd 2019, uncertainty from January 30th 2019 to February 6th 2019) at the location of RA 54.510 and DEC -26.939, with an uncertainty 3 arcmin (J.D. Gropp et al., GCN 23688). The follow-up Observations, especially the optical bands for the SN, are recommended.

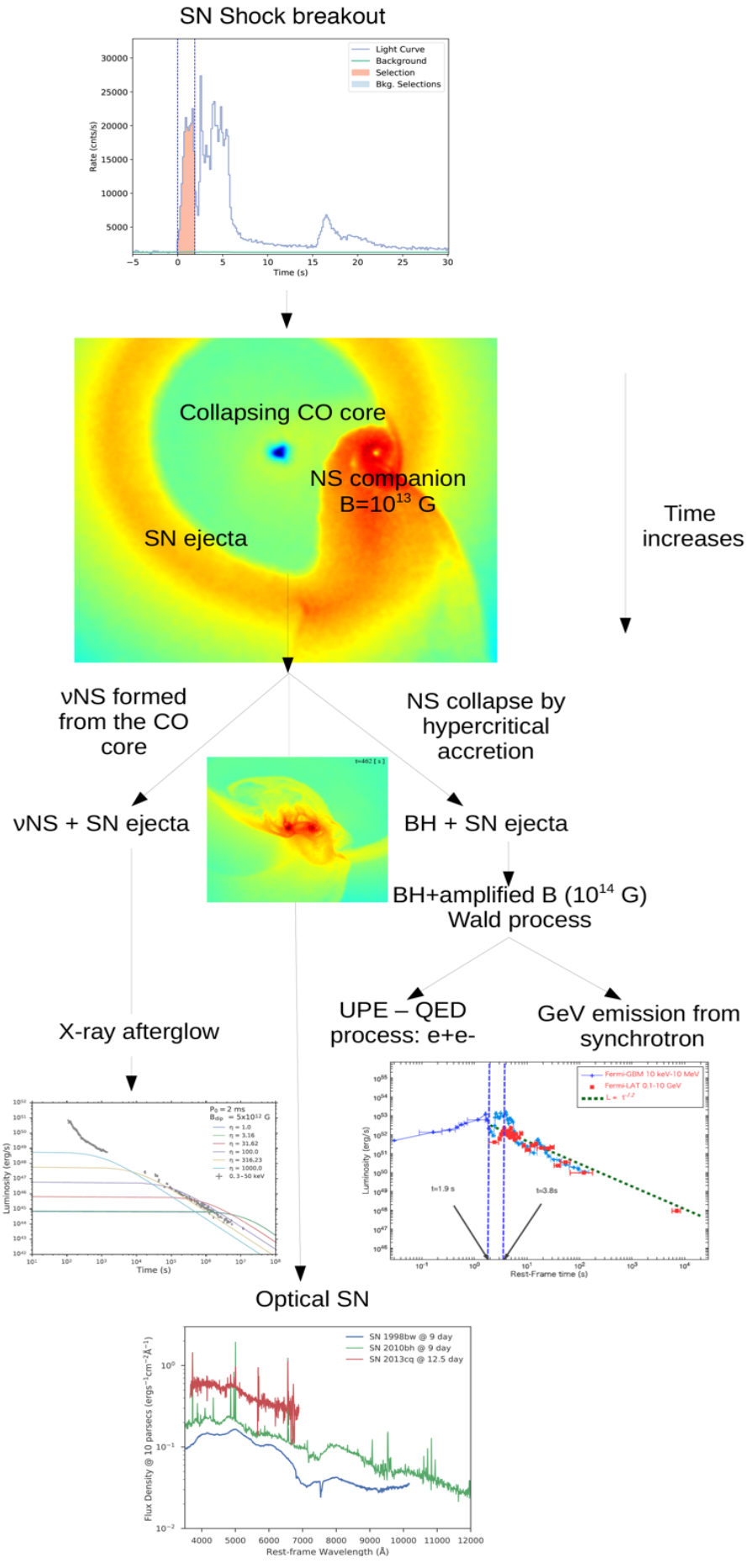
GCN CIRCULAR

NUMBER: 23983
SUBJECT: GRB 190114C: photometric detection of a SN component
DATE: 19/03/20 21:25:17 GMT
FROM: Andrea Melandri at INAF-OAB <andrea.melandri@brera.inaf.it>

A. Melandri (INAF-OAB), L. Izzo (HETH/IAA-CSIC), P. D'Avanzo (INAF-OAB), D. Malesani (DAWN/NBI and DARK/NBI), M. Della Valle (INAF-OAC), E. Pian (INAF-OAS), N. R. Tanvir (U. of Leicester), F. Ragosta (U. Federico II/OAC), F. Olivares (MAS/U. de Chile), R. Carini (INAF-OAR), E. Palazzi (INAF-OAS), S. Piranomonte (INAF-OAR), P. Jonker (SRON), A. Rossi (INAF-OAS), D. A. Kann (HETH/IAA-CSIC), D. Hartmann (Clemson U.), C. Inserra (Cardiff), E. Kankare (Turku), K. Maguire (QUB), S. J. Smartt (QUB), O. Yaron (Weizmann), D. R. Young (QUB), I. Manulis (Weizmann) on behalf of a larger collaboration

We report the discovery of the supernova associated with the gamma-ray burst GRB 190114C (Gropp et al., GCN 23688) at z=0.42 (Selsing et al., GCN 23695; Castro-Tirado et al., GCN 23708; Kann et al., GCN 23710). An observational campaign lasting about 50 days has been carried out with the VLT+FORS2, the NTT+EFOSC2 and the REM+ROS2 at the European Southern Observatory (Chile), the TNG+DOLORES, the LBT+MODS2 located at Mount Graham (Arizona), and the WHT+ACAM located at the Roque de los Muchachos Observatory (Canary Islands). These observations show, at about 15 days after the burst, an apparent flattening of the afterglow light curves, in the i and z filters, in excess of the host galaxy flux, as measured in our latest epochs. This is the consistent with the emergence of a SN associated with GRB 190114C, as observed in several previous events.
By modelling the overall light curve between 0.01 and 15 days after the burst trigger (including also data from GCN circulars) with a broken power-law (afterglow contribution) + constant (host galaxy contribution), the residual fluxes in the observed i and z bands show a peak of brightness of ~23.9 and ~23.5 mag (AB), respectively. With these values we derive an estimate for the rest frame visual absolute magnitude of the SN associated with GRB 190114C of about -18 mag. This value is about 1 mag fainter than SN 1998bw (Patat et al. 2001, ApJ, 555, 900). However, the two SNe could have a comparable brightness considering the significant extinction, yet to be quantified, suffered by this event (see e.g. Kann et al., GCN 23710).
We caution that the reported values for the SN peak brightness strongly depend on the modeling of the temporal behavior of the overall light curve. Further photometric and spectroscopic analysis is ongoing.
We thank the VLT, TNG, LBT and WHT staffs for executing these observations. Part of these data have been obtained under the extended Public ESO Spectroscopic Survey for Transient Objects (ePESSTO; see Smartt et al. 2015, A&A, 579, 40; http://www.pessto.org <http://www.pessto.org/>).

The many episodes of a Binary driven Hypernova (BdHN)



2. 56° session of the Scientific and Technical Subcommittee of COPUOS (UNOOSA), February 9, 2019

The Scientific and Technical Subcommittee of the Committee on the Peaceful Uses of Outer Space (COPUOS) held its fifty-sixth session at the United Nations Office at Vienna from February 11 – 22, 2019. Professor Ruffini took part to the side event panel "*Progress on the technical development and on the establishment of the Open UNiverse initiative: Space science data for everyone*", organized by Paolo Giommi, Senior Scientist and coordinator of the Open UNiverse initiative at the Italian Space Agency (ASI). In this side event, the Open UNiverse initiative was presented, together with its principles, objectives and advantages.

3. Upcoming meetings

- **Armenian-Italian Science Day, April 15, 2019, Yerevan**

It gives us great pleasure to announce the Armenian-Italian Science Day event "*Joint ICRANet activities in Relativistic Astrophysics*", a one day conference which will take place in Yerevan on April 15, 2019. The event will be held in the National Academy of Sciences both in Armenian and in English, and has been organized thanks to the collaboration among ICRANet, the National Academy of Sciences of Armenia (NASRA) and the Italian Embassy in Yerevan. Institutional representatives from Armenia and from several other countries will be present and address the morning session. After lunch, there will be a series of conferences by eminent Professors and researchers, who will illustrate the most recent scientific developments on which ICRANet is working on. You can find more details about the event on our webpage: http://www.icranet.org/Armenian-ItalianScienceDay).

- **The Open Universe International Doctoral School, June 10 – 14, 2019**

It gives us great pleasure to announce the Open Universe International Doctoral School on "*Magnetized Black Holes, GRBs, AGNs and the most violent Universe: from observation on data acquisition to the theory and model-building of GRB 190114C*", a 4 days conference which will be held from June 10 – 14, 2019 in the ICRANet Seat at Villa Ratti (Nice - France). It has been organized thanks to the collaboration among ICRANet, LAPP (Laboratoire d'Annecy de Physique des particules) and the Max Planck Institute for Physics. The scientific program is under preparation, and more details about the event will be published on our webpage (http://www.icranet.org/) soon.

- **16th Italian-Korean Symposium on Relativistic Astrophysics**

It gives us great pleasure to announce the 16th Italian-Korean Symposium on Relativistic Astrophysics, that will be held at ICRANet center in Pescara from July 1 – 5, 2019. 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 our webpage (http://www.icranet.org/) soon.

4. Publication of the Third Zeldovich meeting proceedings

The proceedings of the Third Zeldovich meeting, held in Minsk (Belarus) on April 23 – 27, 2018, have been published by Springer in Astronomy Reports, Volume 62, Issue 12, December 2018 (see: https://link.springer.com/journal/11444/62/12/page/1).

The special editors of this volume are Professors Remo Ruffini, Sergei Kilin and Gregory Vereshchagin.

The preface of the editors can be found here:

http://www.icranet.org/images/stories/Meetings/ZM3/preface.pdf

This volume includes the following articles:

- N. I. Shakura, "*Ya.B. Zeldovich and Foundation of the Accretion Theory*", pages 823-833.
- G. Aksenov, V. M. Chechetkin, "*Supernova Explosion Mechanism with the Neutrinos and the Collapse of the Rotation Core"*, pages 834-839.
- L. Becerra, C. Ellinger, C. Fryer, J. A. Rueda, R. Ruffini, "*On the Induced Gravitational Collapse: SPH Simulations*", pages 840-846.
- K. Boshkayev, "*Equilibrium Configurations of Rotating White Dwarfs at Finite Temperatures*", pages 847-852.
- Y.-C. Chen, C.-Y. Hwang, "*Morphology of Seyfert Galaxies*", pages 853-858.
- M. Demiański, A. Doroshkevich, "*Observations of the Ly-α Forest*", pages 859-867.
- E. Derishev, "*Radiation-Mediated Shocks: Kinetic Processes and Transition to Collisionless Shocks*", pages 868-873.
- G. Fodor, "*Localized Objects Formed by Self-Trapped Gravitational Waves*", pages 874-881.
- M. Galper, N. P. Topchiev, Yu. T. Yurkin, "*GAMMA-400 Project*", pages 882-889.
- M. Hohmann, "*Polarization of Gravitational Waves in General Teleparallel Theories of Gravity*", pages 890-897.
- Krut, C. R. Arguëlles, J. Rueda, R. Ruffini, "*Galactic Constraints on Fermionic Dark Matter*", pages 898-904.
- R. Moradi, R. Ruffini, C. L. Bianco, Y.-C. Chen, M. Karlica, et al., "*Relativistic Behavior and Equitemporal Surfaces in Ultra-Relativistic Prompt Emission Phase of Gamma-Ray Bursts*", pages 905-910.
- E. A. Panko, S. M. Andrievsky, S. I. Yemelianov, A. M. Stepaniuk, "*Regular Substructures in the Rich Open Galaxy Clusters*", pages 911-916.
- T. Petrushevska, T. Okamura, R. Kawamata, L. Hangard, G. Mahler, "*Prospects for Strongly Lensed Supernovae Behind Hubble Frontier Fields Galaxy Clusters with the James Webb Space Telescope*", pages 917-925.
- M. A. Prakapenia, I. A. Siutsou, G. V. Vereshchagin, "*Numerical Scheme for Treatment of Uehling–Uhlenbeck Equation for Binary and Triple Interactions in Relativistic Plasma*", pages 926-932.
- D. Primorac, M. Muccino, R. Moradi, Y. Wang, J. D. Melon Fuksman, et al., "*Structure of the Prompt Emission of GRB 151027A Within the Fireshell Model*", pages 933-939.
- J. F. Rodriguez, J. A. Rueda, R. Ruffini, "*On the Final Gravitational Wave Burst from Binary Black Holes Mergers*", pages 940-952.
- Rácz, "*A Simple Method of Constructing Binary Black Hole Initial Data*", pages 953-958.
- G. Vereshchagin, S. Bedić, "*Loop Quantum Cosmology and Probability of Inflation*", pages 959-964.

For more details, please see: http://www.icranet.org/index.php?option=com_content&task=view&id=1192

5. Recent publications

D. Bini, A. Geralico, R.T. Jantzen, *Black hole geodesic parallel transport and the Marck reduction procedure*, accepted for publication by Phys. Rev. D (2019).

The Wigner rotations arising from the combination of boosts along two different directions are rederived from a relative boost point of view and applied to study gyroscope spin precession along timelike geodesics in a Kerr spacetime. First this helps to clarify the geometrical properties of Marck's recipe for reducing the equations of parallel transport along such world lines expressed in terms of the constants of the motion to a single differential equation for the essential planar rotation. Secondly this shows how to bypass Marck's reduction procedure by direct boosting of orthonormal frames associated with natural observer families. Wigner rotations mediate the relationship between these two descriptions for reaching the same parallel transported frame along a geodesic. The comparison is particularly straightforward in the case of equatorial plane motion of a test gyroscope, where Marck's scalar angular velocity captures the essential cumulative spin precession relative to the spherical frame locked to spatial infinity. These cumulative precession effects are computed explicitly for both bound and unbound equatorial plane geodesic orbits. The latter case is of special interest in view of recent applications to the dynamics of a two-body system with spin. Our results are consistent with the point-particle limit of such two-body results and also pave the way for similar computations in the context of gravitational self-force.

Link: https://arxiv.org/abs/1807.10085

R. Riahi, S. Z. Kalantari, J. A. Rueda, *Universal relations for the Keplerian sequence of rotating neutron stars*, published on 11 February 2019 in Phys. Rev. D 99, 043004 – P.

