ICRANet Newsletter

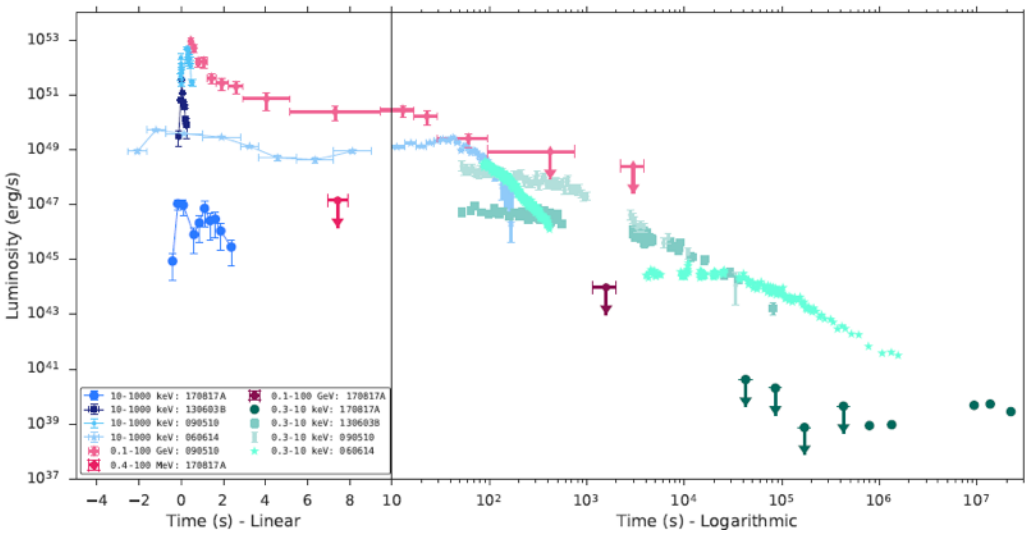
八月 – 九月 2018

SUMMARY

1. GRB 170817A-GW170817-AT 2017gfo 合併事件

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

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



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

There are a number of new astrophysical results:

a. The NS-NS scenario cannot explain GRB170817A-GW170817 since this solution implies an X and gamma-ray prompt emission missing in GRB 170817A (see data up to 10 s data in the figure).

b. Instead, X- and gamma-ray observations of GRB 170817A have led us to propose a new subclass of GRBs originating from WD-WD mergers leading to a massive WD. The occurrence rate of these mergers can explain the rate of GRB 170817A-like sources, they produce a gamma- and X-ray emission consistent with GRB 170817A and cannot be associated with GW170817.

c. The kilonova AT 2017gfo can be powered by a different physical mechanism that the radioactive decay of r-processed heavy nuclei in the ejecta of NS-NS mergers: the cooling of the ejecta expelled in a WD-WD merger and heated up by fallback accretion onto the newly-formed massive WD.

d. The WD-WD merger ejecta have a lighter nuclear composition with respect to the r-processed heavy nuclei present in the ejecta of a NS-NS merger. The identification of atomic species in kilonova spectra can therefore discriminate between the two scenarios. However, such an identification has not been possible in observed kilonovae since it needs accurate models of atomic spectra, nuclear reaction network, density profile, as well as radiative transport (opacity), not yet available in the literature.

e. The outcome configuration of a GRB from WD-WD merger, namely a massive, highly magnetized, fast rotating WD, can become observable as a soft gamma repeater (SGR) or anomalous X-ray pulsar (AXP) as indicated in the WD-pulsar model introduced by Malheiro, Rueda and Ruffini in 2012.

f. The association of GRB 170817A and GW170817, from an observational point of view is, in our opinion, not yet sufficiently established to formulate a well-motivated answer on the non-null chance coincidence probability of the events. It is thus auspicable that the LIGO collaboration releases the templates of GW170817 in the interferometers to reconstruct the precise chronology of the space-time sequence of events in the LIGO detectors and in the Fermi and Integral satellites, necessary to validate the GW170817-GRB 170817A association.