We investigate the Keplerian (mass-shedding) sequence of rotating neutron stars. Twelve different equations of state are used to describe the nuclear structure. We find four fitting relations which connect the rotating frequency, mass and radius of stars in the mass-shedding limit to the mass and radius of stars in the static sequence. We show the breakdown of approximate relation for the Keplerian frequency derived by Lattimer and Prakash [Science, 304, 536, (2004)] and then we present a new, EOS-independent and more accurate relation. This relation fits the Keplerian frequency of rotating neutron stars to about 2% for a large range of the compactness MS/RS of the reference non-rotating neutron star, namely the static star with the same central density as the rotating one. The performance of the fitting formula is close to 4% for $MS/RS \leq 0.05\, M_{\odot}$/km ($fK \leq 350$~Hz). We present additional EOS-independent relations for the Keplerian sequence including relations for $MKfK$ and $RKfK$ in terms of $MSfS$ and $RSfS$, respectively, one of MK/RK as a function of fK/fS and MS/RS, and a relation between the MK, RK and fK. These new fitting relations are approximately EOS-independent with an error in the worst case of 8%. The universality of the Keplerian sequence properties presented here add to the set of other neutron star universal relations in the literature such as the I-Love-Q relation, the gravitational binding energy and the energy, angular momentum and radius of the last circular orbit of a test-particle around rotating neutron stars. This set of universal, analytic formulas, facilitate the inclusion of general relativistic effects in the description of relativistic astrophysical systems involving fast rotating neutron stars.

Link to the journal: https://journals.aps.org/prd/abstract/10.1103/PhysRevD.99.043004
Link to the arXiv: https://arxiv.org/abs/1902.00349

C.R. Argüelles, A. Krut, J.A. Rueda, R.Ruffini, *Novel constraints on fermionic dark matter from galactic observables II: Galaxy scaling relations*, accepted for publication in Physics of the Dark Universe (DARK_100278) on January 29, 2019, available online from February 14, 2019.

We have recently introduced in paper I an extension of the Ruffini-Argüelles-Rueda (RAR) model for the distribution of DM in galaxies, by including for escape of particle effects. Being built upon self-gravitating

fermions at finite temperatures, the RAR solutions develop a characteristic dense quantum core-diluted halo} morphology which, for fermion masses in the range $mc^2 \approx 10-345$ keV, was shown to provide good fits to the Milky Way rotation curve. We study here for the first time the applicability of the extended RAR model to other structures from dwarfs to ellipticals to galaxy clusters, pointing out the relevant case of $mc^2 = 48$ keV. By making a full coverage of the remaining free parameters of the theory, and for each galactic structure, we present a complete family of astrophysical RAR profiles which satisfy realistic halo boundary conditions inferred from observations. Each family-set of RAR solutions predicts given windows of total halo masses and central quantum-core masses, the latter opening the interesting possibility to interpret them as alternatives either to intermediate-mass BHs (for dwarf galaxies), or to supermassive BHs (SMBHs, in the case of larger galaxy types). The model is shown to be in good agreement with different observationally inferred scaling relations such as: (1) the Ferrarese relation connecting DM halos with supermassive dark central objects; and (2) the nearly constant DM surface density of galaxies. Finally, the theory provides a natural mechanism for the formation of SMBHs of few $10^8 M_\odot$ via the gravitational collapse of unstable DM quantum-cores.

Link to the journal: https://doi.org/10.1016/j.dark.2019.100278

Link to the arXiv: https://arxiv.org/abs/1810.00405

Yen-Chen Chen, Chorng-Yuan Hwang, *Emission Line Luminosity Distributions of Seyfert 2 Galaxies*, accepted for publication in March 2019 on MNRAS, to be published in May, 2019.

We probed the relation between line activities of Seyfert 2 galaxies and their host galaxies. We selected Seyfert 2 galaxies from the Sloan Digital Sky Survey Data Release 10 with redshifts less 0.2. We used the luminosity of the emission lines as indicators of AGN power. We found that the Seyfert 2 galaxies seem to have two populations in the emission line luminosity distributions. We considered the L[OIII]/Lbulge ratio as an accretion rate indicator and found that the two Seyfert 2 distributions seem to have different accretion rates. We found that these two Seyfert 2 populations, although classified by their emission line distributions, turned out to have different morphology distributions. These results indicate that these different populations of the Seyfert 2 galaxies might be significantly different in their physical conditions.

Link: https://arxiv.org/abs/1903.03581

ICRANet Newsletter

April – May 2019

SUMMARY

1. ICRANet receives Awards for Essay for the Gravity Research Foundation Award Competition 2019

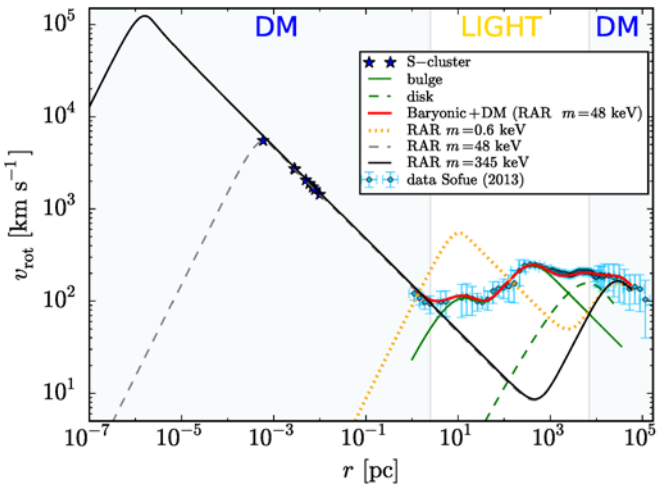


Fig. 1. Theoretical RAR rotation curves from 10^{-7} pc all the way to 10^{5} pc, for three representative fermion masses in the mc^2 keV region: 0.6 keV (dotted yellow curve), 48 keV (long-dashed-gray curve) and 345 keV (solid black curve).

The article "Can Fermionic Dark Matter Mimic Supermassive Black Holes?" by C. R. Argüelles, A. Krut, J. A. Rueda and R. Ruffini receives the Third Award by the Gravity Research Foundation www.gravityresearchfoundation.org in the Award Competition 2019. The paper analyzes the intriguing possibility to explain both dark mass components in a galaxy: the dark matter (DM) halo and the supermassive dark compact object lying at the center, by a unified approach in terms of a quasi-relaxed system of massive, neutral fermions in general relativity. The solutions to the mass distribution of such a model that fulfill realistic halo boundary conditions inferred from observations, develop a highly-density core supported by the fermion degeneracy pressure able to mimic massive black holes at the center of galaxies. Remarkably, these dense core-dilutedhaloconfigurations can explain the dynamics of the closest stars around Milky Way's center (SgrA*) all the way to the halo rotation curve, without spoiling the baryonic bulge-disk components, for a narrow particle mass range mc^2 ~10-10^2 keV.

The paper can be downloaded here: https://arxiv.org/abs/1905.09776

For details see: https://www.gravityresearchfoundation.org/s/2019abstracts.pdf

2. Renewal of the collaboration agreement ICRANet – UFRGS, April 5, 2019


Instituto de Física

CAMPUS INTERNACIONAL

ADDENDUM TO THE COOPERATION PROTOCOL THAT AMONG THEMSELVES CELEBRATE THE INTERNATIONAL CENTER FOR RELATIVISTIC ASTROPHYSICS NETWORK (ICRANet) AND THE FEDERAL UNIVERSITY OF RIO GRANDE DO SUL (UFRGS) THROUGH THE PHYSICS INSTITUTE OF UFRGS (IFUFRGS), TAKING BY OBJECTIVE TO EXTEND ITS TIME PERIOD, IN THE TERMS PURSUANT AS FOLLOW:

CLAUSE ONE - THE RENEWAL

According to the Seventh Clause, is hereby extended for the term of 60 months starting from April 15, 2019, the Cooperation Protocol between the FEDERAL UNIVERSITY OF RIO GRANDE DO SUL (UFRGS) THROUGH THE PHYSICS INSTITUTE OF UFRGS (IFUFRGS) and the INTERNATIONAL CENTER FOR RELATIVISTIC ASTROPHYSICS NETWORK (ICRANet).

On April 5, 2019, the agreement between ICRANet and UFRGS (Universidade Federal do Rio Grande do Sul) has been renewed. This new agreement was signed by Prof. Dr. Rui Vincente Oppermann (Rector of UFRGS), Prof. Naira Maria Balzaretti (Director of UFRGS Department of Physics), Prof. Dr. Dimiter Hadjimichef (UFRGS Department of Physics) and by Prof. Remo Ruffini (Director of ICRANet).

This agreement will be valid for 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 joint collaboration of faculty members, researchers, post-doctorate fellows and students; the organization of training and teaching courses, seminars, conferences, workshops or short courses, and the joint work on scientific publications.

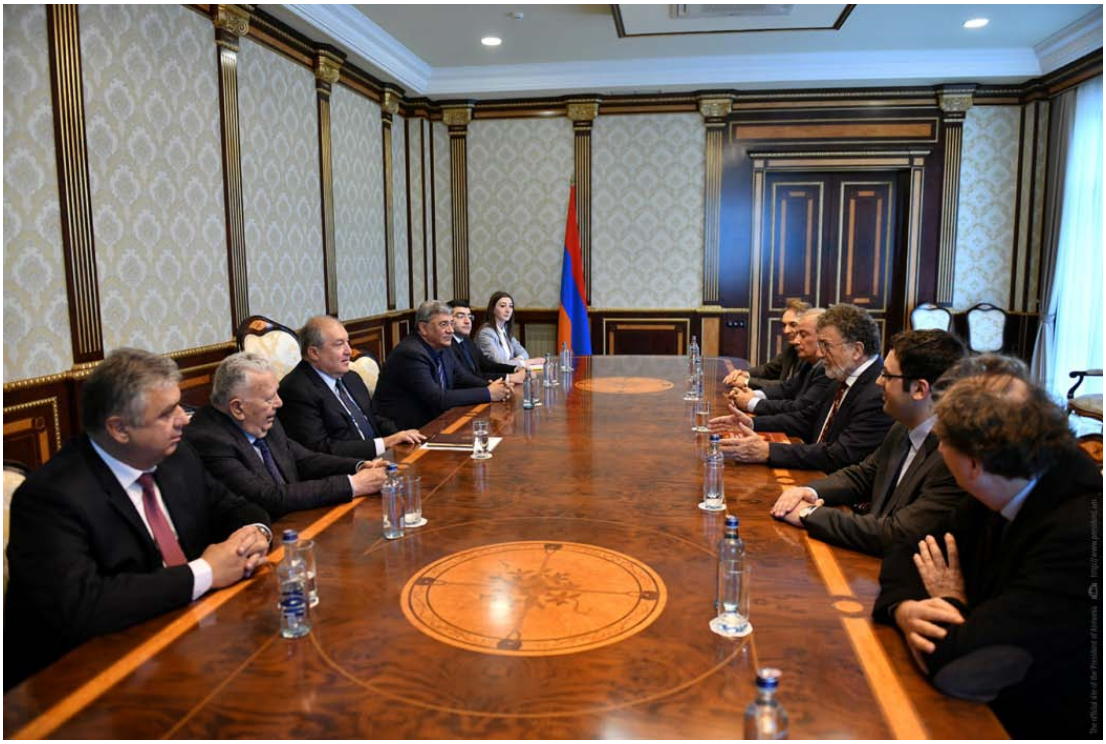
For the text of the agreement: http://www.icranet.org/index.php?option=com_content&task=view&id=842

3. Armenian-Italian Science Day, Yerevan, April 15, 2019

On April 15, 2019, ICRANet organized the Armenian-Italian Science Day event "*Joint ICRANet activities in Relativistic Astrophysics. Information Event for Cooperation in the field of Relativistic Astrophysics* ", a one day conference which took place in Yerevan on April 15, 2019. This event has been organized thanks to the collaboration among ICRANet, the National Academy of Sciences of Armenia (NASRA) and the Italian Embassy in Yerevan. The morning session was held at the National Academy of Sciences, whereas the afternoon session was held at the Italian Embassy in Yerevan.

Institutional representatives from Armenia and from several other countries were present and addressed the opening session in the morning, namely: Ambassador Ashot Kocharian (Ministry of Foreign Affairs of the Republic of Armenia), Artak Apitonian (Deputy Minister of Foreign Affairs of Armenia), Radik Martirosyan (President of the NASRA), Samvel Haroutiunian (Chairman of the RA MES Science Committee), Vardan Sahakyan (Deputy Chairman of the RA MES Science Committee), Vincenzo Del Monaco (Ambassador of Italy to Armenia), Matthias Kiesler (Ambassador of Germany to Armenia) and Remo Ruffini (Director of ICRANet). During the day, the most recent scientific developments on which ICRANet is working on, were presented by eminent Professors and researchers, namely by Prof. Narek Sahakyan (ICRANet Armenia), Prof. Razmik Mirzoyan (Max Planck Institute of Physics, Germany), Dr Wang Yu (ICRANet), Rahim Moradi (ICRANet), Prof. Remo Ruffini (ICRANet), Dr Li Liang (ICRANet), Prof. Gregory Vereshchagin – video conference (ICRANet), Prof. Paolo Giommi (ICRANet-ASI), Ashot Chilingaryan (Cosmic Ray Division) and Leonid Bezrukov (vice Director of the Institute for Nuclear Research in Moscow).

In the same afternoon, Professor Remo Ruffini (Director of ICRANet), met the President of the Republic of Armenia, H.E. Armen Sarkissian at his residence in Yerevan, leading an ICRANet delegation composed by Ambassador Ashot Kocharian, President Radik Martirosyan, Prof. Narek Sahakyan, Prof. Razmik Mirzoyan, Prof. Paolo Giommi and Prof. Massimo Della Valle. President Sarkissian stressed the importance of the ICRANet activities in Armenia, pushing for a strong development of education and science in the country. Prof. Ruffini hailed cooperation with Armenia and noted that there is an intention to implement new programs with the countries of Central Asia via Armenia. All the interlocutors discussed possibilities of the implementation of joint programs and further deepening of cooperation with the world's leading centers, organizations, and universities, such as ICRANet.



The Armenian-Italian Science day ended with the Concert "*Primavera Italiana*", held at the Komitas Chamber Music Hall in Yerevan and offered by the Italian Embassy. The concert honored several Italian opera composers, such as Arcangelo Corelli, Giovanni Pergolesi, Antonio Vivaldi and Niccolò Paganini.

For more information about the event: http://www.icranet.org/Armenian-ItalianScienceDay
For photos and videos: http://www.icranet.org/index.php?option=com_content&task=view&id=1240

For the press releases on the event:
http://www.icranet.org/index.php?option=com_content&task=view&id=1239

4. ICRANet press release "*Professor Roy Kerr elected as Royal Society Fellow*", April 18, 2019

The New-Zealander Professor Roy Kerr, mathematician and physicist, holding the Yevgeny Lifshitz Chair at ICRANet and Crafoord Prize in Astronomy 2016 "*for his fundamental work on rotating blacks holes and their astrophysical consequences*", has been nominated Fellow of the Royal Society (UK) for his exceptional contributions to science, placing him among the world's most eminent scientists. He will be officially nominated in a formal admission ceremony, which will be held on July 12, 2019 in London.

The Royal Society awarded Professor Kerr this high and prestigious title "*for the solution of Einstein's equations of General Relativity for rotating black holes, an epochal result now known as the Kerr metric, describing Kerr black holes. Other major contributions include prescient work on algebraically special solutions of reduced holonomy.*"

In fact, Prof. Roy Kerr discovered in 1963 an exact solution to the Albert Einstein's equations on General Relativity of a rotating object: "*This mathematic solution* – recalls the ICRANet Director Prof. Remo Ruffini – *has allowed fundamental unprecedented advances in the applications in the fields of Physics, Astronomy and Relativistic Astrophysics: the applications extend to the field of the micro-physics of the elementary particles, such as the structure of the electron, to the astrophysics of Black Holes, which arise at the end of a star evolution, up to the most energetic processes in the universe, such as GRBs and the active galactic*

nuclei, where Black Holes and maxi-Black Holes, up to billions of times greater than our sun, dominate." It was indeed Remo Ruffini with John Archibald Wheeler who used the Kerr mathematic solution, introducing it in the description of the fundamental physics processes, giving them the name of "Black Hole", which has been then translated in all languages worldwide (Physics Today, 30, 1971). These topics have been further investigated by Blandford and Znajek (MNRAS, 179, 433, 1977) following an article by Ruffini and Wilson (Phys. Rev. D 12, 2959,1975).

Kerr's discovery sparked a revolution in physics and, since then, his work proved of great importance and all subsequent detailed work on black holes has depended fundamentally on it.

In 2006 Prof. Roy Kerr got the Marcel Grossmann Award on the occasion of the institutional international meeting for Relativistic Astrophysics, which takes place every three years in a different country. Prof. Roy Kerr has been teaching at ICRANet within the IRAP PhD program, the first International joint Doctorate, founded by ICRANet and internationally coordinated by the University of Nice "Sophia Antipolis".

Professor Kerr has also been in the news this month after astronomers captured the first image of a black hole, attentively interpreted within ICRANet.

5. Visit of the Erasmus students from the High School ITIS Alessandro Volta, May 7, 2019

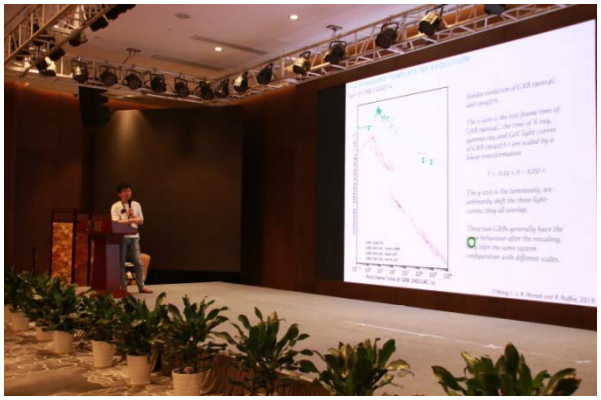
On Mai 7, 2019 a delegation of Erasmus students and Italian students from the High School ITIS Alessandro Volta of Pescara, visited ICRANet center in Pescara. Under the supervision of Gregory Vereshchagin, ICRANet Faculty Professor, the students had the possibility to visit the center and its library and that was for them a unique opportunity to take part in science activities aiming to showcase both the fascination of research as a career and its significant societal impact.

After the opening remarks of Professor Vereshchagin, Prof. She-Sheng Xue (ICRANet), Dr Wang Yu (ICRANet), Dr Liang Li (ICRANet), Rahim Moradi (ICRANet) and Yen-Chen Chen (ICRANet) presented the most recent scientific developments on which ICRANet is working on.

6. Mission of Professor Ruffini to China, May 10 – 22, 2019

From 11 to 18 Mai 2019, Professor Ruffini visited China, together with Dr Yu Wang and Dr Li Liang. During that visit, they were invited to participate and deliver a talk to the "*Gamma-Ray Bursts and Related Astrophysics in Multi-Messenger Era*", a conference held in Nanjing University Center from 13 to 17 Mai 2019.

Professor Ruffini delivered a talk titled "*Self-similar structure of the ultra-relativistic prompt emission of GRB 190114C*", Dr Wang Yu delivered a talk titled "*GRB 190114C: most comprehensive portrait of gamma-ray burst*" and Dr Liang Li delivered a talk titled "*Shock breakout in BdHN I and BdHN II, the case of GRB 13027A, 180728A and 190114C*".



During his visit, Prof. Ruffini also visited some Chinese researchers in Shanghai at Jiaotong University and was invited by Professor Shing-Tung Yau, Director of the Yau Mathematical Science Center, to visit Tsinghua University in Beijing, one of the most important Chinese universities. On that occasion, Prof. Ruffini had a fruitful meeting both with Prof. Yau and with Prof. Shude Mao, Director of the Department of Astronomy at Tsinghua University. After that, Prof. Ruffini flew to Hefei in order to meet Porf. Ye-Fei Yuan from the Department of Astronomy of the University of Science and Technology of China (USTC).


During his visit, Prof. Ruffini had the possibility to present the most recent scientific developments on which ICRANet is working on and to have fruitful exchange of ideas with other researchers from all over the world.

On Friday 17 Mai 2019, Prof. Remo Ruffini, Director of ICRANet, sent an important message from China, on the occasion of the 40° anniversary of his first visit to China:

"*When I introduced in Princeton the concept of "Black Hole" with John Archibald Wheeler, our omen was to open a new era thanks to the study of Relativistic Astrophysics. Daily phone conversations between me (who was in Princeton) and Riccardo Giacconi (who was in Harvard), tying to interpret data from the satellite UHURU ("freedom" in Swahili, launched by Luigi Broglio from the space station San Marco in Kenia), made this omen a reality. In 1973, I received the Cressy Morrison Award from the New York Academy of Sciences for the discovery of the first "Black Hole" in the galaxy and, in 2002, Riccardo Giacconi received the Nobel Prize in Physics.*
This progresses have also been marked in 1973 by another event destined to become memorable: the discovery of Gamma Ray Bursts (GRBs). To achieve their understanding/comprehension, it took more than 40 years marked by everyday theoretical studies, accompanied by a "multimessanger" technological and optical development without
precedent in the history of humanity. Recently, there have been announcements of a Black Hole at the center of the galaxy, of binary Black Holes, a photo of a Black Hole with enormous multi-media clamor: very interesting if true, using an euphemism by Wigner.
Thanks to GRB 190114C observed on January 14, 2019, we have identified for the first time, the birth/origin of a "Black Hole", which manifested its existence through the emission of the biggest energy source in the Universe. A "new" energy source, 1030 bigger than the one of the atomic bomb of Los Alamos, with a particle flux 1042 and energies 1012 bigger than those of CERN and those planned in China at the CEPC. Fermi led the way: with his research in nuclear physics begun a new age economic, political and military

development. Those who will control the science and technology based on this new enormous cosmic energy source, will decide the economic, political and military future of the planet".

7. Upcoming meetings

The Open Universe International Doctoral School, June 11 – 14, 2019

It gives us great pleasure to announce the Open Universe International Doctoral School on "*Magnetized Black Holes, GRBs, AGNs and the most violent Universe: from observation on data acquisition to the theory and model-building of GRB 190114C*", a 3 days conference which will be held from June 11 – 14, 2019 in the ICRANet Seat at Villa Ratti (Nice - France). It has been organized thanks to the collaboration among ICRANet, LAPP (Laboratoire d'Annecy de Physique des particules) and the Max Planck Institute for Physics. The scientific program is under preparation, and more details about the event will be published soon on our webpage: http://www.icranet.org/index.php?option=com_content&task=view&id=1241

16th Italian-Korean Symposium on Relativistic Astrophysics

It gives us great pleasure to announce the 16th Italian-Korean Symposium on Relativistic Astrophysics, that will be held at ICRANet center in Pescara from July 1 – 5, 2019. 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 soon on our webpage:
http://www.icranet.org/index.php?option=com_content&task=view&id=1234

8. Recent publications

Seddigheh Tizchang, Rohoollah Mohammadi, She-Sheng Xue, *Probing Lorentz violation effects via a laser beam interacting with a high-energy charged lepton beam*, published on The European Physical Journal C, March 2019, 79:224.

In this work, the conversion of linear polarization of a laser beam to circular one through its forward scattering by a TeV order charged lepton beam in the presence of Lorentz violation correction is explored. We calculate the ratio of circular polarization to linear one (Faraday Conversion phase $\Delta\phi_{FC}$) of the laser beam interacting with either electron or the muon beam in the framework of the quantum Boltzmann equation. Regarding the experimentally available sensitivity to the Faraday conversion $\Delta\phi_{FC}\simeq 10^{-3}-10^{-2}$, we show that the scattering of a linearly polarized laser beam with energy $k_0\sim 0.1$ eV and an electron/muon beam with flux $\dot{\epsilon}_{e,\mu}\sim 10^{10}/10^{12}$ TeV cm^{-2} s^{-1} places an upper bound on the combination of lepton sector Lorentz violation coefficients $c_{\mu\nu}$components $(c_{TT}+1.4\, c_{(TZ)}+0.25(c_{XX}+c_{YY}+2\, c_{ZZ}))$. The obtained bound on the combination for the electron beam is at the $4.35\times 10-15$ level and for the muon beam at the 3.9×10^{-13} level. It should be mentioned that the laser and charged lepton beams considered here to reach the experimentally measurable $\Delta\phi_{FC}$ are currently available or will be accessible in the near future. This study provides a valuable supplementary to other theoretical and experimental frameworks for measuring and constraining Lorentz violation coefficients.

Link: https://link.springer.com/article/10.1140%2Fepjc%2Fs10052-019-6716-5

Glauch, Theo; Padovani, Paolo; Giommi, Paolo; Resconi, Elisa; Arsioli, Bruno; Sahakyan, Narek; Huber, Matthias, *Dissecting the region around IceCube-170922A: the blazar TXS 0506+056 as the first cosmic neutrino source*, published online on Mai 10, 2019 in EPJ Web of Conferences 207, 02003 (2019).

On MJD 58018 the IceCube neutrino observatory detected a highlyenergetic, well-reconstructed neutrino, IceCube-170922A, at a distance of 0:1° to a γ-ray flaring blazar, TXS 0506+056. Follow-up searches in archival data additionally revealed a larger flare of neutrinos from the same direction. In order to complete the picture we present here a full multi-wavelength study of the region around IceCube-170922A. While we identify also other non-thermal counterpart candidates, we show that all the evidence points to TXS 0506+056 as the dominant neutrino emitter. Additionally, an analysis of all the available Fermi-LAT data indicates a hard spectrum/low flux of TXS 0506+056 during the neutrino flare in contrast to a soft spectrum/high flux at the arrival time of IceCube-170922A. Putting all the pieces together we conclude that the SED of TXS 0506+056 can be energetically reconnected for both neutrino observations.

Link: https://www.epj-conferences.org/articles/epjconf/abs/2019/12/epjconf_vlvnt2018_02003/epjconf_vlvnt2018_02003.html

V. A. Acciari, S. Ansoldi, L.A. Antonelli, A. Arbet Engels, D. Baack, A. Babić, B. Banerjee, U. Barres de Almeida, J. A. Barrio, J. Becerra González, W. Bednarek, L. Bellizzi, E. Bernardini, A. Berti, J. Besenrieder, W. Bhattacharyya, C. Bigongiari, A. Biland, O. Blanch, G. Bonnoli, G. Busetto, R. Carosi, G. Ceribella, Y. Chai, S. Cikota, S. M. Colak, U. Colin, E. Colombo, J.L. Contreras, J. Cortina, S. Covino, V. D'Elia, P. Da Vela, F. Dazzi, A. De Angelis, B. De Lotto, M. Delfino, J. Delgado, F. Di Pierro, E. Do Souto Espiñeira, A. Domínguez, D. Dominis Prester, D. Dorner, M. Doro, D. Elsaesser, V. Fallah Ramazani, A. Fattorini, A. Fernández-Barral, G. Ferrara, D. Fidalgo, L. Foffano, M. V. Fonseca, L. Font, C. Fruck, D. Galindo, S. Gallozzi, R. J. García López, M. Garczarczyk, S. Gasparyan, M. Gaug, N. Godinović, D. Green, D. Guberman, D. Hadasch, A. Hahn, T. Hassan, J. Herrera, J. Hoang, D. Hrupec, S. Inoue, K. Ishio, Y. Iwamura, H. Kubo, J. Kushida, A. Lamastra, D. Lelas, F. Leone, E. Lindfors, S. Lombardi, F. Longo, M. López, R. López-Coto, A. López-Oramas, B. Machado de Oliveira Fraga, C. Maggio, P. Majumdar, M. Makariev, M. Mallamaci, G. Maneva, M. Manganaro, K. Mannheim, L. Maraschi, M. Mariotti, M. Martínez, S. Masuda, D. Mazin, S. Mićanović, D. Miceli, M. Minev, J. M. Miranda, R. Mirzoyan, E Molina, A. Moralejo, D. Morcuende, V. Moreno, E. Moretti, P. Munar-Adrover, V. Neustroev, A. Niedzwiecki, M. Nievas Rosillo, C. Nigro, K. Nilsson, D. Ninci, K. Nishijima, K. Noda, L. Nogués, M. Nöthe, S. Paiano, J. Palacio, M. Palatiello, D. Paneque, R. Paoletti, J. M. Paredes, P. Peñil, M. Peresano, M. Persic, P. G. Prada Moroni, E. Prandini, I. Puljak, W. Rhode, M. Ribó, J. Rico, C. Righi, A. Rugliancich, L. Saha, N. Sahakyan, T. Saito, K. Satalecka, T. Schweizer, J. Sitarek, I. Šnidarić, D. Sobczynska, A. Somero, A. Stamerra, D. Strom, M. Strzys, T. Surić, F. Tavecchio, P. Temnikov, T. Terzić, M. Teshima, N. Torres-Albà, S. Tsujimoto, J. van Scherpenberg, G. Vanzo, M. Vázquez Acosta, I. Vovk, M. Will, D. Zarić, *Measurement of the extragalactic background light using MAGIC and Fermi-LAT gamma-ray observations of blazars up to z = 1*, published on 4 April 2019 on Monthly Notices of the Royal Astronomical Society, Volume 486, Issue 3, July 2019, Pages 4233–4251.

We present a measurement of the extragalactic background light (EBL) based on a joint likelihood analysis of 32 gamma-ray spectra for 12 blazars in the redshift range z = 0.03–0.944, obtained by the MAGIC telescopes and Fermi-LAT. The EBL is the part of the diffuse extragalactic radiation spanning the ultraviolet, visible, and infrared bands. Major contributors to the EBL are the light emitted by stars through the history of the Universe, and the fraction of it that was absorbed by dust in galaxies and re-emitted at longer wavelengths. The EBL can be studied indirectly through its effect on very high energy photons that are emitted by cosmic sources and absorbed via γγ interactions during their propagation across cosmological distances. We obtain estimates of the EBL density in good agreement with state-of-the-art models of the EBL production and evolution. The 1σ upper bounds, including systematic uncertainties, are between 13 per cent and 23 per cent above the nominal EBL density in the models. No anomaly in the expected transparency of the Universe to gamma-rays is observed in any range of optical depth. We also perform a

wavelength-resolved EBL determination, which results in a hint of an excess of EBL in the 0.18–0.62 μmμm range relative to the studied models, yet compatible with them within systematic.

Link: https://doi.org/10.1093/mnras/stz943

Gallego Cadavid, Alexander; Romano, Antonio Enea, *One spectrum to rule them all?*, to be published on Physics Letters B, Volume 793, p. 1-7 on June 2019.

We show that in absence of entropy or effective anisotropic stress the freedom in the choice of the initial energy scale of inflation implies the existence of an infinite family of dual slow-roll parameters histories which can produce the same spectrum of comoving curvature perturbations. This implies that in general there is no one-to-one correspondence between the spectrum and higher order correlation functions. We give some numerical examples of expansion histories corresponding to different initial energy scales, with the same spectrum of curvature perturbations, the same squeezed limit bispectrum, in agreement with the squeezed limit consistency condition, but with different bispectra in other configurations and different spectra of primordial gravitational waves. The combined analysis of data from future CMB and gravitational wave experiments could allow to distinguish between dual models.

Link: https://www.sciencedirect.com/science/article/pii/S0370269319302497?via%3Dihub

Yen-Chen Chen, Chorng-Yuan Hwang, *Emission line luminosity distributions of Seyfert 2 galaxies*, published on March 8, 2019 on Monthly Notices of the Royal Astronomical Society, Volume 485, Issue 3, May 2019, Pages 3402–3408.

We probed the relation between line activities of Seyfert 2 galaxies and their host galaxies. We selected Seyfert 2 galaxies from the Sloan Digital Sky Survey Data Release 10 with redshifts less than 0.2. We used the luminosity of the emission lines as indicators of AGN power. We found that the Seyfert 2 galaxies seem to have two populations in the emission line luminosity distributions. We considered the $L_{[OIII]}/L_{bulge}$ ratio as an accretion rate indicator and found that the two Seyfert 2 distributions seem to have different accretion rates. We found that these two Seyfert 2 populations, although classified by their emission line distributions, turned out to have different morphology distributions. These results indicate that these different populations of the Seyfert 2 galaxies might be significantly different in their physical conditions.

Link: https://doi.org/10.1093/mnras/stz677

T. Maiolino, P. Laurent, L. Titarchuk, M. Orlandini and F. Frontera, *Red-skewed Kα iron lines in GX 13+1*, published on April 30, 2019 on A&A, Volume 625, May 2019.

Context. Broad, asymmetric, and red-skewed Fe Kα emission lines have been observed in the spectra of low-mass X-ray binaries hosting neutron stars (NSs) as a compact object. Because more than one model is able to describe these features, the explanation of where and how the red-skewed Fe lines are produced is still a matter of discussion. It is broadly accepted that the shape of the Fe Kα line is strongly determined by the special and general relativistic effects occurring in the innermost part of the accretion disk. In this relativistic framework, the Fe fluorescent lines are produced in the innermost part of the accretion disk by reflection of hard X-ray photons coming from the central source (corona and/or NS surface). We developed an alternative and nonrelativistic model, called the WINDLINE model, that is capable to describe the Fe line features. In this nonrelativistic framework, the line photons are produced at the bottom of a partly ionized outflow (wind) shell as a result of illumination by the continuum photons coming from the central source. In this model the red-skewness of the line profile is explained by repeated electron scattering of the photons in a diverging outflow.
Aims. Examining the asymmetry of the fluorescent Fe K emission line evident in the XMM-Newton EPIC-pn spectra of the NS source GX 13+1, we aim to distinguish between the two line models. Because GX 13+1

is a well-known disk-wind source, it is a perfect target for testing the WINDLINE model and compare the spectral fits between the relativistic and nonrelativistic line models.
Methods. We used two XMM-Newton EPIC-pn observations in which the Fe line profiles were previously reported in the literature. These observations are not strongly affected by pile-up, and the Fe emission lines appear very strong and red-skewed. In order to access the goodness of the fit and distinguish between the two line models, we used the run-test statistical method in addition to the canonical $\chi 2$ statistical method.
Results. The DISKLINE and WINDLINE models both fit the asymmetric Fe line well that is present in the XMM-Newton energy spectra of GX 13+1. From a statistical point of view, for the two observations we analyzed, the run-test was not able to distinguish between the two Fe line models, at 5% significance level.

Link: https://doi.org/10.1051/0004-6361/201833163

Loppini, Alessandro, Filippi, Simonetta; Stanley, H. Eugene, *Critical transitions in heterogeneous networks: Loss of low-degree nodes as an early warning signal*, published on April 2, 2019 in Phys. Rev. E 99, 040301(R).

A large number of real networks show abrupt phase transition phenomena in response to environmental changes. In this case, cascading phenomena can induce drastic and discontinuous changes in the system state and lead to collapse. Although complex network theory has been used to investigate these drastic events, we are still unable to predict them effectively. We here analyze collapse phenomena by proposing a minimal two-state dynamic on a complex network and introducing the effect of local connectivities on the evolution of network nodes. We find that a heterogeneous system of interconnected components presents a mixed response to stress and can serve as a control indicator. In particular, before the critical transition point is reached a severe loss of low-degree nodes is observed, masked by the minimal failure of higher-degree nodes. Accordingly, we suggest that a significant reduction in less connected nodes can indicate impending global failure.

Link: https://journals.aps.org/pre/abstract/10.1103/PhysRevE.99.040301

MAGIC Collaboration; Acciari, V. A.; Ansoldi, S.; Antonelli, L. A.; Arbet Engels, A.; Baack, D.; Babić, A.; Banerjee, B.; Barres de Almeida, U.; Barrio, J. A.; Becerra González, J.; Bednarek, W.; Bernardini, E.; Berti, A.; Besenrieder, J.; Bhattacharyya, W.; Bigongiari, C.; Biland, A.; Blanch, O.; Bonnoli, G. Busetto, G.; Carosi, R.; Ceribella, G.; Cikota, S.; Colak, S. M.; Colin, P.; Colombo, E.; Contreras, J. L.; Cortina, J.; Covino, S.; D'Elia, V.; Da Vela, P.; Dazzi, F.; De Angelis, A.; De Lotto, B.; Delfino, M.; Delgado, J.; Di Pierro, F.; Do Souto Espiñera, E.; Domínguez, A.; Dominis Prester, D.; Dorner, D.; Doro, M.; Einecke, S.; Elsaesser, D.; Fallah Ramazani, V.; Fattorini, A.; Fernández-Barral, A.; Ferrara, G.; Fidalgo, D.; Foffano, L.; Fonseca, M. V.; Font, L.; Fruck, C.; Galindo, D.; Gallozzi, S.; García López, R. J.; Garczarczyk, M.; Gasparyan, S.; Gaug, M.; Giammaria, P.; Godinović, N.; Green, D.; Guberman, D.; Hadasch, D.; Hahn, A.; Herrera, J.; Hoang, J.; Hrupec, D.; Inoue, S.; Ishio, K.; Iwamura, Y.; Kubo, H.; Kushida, J.; Kuveždić, D.; Lamastra, A.; Lelas, D.; Leone, F.; Lindfors, E.; Lombardi, S.; Longo, F.; López, M.; López-Oramas, A.; Machado de Oliveira Fraga, B.; Maggio, C.; Majumdar, P.; Makariev, M.; Mallamaci, M.; Maneva, G.; Manganaro, M.; Mannheim, K.; Maraschi, L.; Mariotti, M.; Martínez, M.; Masuda, S.; Mazin, D.; Minev, M.; Miranda, J. M.; Mirzoyan, R.; Molina, E.; Moralejo, A.; Moreno, V.; Moretti, E.; Munar-Adrover, P.; Neustroev, V.; Niedzwiecki, A.; Nievas Rosillo, M.; Nigro, C.; Nilsson, K.; Ninci, D.; Nishijima, K.; Noda, K.; Nogués, L.; Nöthe, M.; Paiano, S.; Palacio, J.; Paneque, D.; Paoletti, R.; Paredes, J. M.; Pedaletti, G.; Peñil, P.; Peresano, M.; Persic, M.; Prada Moroni, P. G.; Prandini, E.; Puljak, I.; Garcia, J. R.; Rhode, W.; Ribó, M.; Rico, J.; Righi, C.; Rugliancich, A.; Saha, L.; Sahakyan, N.; Saito, T.; Satalecka, K.; Schweizer, T.; Sitarek, J.; Šnidarić, I.; Sobczynska, D.; Somero, A.; Stamerra, A.; Strzys, M.; Surić, T.; Tavecchio, F.; Temnikov, P.; Terzić, T.; Teshima, M.; Torres-Albà, N.; Tsujimoto, S.; van Scherpenberg, J.; Vanzo, G.; Vazquez Acosta, M.; Vovk, I.; Will, M.; Zarić, D., *Deep observations of the globular cluster M15 with the MAGIC telescopes*, published on Monthly Notices of the Royal Astronomical Society, Volume 484, Issue 2, April 2019, Pages 2876–2885.

A population of globular clusters (GCs) has been recently established by the *Fermi*-LAT telescope as a new class of GeV γ-ray sources. Leptons accelerated to TeV energies, in the inner magnetospheres of MSPs or in their wind regions, should produce γ-rays through the inverse Compton scattering in the dense radiation field from the huge population of stars. We have conducted deep observations of the GC M15 with the MAGIC telescopes and used 165h in order to search for γ-ray emission. A strong upper limit on the TeV γ-ray flux $<3.2\times10^{-13}\mathrm{cm}^{-2}\mathrm{s}^{-1}$ above 300GeV (<0.26 per cent of the Crab nebula flux) has been obtained. We interpret this limit as a constraint on the efficiency of the acceleration of leptons in the magnetospheres of the MSPs. We constrain the injection rate of relativistic leptons, ηe, from the MSPs magnetospheres and their surrounding. We conclude that ηe must be lower than expected from the modelling of high-energy processes in MSP inner magnetospheres. For leptons accelerated with the power-law spectrum in the MSP wind regions, ηe is constrained to be much lower than derived for the wind regions around classical pulsars. These constraints are valid for the expected range of magnetic field strengths within the GC and for the range of likely energies of leptons injected from the inner magnetospheres, provided that the leptons are not removed from the GC very efficiently due to advection process. We discuss consequences of these constraints for the models of radiation processes around millisecond pulsars.

Link: https://academic.oup.com/mnras/article-abstract/484/2/2876/5298496?redirectedFrom=fulltext

L Becerra K. Boshkayev, J. A. Rueda, R. Ruffini, *Time evolution of rotating and magnetized white dwarf stars*, published on May 20, 2019 in Monthly Notices of the Royal Astronomical Society.

We investigate the evolution of isolated, zero and finite temperature, massive, uniformly rotating and highly magnetized white dwarf stars under angular momentum loss driven by magnetic dipole braking. We consider the structure and thermal evolution of the white dwarf isothermal core taking also into account the nuclear burning and neutrino emission processes. We estimate the white dwarf lifetime before it reaches the condition either for a type Ia supernova explosion or for the gravitational collapse to a neutron star. We study white dwarfs with surface magnetic fields from 106 to 109 G and masses from 1.39 to 1.46 $M_\odot$ and analyze the behavior of the WD parameters such as moment of inertia, angular momentum, central temperature and magnetic field intensity as a function of lifetime. The magnetic field is involved only to slow down white dwarfs, without affecting their equation of state and structure. In addition, we compute the characteristic time of nuclear reactions and dynamical time scale. The astrophysical consequences of the results are discussed.

Link: https://doi.org/10.1093/mnras/stz1394; https://arxiv.org/abs/1812.10543

C. R. Argüelles, A. Krut, J. A. Rueda, R. Ruffini, *Can Fermionic Dark Matter Mimic Supermassive Black Holes?*, Article Winner of the Third Award in the "Gravity Research Foundation 2019 awards for essays on Gravitation", to be published in an special issue of the International Journal of Modern Physics D dedicated to the Essay Competition.

We analyze the intriguing possibility to explain both dark mass components in a galaxy: the dark matter (DM) halo and the supermassive dark compact object lying at the center, by a unified approach in terms of a quasi-relaxed system of massive, neutral fermions in general relativity. The solutions to the mass distribution of such a model that fulfill realistic halo boundary conditions inferred from observations, develop a highly-density core supported by the fermion degeneracy pressure able to mimic massive black holes at the center of galaxies. Remarkably, these dense core-diluted halo configurations can explain the dynamics of the closest stars around Milky Way's center (SgrA*) all the way to the halo rotation curve, without spoiling the baryonic bulge-disk components, for a narrow particle mass range mc2 ~ 10-102 keV.

Link to the winners announcement: https://www.gravityresearchfoundation.org/announcement
Link to the article:
https://static1.squarespace.com/static/5852e579be659442a01f27b8/t/5cd46772e4966b1d5dcd2e14/1557423988074/Arguelles%5Bc.a.%5D_Krut_Rueda_Ruffini_2019.pdf

J. A. Rueda, R. Ruffini, Y. Wang, Induced Gravitational Collapse, *Binary-Driven Hypernovae, Long Gamma-ray Bursts and Their Connection with Short Gamma-ray Bursts*, published on Mai 9, 2019 in Universe: Invited Review for the Special Issue "Accretion Disks, Jets, Gamma-Ray Bursts and Related Gravitational Waves".

Short and long Gamma-ray bursts (GRBs) originate in subclasses with specific energy release, spectra, duration, etc, and have binary progenitors. We review here the binary-driven hypernovae (BdHNe) subclass whose progenitor is a COcore-neutron star (NS). The supernova (SN) explosion of the COcore produces at its center a new NS (νNS) and triggers a hypercritical accretion onto the NS. The NS can become a more massive NS or collapse into a black hole (BH). We summarize this topic from the first analytic estimates in 2012 to the most recent three-dimensional (3D) smoothed-particle-hydrodynamics (SPH) numerical simulations in 2018. Long GRBs are richer and more complex than previously thought. The SN and the accretion explain X-ray precursors. The NS accretion, its collapse and the BH formation produce asymmetries in the SN ejecta, implying a 3D GRB analysis. The newborn BH surrounded by the ejecta and the magnetic field inherited from the NS, are the \emph{inner engine} from which the electron-positron (e+e−) plasma and the high-energy emission initiate. The e+e− impact on the ejecta converts the SN into a hypernova (HN). The plasma dynamics in the ejecta explains the ultrarelativistic prompt emission in the MeV domain and the mildly-relativistic flares of the early afterglow in the X-ray domain. The feedback of the νNS emission on the HN explains the X-ray late afterglow and its power-law regime. All the above is in contrast with GRB models attempting to explain all the GRB phases with the kinetic energy of anultrarelativistic jet, as traditionally proposed in the "collapsar-fireball" model. In addition, BdHNe in their different flavors lead to νNS-NS or νNS-BH binaries. These binaries merge by gravitational wave emission producing short GRBs, establishing a connection between long and short GRBs and their occurrence rates.

Links: https://www.mdpi.com/2218-1997/5/5/110; https://arxiv.org/abs/1905.06050

ICRANet Newsletter

June – July – August 2019

SUMMARY

1. On the role of a cavity in the hypernova ejecta of GRB 190114C

The paper with this title co-authored by R. Ruffini, J. D. Melon Fuksman, G. V. Vereshchagin has been accepted for publication by the Astrophysical Journal on 19 of August 2019. It presents an evidence of formation of a cavity in the source of gamma-ray burst GRB190114C. It is proposed that this GRB originates in a binary system composed of a massive carbon-oxygen core, described within the binary-driven hypernova I (BdHN I) scenario. In this scenario the carbon-oxygen core undergoes a supernova explosion with the creation of a new neutron star, hypercritical accretion occurs onto the companion binary neutron star until it exceeds the critical mass for gravitational collapse.

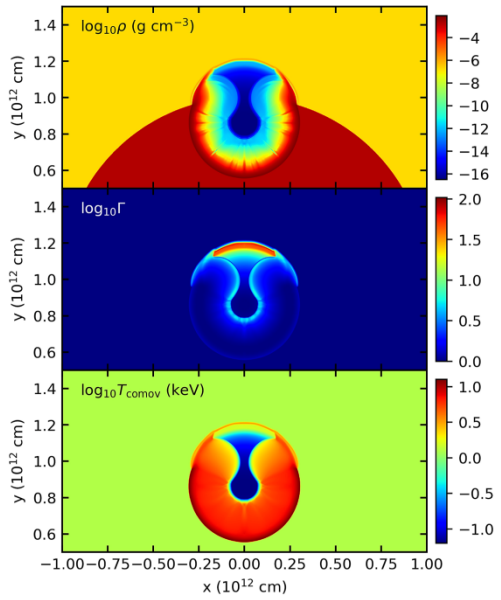


Fig. 1: Spatial distributions of matter density (top), Lorentz factor (middle) and comoving temperature (bottom) at t = 11 s, showing the mildly relativistic reflection wave propagating backward in the cavity, as well as the ultrarelativistic e+e- plasma wave propagating outside the cavity. The shock wave is visible inside the ejecta.

The formation of a black hole captures 10^{57} baryons by enclosing them within its horizon, and thus a cavity of approximately 10^{11} cm is formed around it with initial density 10^{-7} g/cm^3. A further depletion of baryons in the cavity originates from the expansion of the electron-positron-photon plasma formed at the collapse, reaching a density of 10^{-14} g/cm^3 by the end of the interaction. It is demonstrated using an analytical model complemented by a hydrodynamical numerical simulation that part of the electron-positron-photon plasma is reflected off the walls of the cavity. The consequent outflow and its observed properties are shown to coincide with the featureless emission occurring in a time interval of duration, measured in the rest frame of the source, between 11 and 20 s of the GBM observation. Moreover, similar features of the GRB light curve were previously observed in GRB 090926A and GRB 130427A, all belonging to the BdHN I class. This interpretation supports the general conceptual framework presented in (Ruffini et al. 2019) and guarantees that a low baryon density is reached in the cavity, a necessary condition for the operation of the "inner engine" of the GRB presented in an accompanying article (Ruffini & Moradi 2019).

References:

Ruffini, R., Li, L., Moradi, R., Rueda, J. A., Wang, Y., Bianco, C., Melon Fuksman, J. D., Xue, S. S., Cherubini, C., Filippi, S., Karlica, M., & Sahakyan, N. (2019). Self-similarity and power-laws in GRB 190114c. ArXiv:1904.04162.

Ruffini, R. & Moradi, R., e. a. (2019). On the determination of the mass and spin of the black hole in the inner engine of GRB 190114c. In preparation.

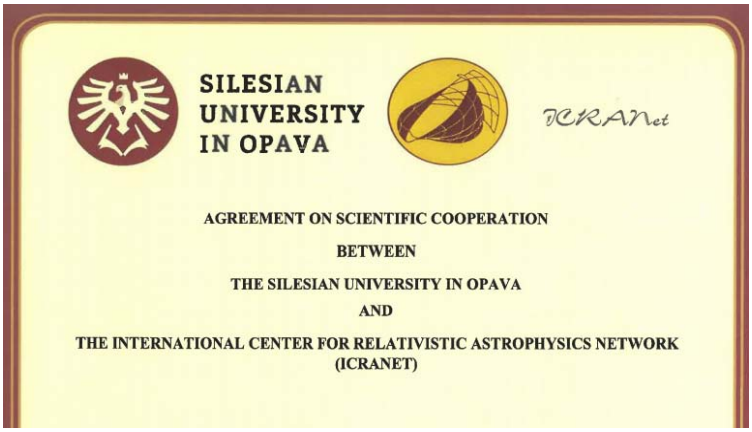
The paper is available here: https://arxiv.org/abs/1904.03163

2. New collaboration agreement between ICTP and ICRANet, August 7, 2019

On August 7, 2019 ICRANet signed a cooperation agreement with ICTP (the Abdus Salam International Centre for Theoretical Physics), which will be valid for 5 years. The document was signed by Prof. Fernando Quevedo, Director of ICTP, and Prof. 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.

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

3. New collaboration agreement between Silesian University in Opava and ICRANet, August 19, 2019



On August 19, 2019 ICRANet signed a cooperation agreement with the Silesian University in Opava (Czech Republic), which will be valid for 5 years. The document was signed by Doc. Ing. Pavel Tuleja (Rector of the Silesian University), by Prof. Zdenek Stuchlik (Head of the Research center for theoretical physics and astrophysics), by Prof. Ruffini (Director of ICRANet) and by Prof. Jorge 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, and the development of inter-institutional research areas associated to local graduate programs; and joint publications. The agreement will be deliver in person to Prof. Ruffini and Prof. Rueda during the RAGtime meeting, which will be held in Opava in September 2019.

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

4. Prof. Ruffini at the Armenian Summit of Minds Yerevan-Dilijan, Armenia, June 7-9, 2019

Fig.2: Group photo of the Armenia Summit of Minds 2019, Yerevan.

From 7 to 9 June 2019, 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 2019. This meeting was an opportunity for participants to experience simultaneously the most ancient and the most innovative that the country has to offer, a special mix of hard thinking and experiential learning. High level representatives in the field of international politics and economy were present. On the first day, Prof. Ruffini was invited to participate to the welcome reception hosted by H.E. Armen Sarkissian at the Central Bank of Armenia's Dilijan Training and Research Centre. On the following day, Prof. Ruffini delivered a talk titled "On the quantum nature of GRB 190114C" in the framework of the afternoon workshop on hi-tech and governance. On that evening, he also attended the official dinner organized by President Sarkissian together with high level personalities, such as Dominique de Villepin, former Prime-Minister of France.

Fig.3: Prof. Remo Ruffini with H.E. Armen Sarkissian, President of the Republic of Armenia.

For videos of the conference: https://www.president.am/en/summit-of-minds-videos/

5. 62nd session of the Scientific and Technical Subcommittee of COPUOS (UNOOSA), Vienna, Austria, June 19, 2019

The Scientific and Technical Subcommittee of the Committee on the Peaceful Uses of Outer Space (COPUOS) held its sixty-second session at the United Nations Office at Vienna from June 12 – 21, 2019.

Professor Ruffini joined the conference on June 19 and, on that day, he was invited to participate to a working dinner by H.E. Ambassador Maria Assunta Accili (Permanent Representative of Italy to the International Organizations in Wien) in her residence. On that occasion Prof. Ruffini had the possibility to illustrate to all the participants the latest scientific results achieved by ICRANet, as well as to open an international dialogue with the highest representatives of UNOOSA (United Nations Office for Outer Space Affairs) and its Director, H.E. Simonetta Di Pippo.

6. Prof. Roy Kerr and Prof. Ruffini met the Mayor of Pescara, July 23, 2019

On Tuesday July 23 Prof. Roy P. Kerr (New-Zealander mathematician and physicist, holding the Yevgeny Lifshitz Chair at ICRANet and Crafoord Prize in Astronomy 2016), met the Mayor of Pescara, Dr Carlo Masci, accompanied by Prof. Remo Ruffini, Director of ICRANet. Prof. Kerr, the discoverer of the "Kerr metric", was awarded the Albert Einstein medal by the Albert Einstein Society in 2013 and has just been nominated Fellow of the Royal Society. He is an honorary citizen of Pescara since 2016 and has been in ICRANet center in July in order to further work with Prof. Ruffini and ICRANet scientists on black holes. During the meeting, on the occasion of the anniversary of first moon landing, Prof. Ruffini showed to Dr Masci the letter with the issue of the first stamp with the image of Armstrong on the moon, sent from Princeton on July 20, 1969. The Mayor expressed to Prof. Kerr and Prof. Ruffini his gratitude for their visit and for their strong contribution to science, as well as his support to further strengthen the collaboration with ICRANet, a flagship for the city of Pescara and for its culture. He also presented the 2 scientists to a delegation of school leaders that was in the same building for a meeting with the city administration, highlighting the importance of a strong collaboration among scientists and schools in order to spread culture among students.

Fig. 4: From left to right: Prof. Remo Ruffini, Prof. Roy P. Kerr and Dr Carlo Masci, Mayor of Pescara.

Fig. 5: Prof. Roy P. Kerr and Dr Carlo Masci.

Fig. 6: Prof. Remo Ruffini, Prof. Roy P. Kerr and Dr Carlo Masci with the local school leaders.

Photo credit to the Municipality of Pescara.

7. Visit of Prof. Ruffini at Stanford University, USA, August 24 – 31, 2019

From August 24 to 31, Prof. Ruffini visited Stanford University, founder member of ICRANet, and give there a seminar titled "On the BdHN I GRB 190114C and its energetics". This visit was an opportunity for Prof. Ruffini to participate to several other meetings, as well as to work together with some of his longtime colleagues and the FERMI team on the latest scientific results on which ICRANet is also working on.

8. Prof. Roy Kerr official nomination as Fellow of the Royal Society, London, United Kingdom, July 12, 2019

On July 11, Professor Ruffini, Director of ICRANet, took part in the formal admission ceremony of Professor Roy P. Kerr as Fellow of the Royal Society, which was held on July 12 at the seat of the Royal Society in London. Professor Kerr was awarded by the Royal Society this high and prestigious title *"for the solution of Einstein's equations of General Relativity for rotating black holes, an epochal result now known as the Kerr metric, describing Kerr black holes. Other major contributions include prescient work on algebraically special solutions of reduced holonomy"*.

9. Prof. Ruffini awarded Commander of the Order of Merit of the Italian Republic, June 2, 2019

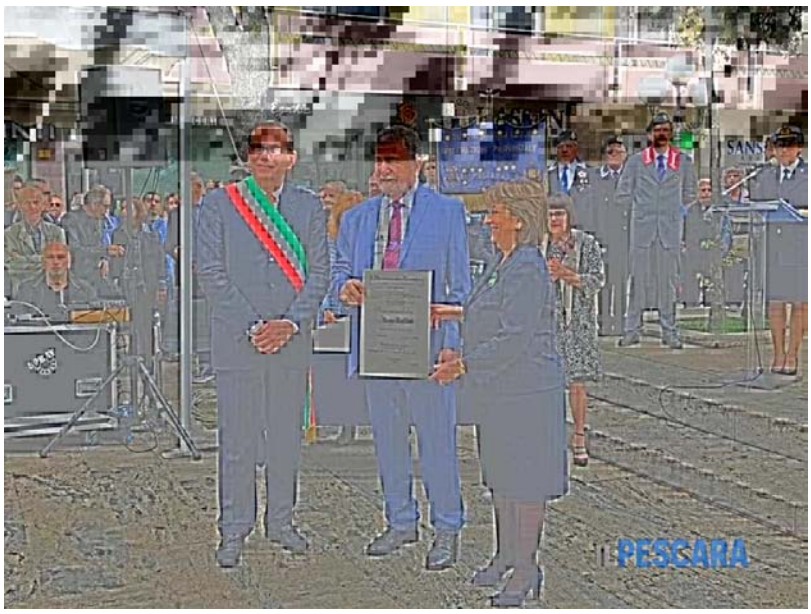


Fig. 7: Prof. Remo Ruffini awarded Commander of the Order of Merit of the Italian Republic with the Prefect of Pescara, H.E. Gerardina Basilicata (on the right) and the then Mayor of Pescara, Dr Marco Alessandrini (on the left). Photo credit to Il Pescara.

On Sunday June 2, 2019, Prof. Remo Ruffini, Director of ICRANet, was awarded Commander of the Order of Merit of the Italian Republic by the Prefect of Pescara, H.E. Gerardina Basilicata, on the occasion of the Italian Republic day. The official ceremony was held in the city center of Pescara, at the presence of the highest local institutional, military and religious authorities. Among them, the then Mayor of Pescara, Dr Marco Alessandrini. The Order of Merit of the Italian Republic was founded as the senior order of knighthood by the second President of the Italian Republic, Luigi Einaudi in 1951. The highest ranking honor of the Republic, it is awarded for *"merit acquired by the nation" in the fields of literature, the arts, economy, public service, and social, philanthropic and humanitarian activities and for long and conspicuous service in civilian and military careers*. The order is classified in 6 kinds of classes, and Prof. Ruffini was awarded the 3rd class, Commander.

For a press release on that event: http://www.ilpescara.it/attualita/festa-repubblica-2-giugno-pescara-piazza-garibaldi-cerimonia-foto.html

For videos of the ceremony:

- Rete 8: http://www.rete8.it/cronaca/249492/
- Rai 3 (Tg Regional): https://www.rainews.it/tgr/abruzzo/notiziari/video/2019/06/ContentItem-79d089f5-2678-4b54-abc9-9daa4bc637a4.html

10.Prof. Ruffini awarded the *Prize Lucio Colletti*, Rome, Italy, June 14, 2019

On June 14, 2019 Professor Remo Ruffini, Director of ICRANet, was awarded the Price "Lucio Colletti" 2019 by the Lucio Colletti Foundation. The ceremony took place in the "Sala Pietro da Cortona" of the Camipoglio, the seat of Rome Municipality and the awards were delivered to people who, in their specific field of study, stand out for their courage, freedom and accuracy. Professor Ruffini was very grateful for this recognition and thanked all the organization for their kindness and regard.

Fig. 8: Professor Ruffini with the Lucio Colletti Award.

11.Open Universe International doctoral School "*The discovery of Black Holes*", Nice, France, June 11 - 14, 2019

Fig. 9: Group photo of the Open Universe International Doctoral School, Nice, 11 – 14 June.

The Open Universe International Doctoral School *"The discovery of Black Holes. How the discovery of a Black Hole in GRB 190114C and in M87 is modifying the human outlook from planet Earth"* has been held at ICRANet Seat at Villa Ratti (Nice - France) from June 11 - 14, 2019. This 5 days conference has been organized thanks to the collaboration among ICRANet, LAPP (Laboratoire d'Annecy de Physique des particules) and the Max Planck Institute for Physics. The opening addresses and the conclusions were given by Professor Remo Ruffini (Director of ICRANet). During this five days conference, a variety of topics in astrophysics were discussed, such as neutrinos, gamma-ray bursts and compact stars, high energy cosmic rays, dark energy and dark matter, general relativity and black holes. The most recent scientific developments were presented by eminent Professors and researchers, such as: Prof. Ulisses Barres De Almeida (CBPF, Rio de Janeiro), Prof. Zurab Berezhiani (Università degli Studi dell'Aquila), Prof. Elisa

Bernardini (DESY – Zeuthen, University of Padova), Prof. Paolo Giommi (ASI), Prof. Giovanni Lamanna (Director of LAPP, Annecy), Prof. Mirabel Felix (IAFE), Prof. Jorge A. Rueda H. (ICRANet), Prof. Razmik Mirzoyan (Max Planck Institute for Physics,Munich), Prof. Narek Sahakyan (Director of ICRANet Armenia), Prof. Gregory Vereshchagin (ICRANet), Prof. Shesheng Xue (ICRANet), Dr Martin Kolos (Silesian University in Opava), Dr Arman Tursnov (Silesian University in Opava), Dr Yu Wang (ICRANet), Eduar Becerra (ICRANet), Stefano Campion (ICRANet), Yen-Chen Chen (ICRANet), David Melon Fuksman (ICRANet), Riccardo Middei (Università Degli Studi Roma Tre), Moradi Rahim (ICRANet), José F. Rodriguez R. (ICRANet) and Juan David Uribe Suarez (ICRANet).

On Wednesday 12, H.E. Simonetta Di Pippo, Director of UNOOSA, sent a video message to the participants to the Open Universe School, in order to outline once again the leading role and the outstanding scientific results achieved by the Open Universe initiative.

For photos, program and more information about the event: http://www.icranet.org/OpenUniverseSchool

Fig. 10: Participants of the Open Universe International School, ICRANet Seat at Villa Ratti, Nice.

Fig. 11: Participants of the Open Universe International School, ICRANet Seat at Villa Ratti, Nice.

Fig. 12: Video message of H.E. Simonetta Di Pippo, Director of UNOOSA.

12.16th Italian-Korean Symposium on Relativistic Astrophysics, Pescara, Italy, June 1-5, 2019

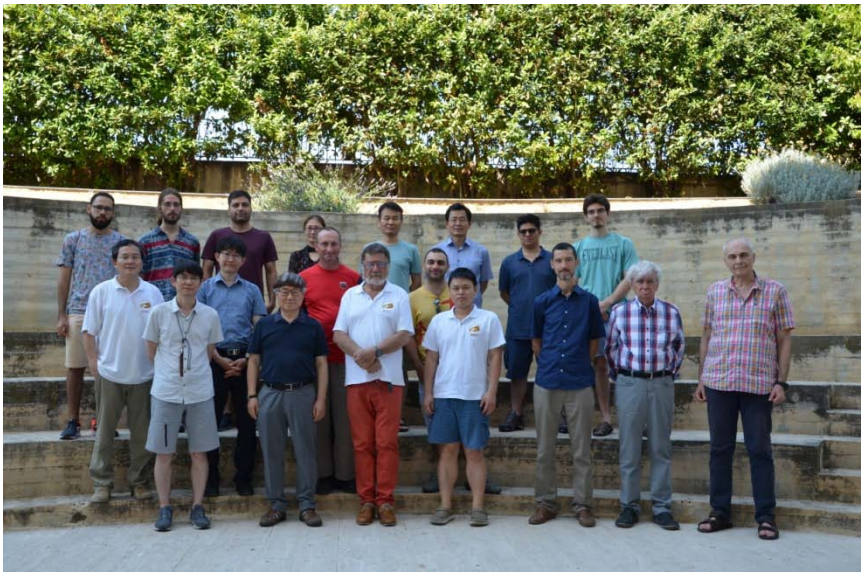


Fig. 13: Group photo of the IK16, Pescara, 1 – 5 July.

The 16th Italian-Korean Symposium on Relativistic Astrophysics has been held at ICRANet center in Pescara from July 1 - 5, 2019. The Italian-Korean Symposia on Relativistic Astrophysics is a series of biannual

meetings, alternatively organized in Italy and in Korea since 1987. The opening addresses and the conclusions were given by Professor Hyung Won Lee (Inje University - Korea) and Professor Remo Ruffini (Director of ICRANet). 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 Korean speakers were Prof. Hyung Won Lee, Prof. Aera Jung (Department of engineering physics, Tsinghua University - China), Prof. Sung-Won Kim (Ewha Womans University - Korea), Prof. Chang-Hwan Lee (Pusan National University - Korea), Prof. Dong-Han Yeom (Pusan National University - Korea) and Prof. Jin Young Kim (Kunsan National University - Korea). Speakers from ICRANet were Prof. Remo Ruffini, Prof. Jorge A. Rueda H., Prof. Gregory Vereshchagin, Prof. Vladimir Belinski, Prof. Shesheng Xue, Prof. Costantino Sigismondi, Dr Wang Yu, Dr José F. Rodriguez R., Dr Liang Li, Dr Gabriel Gomez, Stefano Campion, Rahim Moradi and Rafael Yunis. On Wednesday evening (July 3), there was the official IK16 banquet, held at Hai Bin wok restaurant in Pescara, and this was an interesting opportunity for all the participants to discuss in about science in an informal way.

For photos, program and more information about the event: http://www.icranet.org/ik16

Fig. 14: Prof. Ruffini and Prof. Hyung Won Lee during the concluding remarks of IK16.

13.Scientific visits to ICRANet

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

- **Prof. Roy P. Kerr** (Yevgeny Lifshitz Chair at ICRANet, Crafoord Prize in Astronomy 2016, Fellow of the Royal Society), 19 July – 2 August 2019;
- **Prof. Hyung Won Lee** (Inje University – South Korea), 27 June – 16 July 2019;
- **Prof. Asghar Qadir** (National University of Sciences & Technology - Pakistan), 11 – 29 July 2019;
- **Prof. Yury Vybly** (National Academy of Sciences NASB – Belarus), 5 – 15 August 2019;
- **Dr Soroush Shakeri** (Isfahan University of Technology - Iran), 24 – 30 June 2019;
- **Dr Muhsin Burhan Mohammed Rashid Al-Jaf** (University of Science and Technology of China - Hefei), 23 – 26 June 2019;
- **Dr Gabriel Gomez** (Universidad Industrial de Santander – Colombia), 4 – 7 July 2019.

During their visit, those scientists had the opportunity to carry on important analysis and research with other ICRANet scientists from all over the world.

Following the Agreement between ICRANet and Al-Farabi Kazakh National University, three groups of Kazakh students, under the supervision of Professor Medeu Abishev, Prof. Kuantay Boshkayev and Prof. Saken Toktarbay, visited ICRANet center in Pescara. The first group came from 1 to 14 July 2019, and was composed by: Aidana Bauyrzhan, Zhaniya Kuanyshova, Yerkebulan Kabulbek, Bediyar Zhumadil and

Arailym Tolegen. The second and the third groups came both from 10 to 24 July, and were composed by: Sandugash Imanbay, Ardak Omargali, Sandugash Toktarbek, Balnur Kusmanova, Tokhir Rametov, Nursultan Seitkerim, Alua Tussupbekova, Arailym Murat, Ashen Akmaral and Aigerim Toktamuratova.

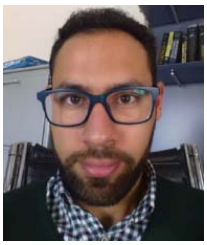
Prof. Roy P. Kerr

Prof. Asghar Qadir

Prof. Hyung Won Lee

Dr Soroush Shakeri

Dr Muhsin Burhan Mohammed Rashid Al-Jaf



Dr Gabriel Gomez

14.Recent publications

Li, Liang, *Multipulse Fermi Gamma-Ray Bursts. I. Evidence of the Transition from Fireball to Poynting-flux-dominated Outflow*, published in The Astrophysical Journal Supplement Series, Volume 242, Issue 2, article id. 16, 33 pp. (2019).

The composition of a jet is still an unsolved problem in gamma-ray bursts (GRBs). Several previous studies have suggested that the prompt emission spectrum of GRBs is likely to consist of a few components that may arise from different jet compositions. Here we present a systematic analysis to search for the GRBs that seem to show the transition from a fireball to the Poynting-flux-dominated outflow between well-separated pulses within a single burst, like GRB 160626B, using the Gamma-ray Burst Monitor data of the Fermi satellite. We obtain 43 GRBs with clear multiple pulses and find that 9/43 (21%) bursts may exhibit such a transition based on the time-integrated spectral analysis. We then select a further four bursts with data of adequate quality to perform a detailed time-resolved spectral analysis, and we find that in three bursts the thermal-like pulse is a precursor. Furthermore, based on the time-resolved spectra, we constrain the outflow properties for those thermal pulses and find them consistent with the typical properties of the photosphere emission. Also, the later pulses with the softer low-energy spectral index are compatible with the optically thin synchrotron emission model. Our analysis indicates that a good fraction of the multipulse Fermi bursts may obtain the transition from fireball to the Poynting-flux-dominated outflow.

Link: https://iopscience.iop.org/article/10.3847/1538-4365/ab1b78

P. Giommi, C.H. Brandt, U. Barres de Almeida, A.M.T. Pollock, F. Arneodo, Y. L. Chang, O. Civitarese, M. De Angelis, V. D'Elia, J. Del Rio Vera, S. Di Pippo, R. Middei, A. V. Penacchioni, M. Perri, R. Ruffini, N. Sahakyan, S. Turriziani, *Open Universe for Blazars: a new generation of astronomical products based on 14 years of Swift-XRT data*, accepted for publication in Astronomy and Astrophysics.

Open Universe for blazars is a set of high-transparency data products for blazar science, and the tools designed to generate them. Blazar astrophysics is becoming increasingly data driven, depending on the integration and combined analysis of large quantities of data from the entire span of observational astrophysics techniques. The project was therefore chosen as one of the pilot activities within the United Nations Open Universe Initiative. In this work we developed a data analysis pipeline called Swift_deepsky, based on the Swift XRTDAS software and the XIMAGE package, encapsulated into a Docker container. Swift_deepsky, downloads and reads low-level data, generates higher-level products, detects X-ray sources and estimates several intensity and spectral parameters for each detection, thus facilitating the generation of

complete and up-to-date science-ready catalogues from an entire space-mission dataset. The Docker version of the pipeline and its derived products is publicly available from the Open Universe Website at this http URL. We present the results of a detailed X-ray image analysis based on Swift_deepsky on all Swift XRT observations including a known blazar, carried out during the first 14 years of operations of the Swift Observatory. The resulting database includes over 27,000 images integrated in different X-ray bands, and a catalogue, called 1OUSXB, that provides intensity and spectral information for 33,396 X-ray sources, 8,896 of which are single or multiple detections of 2,308 distinct blazars. All the results can be accessed on-line in a variety of ways: e.g., from the Open Universe portal at this http URL, through Virtual Observatory services, via the VOU-Blazar tool and the SSDC SED builder. One of the most innovative aspects of this work is that the results can be safely reproduced and extended by anyone.

Link: https://arxiv.org/abs/1904.06043

Becerra, L.; Boshkayev, K.; Rueda, J. A.; Ruffini, R., Time evolution of rotating and magnetized white dwarf stars, Monthly Notices of the Royal Astronomical Society, Volume 487, Issue 1, p.812-818, 2019.

We investigate the evolution of isolated, zero and finite temperature, massive, uniformly rotating and highly magnetized white dwarf stars under angular momentum loss driven by magnetic dipole braking. We consider the structure and thermal evolution of white dwarf isothermal cores taking also into account the nuclear burning and neutrino emission processes. We estimate the white dwarf lifetime before it reaches the condition either for a type Ia supernova explosion or for the gravitational collapse to a neutron star. We study white dwarfs with surface magnetic fields from 10^6 to 10^9 G and masses from 1.39 to 1.46 $M_\odot$ and analyze the behavior of the white dwarf parameters such as moment of inertia, angular momentum, central temperature and magnetic field intensity as a function of lifetime. The magnetic field is involved only to slow down white dwarfs, without affecting their equation of state and structure. In addition, we compute the characteristic time of nuclear reactions and dynamical time scale. The astrophysical consequences of the results are discussed.

Journal website link: https://doi.org/10.1093/mnras/stz1394
ArXiv link: https://arxiv.org/abs/1812.10543

ICRANet Newsletter

September - October 2019

SUMMARY

1. ICRANet press release *"On the role of a cavity in the hypernova ejecta of GRB 190114C"*

Since 2018, a new style of research has been introduced in Gamma-Ray-Bursts (GRBs) studies: it does not describe the prompt radiation phase observed by the Neil Gehrels Swift Observatory and the NASA Fermi Gamma-ray Space Telescope by a time-integrated spectral analysis, typically applied to long GRBs and obtaining a Band spectrum with various fitting parameters, this procedure, as recognized by David Band, does not permit a taxonomy of GRBs [1]. The approach followed by the ICRANet group, developing the Binary driven Hypernova (BdHN) model of long GRBs, focuses only on luminous GRBs with a large signal to noise ratio which allow to proceed to a time-resolved analysis. In doing so three main events in the prompt radiation phase have been identified [2]: 1) the supernova rise, 2) the moment of formation of a black hole coinciding with the onset of the GeV radiation and 3) the emission of a cavity, created by the explosion of electron-positron plasma in the expanding supernova ejecta, see Fig. 1. In addition to these results, the greatest novelty in this field has been so far the discovery of self-similarity and power laws in the data, following the black hole formation from 1.9 second to 3.9 seconds, see the accompanying article [2], leading to evidence of quantized versus continuous emission in the GeV radiation, see the accompanying article [3].

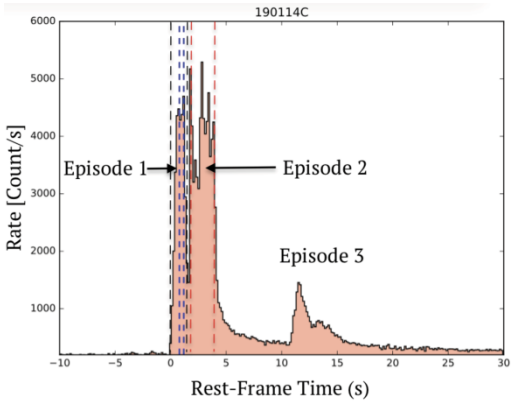


Fig. 1. The light curve of GRB190114c in the rest frame of the source contains the precursor up to 1.9 s (Episode 1), then ultrarelativistic prompt emission (UPE) up to 3.9 s (Episode 2), then the residual emission following the UPE from 3.9 s up to 11 s. The emission from the cavity (Episode 3) occurs at 11 s and continues up to 20 s.

The new study, co-authored by R. Ruffini, J. D. Melon Fuksman, G. V. Vereshchagin [4], has been accepted for publication by the Astrophysical Journal on August 19, 2019. It presents the evidence of the formation of a cavity in the source of gamma-ray burst GRB 190114C. It is proposed that this GRB originates in a binary system composed of a massive carbon-oxygen core, described within the binary-driven hypernova I (BdHN I) scenario. In this scenario, the carbon-oxygen core undergoes a supernova explosion with the creation of a new neutron star, hypercritical accretion occurs onto the companion binary neutron star until it exceeds the critical mass for gravitational collapse.

It is shown that the formation of a black hole captures 10^{57} baryons by enclosing them within its horizon, and thus a cavity of approximately 10^{11} cm is formed around it with initial density 10^{-7} g/cm^3. A further depletion of baryons in the cavity originates from the expansion of the electron-positron-photon plasma formed at the moment of the collapse, reaching a density of 10^{-14} g/cm^3 by the end of the interaction. It is demonstrated, using an analytical model complemented by a hydrodynamic numerical simulation, see Fig. 2, that part of the electron-positron-photon plasma is reflected off the walls of the cavity. The consequent outflow and its observed properties are shown to coincide with the featureless emission occurring in a time interval of duration, measured in the rest frame of the source, between 11 and 20 s of the GBM observation. Moreover, similar features of the GRB light curve were previously observed in GRB 090926A and GRB 130427A, all belonging to the BdHN I class. These results support the general framework presented in [2] and guarantees that a low baryon density is reached in the cavity, a necessary condition for the operation of the "inner engine" of the GRB, presented in the accompanying article [3].

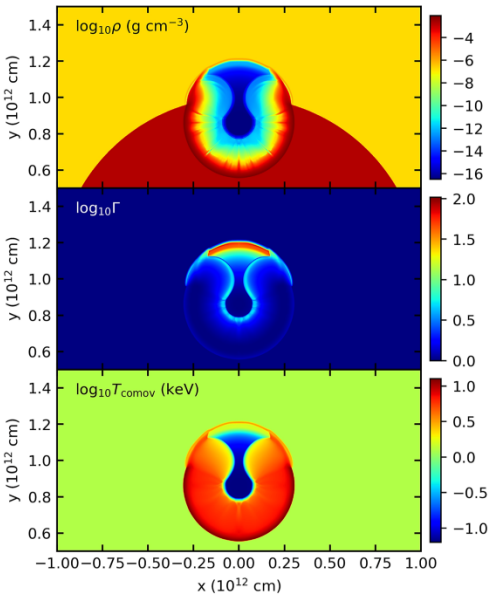


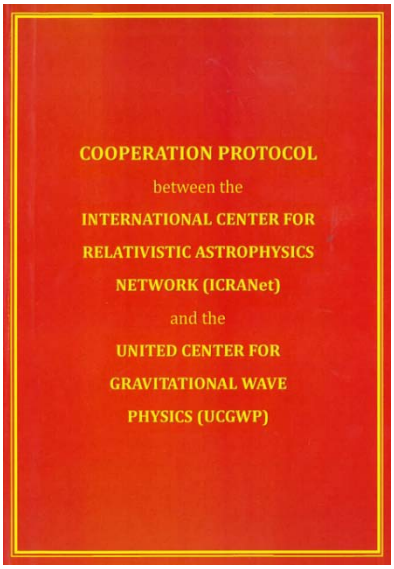
Fig. 2. Spatial distributions of matter density (top), Lorentz factor (middle) and comoving temperature (bottom) at t = 11 s, showing the mildly relativistic reflection wave propagating backward in the cavity, as well as the ultrarelativistic electron-positron plasma wave propagating outside the cavity. The shock wave is visible inside the ejecta.

The density of 10^{-14} g/cm^3 here discovered points clearly to a completely different origin of the MeV and GeV emission hosted in the cavity: an electromagnetic machine, producing emission very close to the black hole horizon, and based on three components: 1) a Kerr black hole, 2) a uniform magnetic field following the Papapetrou theorem and 3) a low density plasma of 10^{-14} g/cm^3 [4]. This contrasts with the traditional gravitational accretion of very high density matter onto a black hole. This result profoundly changes the traditional mechanism of emission of GRBs and can be extended to active galactic nuclei (AGNs) [5]. As a consequence, also the physics of GRBs afterglows has been modified avoiding the ultra relativistic blast wave emission and utilizing the synchrotron process occurring around the new neutron star expected in the BdHN model [6].

References:

1. D. Band, et al., "BATSE Observations of Gamma-Ray Burst Spectra. I. Spectral Diversity", ApJ v.413, p.281 (1993).
2. Ruffini, R., Li, L., Moradi, R., Rueda, J. A., Wang, Y., Bianco, C., Melon Fuksman, J. D., Xue, S. S., Cherubini, C., Filippi, S., Karlica, M., & Sahakyan, N. (2019). "Self-similarity and power-laws in GRB 190114c", arXiv:1904.04162.
3. Ruffini, R. & Moradi, R., e. a. (2019). "On the determination of the mass and spin of the black hole in the inner engine of GRB 190114c", submitted.
4. R. Ruffini, J.D. Melon Fuksman, G.V. Vereshchagin, "On the role of a cavity in the hypernova ejecta of GRB 190114C", ApJ, 2019, October 3, 2019; https://iopscience.iop.org/article/10.3847/1538-4357/ab3c51
5. J. A. Rueda, R. Ruffini, "The blackholic quantum", arXiv:1907.08066.
6. J. A. Rueda, R. Ruffini, M. Karlica, R. Moradi, Y. Wang, "Inferences from GRB 190114C: Magnetic Field and Afterglow of BdHN", arXiv:1905.11339.

2. New cooperation protocol between the United Center for Gravitational Wave Physics and ICRANet, October 12, 2019



On October 12, a cooperation protocol between ICRANet and the United Center for Gravitational Wave Physics (Hangzhou - China) was signed by Prof. Anzhong Wang (Director of UCGWP), by Prof. Bin Wang (Vice Director of UCGWP), by Prof. Jiliang Jing (Vice Director of UCGWP), by Prof. Remo Ruffini (Director of ICRANet) and by Prof. Jorge Rueda (ICRANet Faculty Professor). The main joint activities to be developed under the framework of this protocol 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 has been signed on the occasion of the Inauguration ceremony of the center and of the First Hangzhou International meeting on gravitational waves, both held in Zhejiang University (Hangzhou, China) from October 11 to 13, 2019. The cooperation protocol will be valid for 5 years.

For the text of the protocol, see: http://www.icranet.org/index.php?option=com_content&task=view&id=1272

3. New collaboration agreement between the UoS/SAASST and ICRANet, October 15, 2019


جامعة الشارقة
UNIVERSITY OF SHARJAH
ICRANet

AGREEMENT ON SCIENTIFIC COOPERATION

BETWEEN

THE UNIVERSITY OF SHARJAH

AND

THE INTERNATIONAL CENTER FOR RELATIVISTIC ASTROPHYSICS NETWORK (ICRANet)

On October 15, a cooperation agreement between ICRANet and the University of Sharjah (United Arab Emirates) was signed by H.E. Prof. Hamid Al-Naimiy (Chancellor of the UoS), by Prof. Gaffar Attaelmanan (Chairman of the Physics Department of the UoS), by Prof. Remo Ruffini (Director of ICRANet) and by Prof. Jorge 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, and the development of inter-institutional research areas associated to local graduate programs; and joint publications. The agreement has been signed on the occasion of the visit Prof. Ruffini payed in Sharjah October 14 to 17, 2019 and 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=1274

4. New collaboration agreement between the University of L'Aquila and ICRANet, October 21, 2019


REP. nr. 1219
PROT. nr. 58199
(21/10/2019)
UNIVERSITÀ DEGLI STUDI DE L'AQUILA

CONVENZIONE TRA IL NETWORK INTERNAZIONALE DI CENTRI PER L'ASTROFISICA RELATIVISTICA (ICRANET) E L'UNIVERSITÀ DEGLI STUDI DELL'AQUILA

On October 21, a cooperation agreement between ICRANet and the University of L'Aquila (Italy) was signed by Prof. Edoardo Alesse (Rector of the University of L'Aquila) 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=1276

5. Prof. Ruffini met Nobel Laureate, Prof. Gérard Mourou, Elba Island, Italy, September 16, 2019

On September 16, Prof. Ruffini met Prof. Gérard Mourou (Nobel Prize in Physics in 2018) at Hotel Hermitage in Elba Island (Italy), on the occasion of the EAAC 2019 conference. Prof. Gregory Vereshchagin (ICRANet Faculty Professor) and Prof. Sang Pyo Kim (Inje University – South Korea) were also present at the meeting. During that meeting, the 4 scientists had a fruitful and stimulating discussion, and Prof. Ruffini presented to Prof. Mourou the most recent scientific results on which ICRANet is working on.

Fig. 3: Prof. Mourou discussing with Prof. Ruffini and Prof. Sang Pyo Kim.

Fig. 4: from left to right: Prof. Gregory Vereshchagin, Prof. Remo Ruffini, Prof. Gérard Mourou and Prof. Sang Pyo Kim, during the meeting at Hotel Hermitage in Elba Island (Italy) on September 16, 2019.

6. 21st RAGtime meeting, Opava, Czech Republic, September 18-19, 2019

Fig. 5: Prof. Remo Ruffini presenting his talk at the 21st RAGtime meeting in Opava, September 18, 2019.

From 18 to 19 September, Professor Ruffini, Director of ICRANet, visited Silesian University in Opava (Czech Republic). Together with Prof. Jorge Rueda (ICRANet faculty) and Dr Liang Li (ICRANet) they have been invited to deliver talks on the occasion of the 21st RAGtime meeting. Prof. Ruffini presented a talk entitled *"On the BdHNI GRB 190114C and its energetic"*, Prof. Rueda's talk was entitled *"The physical ingredients of a binary-driven hypernova (BdHN) and their role in the explanation of a long gamma-ray bursts"* and Dr Liang Li delivered a talk entitled *"Self-Similarities and Power-laws in the Time-and 190114C"*. On that occasion, Prof. Ruffini released an interview that has been broadcasted on the Czech television.

During his visit, Prof. Remo Ruffini had the opportunity to meet personally Prof. Zdeneck Stuchlik (Head of the Research Center for Theoretical Physics and Astrophysics, Silesian University), who officially presented

him the collaboration agreement between the Silesian University in Opava and ICRANet, signed on August 19, 2019.

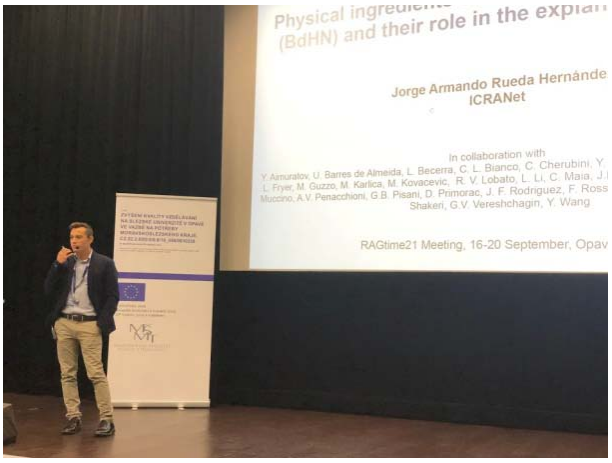


Fig. 6: Prof. Jorge Rueda presenting his talk at the 21st RAGtime meeting in Opava, September 19, 2019.

Fig. 7: Dr Liang Li presenting his talk at the 21st RAGtime meeting in Opava, September 19, 2019.

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

For the video of Prof. Ruffini's conference and interview:

http://www.icranet.org/index.php?option=com_content&task=view&id=1268

7. 105° SIF national Congress, L'Aquila, Italy, September 23-27, 2019

From September 23-27, the Italian Physical Society (Società Italiana di Fisica, SIF) held its 105th national congress in L'Aquila. Several ICRANet researchers were invited to participate and delivered talks on that occasion on Friday September 27, namely: Prof. Remo Ruffini (*"Perspectives in physics and fundamental physics following the observations of a Kerr Black Hole in GRB 190114C"*), Prof. Gregory Vereshchagin (*"Cavity in the hypernova ejecta of GRB 190114C"*), Prof. Jorge Rueda (*"Induced gravitational collapse, binary-driven hypernovae, long gamma-ray bursts and their connection with short Gamma-ray bursts"*), Prof. Shesheng Xue (*"Emission from accelerated protons and electrons/positrons in the BdHN paradigm"*) and Stefano Campion (*"Neutrino production from proton-proton interactions in a BdHN event"*).

The website of the conference: https://congresso.sif.it/

8. First Hangzhou International meeting on gravitational waves and inauguration of the United Center for Gravitational Wave Physics, Hangzhou, China, October 11 - 13, 2019

From October 11 to 13, Professor Ruffini, Director of ICRANet, visited Hangzhou (China) together with Prof. Shesheng Xue (ICRANet Faculty professor) where they have been invited to deliver a talk on the occasion of the inauguration of the United Center for Gravitational Wave Physics (UCGWP) and of the first Hangzhou International meeting on gravitational waves. Both the events took place in Zhejiang university (Hangzhou) and were attended by a large number of scientist from all over the world. On that occasion, Prof. Ruffini presented a congratulatory address and plenary lecture titled *"Discovery of energy extraction by discrete "Black-Holic" quanta from a Kerr Black Hole in GRB 190114C"*, while Prof. Xue gave a talk

entitled *"Cosmological constant, matter, inflation and cosmic coincidence"*. During his visit, Prof. Remo Ruffini had the opportunity to sign the cooperation protocol between ICRANet and UCGWP, the new center located in Zhejiang University, on October 12.

Fig. 8: Group photo of the first Hangzhou International meeting on gravitational waves.

Fig. 9: Prof. Remo Ruffini at the inauguration of the United Center for Gravitational Wave Physics (UCGWP).

Fig. 10: Prof. Anzhong Wang (Director of UCGWP) and Prof. Remo Ruffini (Director of ICRANet), signing the cooperation protocol between UCGWP and ICRANet.

9. Mission of Prof. Ruffini at Sharjah, United Arab Emirates, October 14-17, 2019

From October 14 to 17, Professor Ruffini, Director of ICRANet, visited Sharjah (United Arab Emirates). On that occasion, he had the opportunity to visit the University of Sharjah (UoS) and its laboratories, the Sharjah Academy for Astronomy, Space Sciences, and Technology (SAASST), as well as to meet the applied Physics & Astronomy faculty members and Prof. Hamid M. K. Ainaimiy (Chancellor of the UoS, President of the Arab Union for Astronomy and Space Sciences). During his visit, Prof. Ruffini was also invited to give two seminars: one to the general audience titled *"Einstein, Fermi, Heisenberg and the Birth of Relativistic Astrophysics"* and one to a professional audience, in presence of the Chancellor of UoS, titled *"Discovery of energy extraction by discrete "Black-Holic" quanta from a Kerr Black Hole in GRB 190114C"*. This fruitful visit gave also Prof. Ruffini the possibility to personally sign the collaboration agreement between the UoS/SAASST and ICRANet on October 15, 2019.

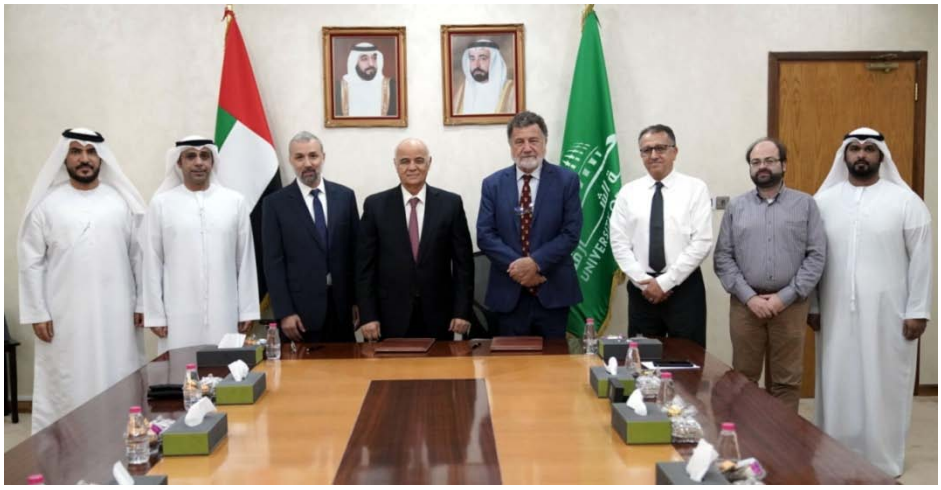


Fig. 11: Prof. Remo Ruffini (Director of ICRANet) after the signature of the collaboration agreement between the UoS/SAASST and ICRANet on October 15, 2019.

For a press release of the event (in Arabic): http://www.sharjah.ac.ae/ar/Media/Pages/news-details.aspx?mcid=2792&clt=ar&fbclid=IwAR1P99Tgt8uP0uvn5ZCZa3jamS7xE25s25F53kA3w4wOinW5xuSZhg35Wgc#

10. Prof. Ruffini met Prof. Vincenti and Prof. Quéré at ICRANet Seat Villa Ratti, Nice, September 23, 2019

On September 23, Prof. Ruffini visited Nice (France) in order to meet Prof. Henri Vincenti and Prof Fabien Quéré from Centre CEA Paris-Saclay, at ICRANet Seat in Villa Ratti. During the meeting, the two scientists had the possibility to visit the Villa, and they had a fruitful discussion with Prof. Ruffini, who presented them the most recent scientific results achieved by ICRANet.

11. Opening event of the project "Alternanza scuola-lavoro" with High School G. Galilei of Pescara at ICRANet center, October 4, 2019

Fig. 12: Prof. Gregory Vereshchagin (ICRANet Faculty Professor) presenting the lecture to the students entitled *"How we discovered an echo from the formation of a Black Hole"*.

Fig. 13: Prof. Costantino Sigismondi commenting the video *"Misura del diametro solare al meridiano e ad almucantarat zero"* to the students.

On October 4, ICRANet center in Pescara hosted the opening event of the project "*Alternanza scuola-lavoro*". Students from the class 4°D of High School Galileo Galilei of Pescara had the possibility to visit ICRANet center and its library, welcomed by Prof. Remo Ruffini (Director of ICRANet), by Prof. Gregory

Vereshchagin (ICRANet Faculty Professor) and by Prof. Costantino Sigismondi (ICRANet collaborator and professor at ITIS Galileo Ferraris in Rome). This event offered to the students a unique opportunity to take part in science activities aiming to showcase both the fascination of research as a career and its significant societal impact. After the opening remarks made by Prof. Ruffini, the most important scientific results on which ICRANet is working on, have been presented. Prof. Vereshchagin spoke about *"How we discovered an echo from the formation of a Black Hole"*, then Prof. Costantino Sigismondi showed and commented to the students the video *"Misura del diametro solare al meridiano e ad almucantarat zero"*. The last part of the event has been dedicated to the practical exercise of the students on the algorithm. Then Prof. Remo Ruffini presented the concluding remarks.

Fig. 14: Prof. Ruffini's opening remarks.

In the framework of the project "*Alternanza scuola-lavoro"* for the three year period 2019-2022, ICRANet will host students from the classes 4°B, 4°D and 4°F from High School Galileo Galilei of Pescara. These students, under the supervision of their tutor, Prof. Tiziana Pompa, will be accompanied and addressed by ICRANet Faculty Professors during that project. Its main aim is to involve students in the different phases of a scientific research process, concentrating on concrete case-studies.

12. Prof. Costantino Sigismondi (ICRANet research scientist) guided ESA scientists to visit the meridian line of Santa Maria degli Angeli, Rome, September 11 – 13, 2019

Fig. 15: The meridian line in the church Santa Maria degli Angeli, Rome.

On the framework of the AIDA international workshop 2019 (https://www.cosmos.esa.int/web/aida-international-workshop), held from September 11 to 13 in the Terme di Diocleziano in Rome, Prof. Costantino Sigismondi (ICRANet research scientist) organized a side event alongside the meeting, guiding ESA scientists to visit the meridian line of Santa Maria degli Angeli church in Rome. The visit was focused on the 2018-19 Astrometric Campaign for the Clementine Gnomon, analyzing the new results for understanding the history and the potential of the instrument built by Francesco Bianchini in 1700-1702. The Meridian Line of Santa Maria degli Angeli was, in fact, built by him with the funding of cardinal Gianfrancesco Albani (who become Pope Clement XI during the building of the instrument). For this reason it was called *"Clementine Gnomon"* by Francesco Bianchini.

13. Prof. Ruffini awarded the prize Delfino d'oro 2019, Pescara, October 10, 2019

On October 10, Prof. Ruffini was awarded the prize Delfino d'oro 2019 by the Municipality of Pescara on the occasion of a solemn City Council in its seat. The ceremony has been opened by a welcome speech of the President of the city council, Dr Marcello Antonelli, and continued with the delivery of the prizes to several

eminent personalities who have contributed, in their relevant field of study, to the cultural, scientific, economical and social development of the city of Pescara. Among them, there was Prof. Ruffini, who recalled all the steps which established the ICRANet center in Pescara as well as the fundamental role played in this process by Prof. Roy Kerr (Yevgeny Lifshitz Chair at ICRANet, Crafoord Prize in Astronomy 2016 and honorary citizen of Pescara since 2016). As the Mayor Carlo Masci reported in his speech, Prof. Ruffini brought *"Pescara at the center of the Universe and the Universe in the center of Pescara"*.

Fig. 16: Group photo of all the Delfino d'oro 2019 prize winners. during the official award ceremony held at the Municipality of Pescara on October 10, 2019.

Fig. 17: Prof. Ruffini receiving the prize Delfino d'oro 2019, in presence of the Major of Pescara, Dr Carlo Masci (on the right) and of the President of the city council, Dr Marcello Antonelli.

Several press releases (in Italian) have been released on that event:

- Municipality of Pescara: http://www.comune.pescara.it/internet/index.php?codice=147&idnews=8136&navBackPage=148
- Il Centro: http://www.ilcentro.it/pescara/ciatt%C3%A8-d-oro-tra-i-premiati-marinelli-basel-e-ruffini-1.2304874 http://www.ilcentro.it/pescara/da-ruffini-a-don-palmerino-ecco-chi-ha-onorato-pescara-1.2306625
- Il Pescara: https://www.ilpescara.it/attualita/ciatte-delfino-oro-2019-nomi-premiati-pescara.html
- Rete 8: http://www.rete8.it/cronaca/123pescara-ciatte-doro-alla-memoria-del-direttore-di-rete8-pacilio/

A regional TV (TG Rete 8) has also took a video of the ceremony: https://www.youtube.com/watch?v=YjGfeuOAoXg

14. Seminar of Prof. Sang Pyo Kim at ICRANet

On Thursday, September 12, 2019, Prof. Sang Pyo Kim (Kunsan National University – Korea, Institute of Theoretical Physics - Chinese Academy of Sciences), gave a seminar entitled *"Magnetars, Magnetized Black Holesand Laboratory Astrophysics"* with the following abstract:

Neutron stars, in particular, magnetars (highly magnetized neutron stars) provide the most intense magnetic fields in the universe, which go by order of two or more beyond the critical field. The vacuum birefringence, a vacuum polarization effect, was predicted and has recently been observed by measuring optical spectrum from a neutron star. Damour and Ruffini studied the Schwinger mechanism in KN black holes and discussed a possibility of astrophysical source for GRBs. Blanford and Znajek proposed a central mechanism for gamma rays bursts (GRBs), in which magnetized rotating black holes power jets by mining the rotational energy through magnetic fields. Ruffini et al further proposed the dyadophere and dyadotorus model of charged black holes, and recently studied the effects of Wald's type magnetic fields on GRBs in rotating black holes. In this talk, magnetized black holes are reviewed and possibility of black hole solutions with

localized magnetic fields beyond Wald, Dokuchaev and Gibbons et al is discussed. Then QED physics in strong magnetic fields with/without electric fields are explained, and QED effects inneutron stars, magnetars and magnetized black holes are suggested. Finally, laboratory astrophysics is proposed using ultra-intense lasers, in which a strong gravity is emulated by Unruh effect of accelerating electrons or charges, and strong electromagnetic fields are provided by the lasers.

Fig. 18 and 19 : Professor Sang Pyo Kim giving his seminar at ICRANet center in Pescara, September 12, 2019.

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

15. Scientific visits to ICRANet

- **Professor Sang Pyo Kim** (Kunsan National University – Korea, Institute of Theoretical Physics - Chinese Academy of Sciences), September 3 – 17, 2019. Prof. Kim visited ICRANet center in Pescara and had the opportunity to discuss his research results with ICRANet scientists. He also gave a seminar titled *"Magnetars, Magnetized Black Holesand Laboratory Astrophysics"*.

- **Mr. Mikalai Prakapenia** (NASB, BSU – Belarus, IRAP PhD student), September 17 – 26, 2019. During his visit, Mr. Prakapenia had the opportunity to discuss his scientific research with ICRANet scientists, as well as to interact with his supervisor, prof. Gregory Vereshchagin.

16. Upcoming meeting: the Fourth Zeldovich meeting, Minsk, Belarus

It is our pleasure to communicate that the Fourth Zeldovich meeting will be held in Minsk, Belarus, from April 20 to 24, 2020.

From October 30, it is possible to submit an abstract through that form: https://uploader.icranet.org/zeld4/. The deadline for abstract submissions is April 1, 2020.

The preliminary list of invited speakers include:

- Abhay Ashtekar, Institute for Gravitation & the Cosmos, Penn State University, USA
- Rong-Gen Cai, Institute of Theoretical Physics, Chinese Academy of Sciences, China
- Jens Chluba, Jodrell Bank Centre for Astrophysics, University of Manchester, UK
- Alexander Dolgov, Novosibirsk State University and ITEP, Russia
- Jaan Einasto, Tartu Observatory, Estonia
- Stefan Gillessen, Max Planck Institute for Extraterrestrial Physics, Germany
- Claus Lämmerzahl, ZARM, Germany
- Vladimir Lipunov, Moscow State University, Russia
- Felix Mirabel, CEA Saclay, France
- Slava Mukhanov, Ludwig-Maximilians-Universität München, Germany
- Konstantin Postnov, Sternberg Astronomical Institute of the Moscow State University, Russia
- Piero Rosati, University of Ferrara, Italy
- Jorge Rueda, ICRANet, Italy
- Remo Ruffini, ICRANet, Italy
- Nikolay Shakura, Sternberg Astronomical Institute of the Moscow State University, Russia
- Alexey Starobinsky, Landau institute for theoretical physics, RAS, Russia

For more information concerning the meeting, please consult the official website at the following link: http://www.icranet.org/zeldovich4

For the registration form: http://dbserver.icra.it:8080/meetings/registration_zeld4.htm

17. Recent publications

R. Ruffini, R. Moradi, J. A. Rueda, L. Becerra, C. L. Bianco, C. Cherubini, S. Filippi, Y. C. Chen, M. Karlica, N. Sahakyan, Y. Wang, S. S. Xue, *GeV emission and the Kerr black hole energy extraction in the BdHN I GRB 130427A*, in press in The Astrophysical Journal.

We propose that the "inner engine" of a type I binary-driven hypernova (BdHN) is composed of a Kerr black hole (BH) in a non-stationary state, embedded in a uniform magnetic field B0 aligned with the BH rotation axis, and surrounded by an ionized plasma of extremely low density of 10^{-14}g/cm^{-3}. Using GRB 130427A as a prototype we show that this "inner engine" acts in a sequence of "elementary impulses". Electrons are accelerated to ultra-relativistic energy near the BH horizon and, propagating along the polar axis, $\theta=0$, they can reach energies of $\sim 10^{18}$ eV, and partially contribute to ultra-high energy cosmic rays (UHECRs). When propagating with $\theta\neq 0$ through the magnetic field B0, they give origin by synchrotron emission to GeV and TeV radiation. The mass of BH, $M=2.31M_{\odot}$, its spin, $\alpha=0.465$, and the value of magnetic field $B0=3.48\times 10^{10}$ G, are determined self-consistently in order to fulfill the energetic and the transparency requirement. The repetition time of each elementary impulse of energy $E\sim 10^{37}$ erg, is $\sim 10^{-14}$ s at the beginning of the process, then slowly increasing with time evolution. In principle, this "inner engine" can operate in a GRB for thousands of years. By scaling the BH mass and the magnetic field the same "inner engine" can describe active galactic nuclei (AGN).

Link arXiv: https://arxiv.org/abs/1812.00354

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The spectral components of the prompt emission of gamma-ray bursts (GRBs) mainly consist of two possible origins: synchrotron (nonthermal) and photosphere (thermal). The typical spectral properties of GRBs can be modeled by a dominant nonthermal component (a Band-like function or cutoff power law), while some of them have an additional thermal component (a Planck-like function). In this paper, we investigate the effects of thermal components on the nonthermal spectral parameters. We focus on eight *Fermi* Gamma-ray Burst Monitor bursts of which the spectra deviate from a Band-only function, and the thermal components are significant. We sort them into thermal-subdominant Group I (e.g., GRB 110721A) and thermal-dominant Group II (e.g., GRB 090902B). Several interesting results are found assuming the spectral component is totally attributed to the nonthermal component: (i) the low-energy photon index α becomes harder; (ii) the peak energy E_c is significantly smaller and lies between the peak temperature of blackbody component and the peak energy of the cutoff power law + blackbody (CPL+BB) model; (iii) total flux F is generally the same; (iv) the changes ($\Delta\alpha$ and ΔE_c) are positively correlated with the ratio between the thermal flux and total flux; and (v) parameter relations (F–α, F–E_c, and E_c–α) also changed prominently. The GRBs in both groups show the same results. Our analysis indicates that the thermal component is important, and it significantly affects the spectral parameters and the consequential physical interpretations.

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