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

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

2. ICRANet的科學家對GRB 180728A / SN 2018fip的預測和確認

在成功預測了與GRB 130427A相關的SN 2013cq（Ruffini等人，2013），作為BdHN案例的一個例子，2018年7月28日，ICRANet研究人員在Remo Ruffini教授領導下有機會預測X射線閃光（XRF）情況下的超新星（SN）外觀。

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

在GRB觸發後的前3天，該組織預測超新星將出現在14.7±2.9天（Ruffini2018），引用於此：

GCN 23066：GRB 180728A：X射線閃光（XRF）子類的長GRB，期待超新星外觀

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

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

2018年7月18日，Izzo（2018）報告了超新星出現的發現：

GCN 23142：GRB 180728A：發現相關的超新星

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

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

3. 研究人員之夜

此外，今年ICRANet還在歐洲研究人員之夜舉辦了“ICRANet研究人員之夜”活動，以便為公民和研究人員提供討論的機會。 這次活動吸引了很多人，並提供了參與科學活動的獨特機會。 這個活動的節目可以在這裡找到：
http://www.icranet.org/Notte_dei_ricercatori_2018/programma.pdf

該活動於2018年9月28日星期五下午4點至10點在佩斯卡拉的ICRANet中心舉行。 佩斯卡拉省長Gerardina Basilicata女士也出席了會議。

所有參與者合影留在2018年9月28日的“ICRANet研究人員之夜”。

學生和公民在ICRANet的研究人員之夜聽取ICRANet教授的解釋

在ICRANet魯菲尼教授簡單的開場白後，王宇博士，葉爾蘭（ICRANet研究員和博士研究生）演示的GRB 180727A和超新星觀測和預測在2018 8月15日出現; 魯菲尼教授的前博士生，Luca Izzo博士，紀紹他目前工作的西班牙的討論。然後科斯坦蒂諾Sigismondi教授（ITIS伽利略法拉利 - 羅馬）慶祝人送上月球50週年。和魯菲尼教授和其他ICRANet學院的教授討論有關科學的發展和未來前景與會者討論。

該會議餘下時間，播放幾個視頻投影：關於"中微子案"，"絕對的相對"，並在羅馬我教育部項目"德爾人才的框架在貝索基金會舉行的會議和好奇心。當老鷹和麻雀一起飛翔時"。活動期間，參與者也有機會參觀的"愛因斯坦，費米和海森堡和相對論天體物理學的誕生"和"ICRANet和中國的"兩個展覽。此外，從8:30 PM，ICRANet組織了對土星和火星的觀測不同的望遠鏡，並且向中學學生說明。

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

4. Ruffini教授於2018年8月8日至15日訪問了清華大學（北京）和李政道學院（上海）

2018年8月8日至15日，ICRANet主任Remo Ruffini教授於2012年8月9日在北京清華大學的丘數學科學中心訪問中國，受到丘成桐教授的邀請，參加了研討會。 標題為"在伽馬射線爆發後期觀測超新星"

Professor Ruffini, ICRANet researchers and PhD students (Y. Aimuratov, L. Becerra, C.L. Bianco, Y.C. Chen, D.M. Fuksman, M. Karlica, G. Mathews, R. Moradi, D. Primorac, J.A. Rueda, N. Sahakyan, Y. Wang, S.-S. Xue).

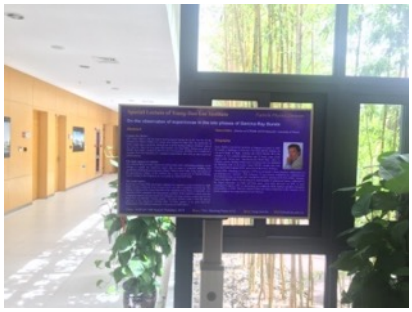
演講影片: https://www.youtube.com/watch?v=Q6xssDI7a84&t=805s

Professor Remo Ruffini during his seminar at Tsinghua University in Beijing, 9 August 2018.
Remo Ruffini教授於2018年8月9日在北京清華大學的研討會上。

From left to right: Dr. Yu Wang, ICRANet PhD student, Prof. Remo Ruffini, Director of ICRANet, and Prof. Shing-Tung Yau, Director of Yau Mathematical Sciences Center at Tsinghua University.
從左到右：ICRANet博士生王瑜博士，ICRANet主任Remo Ruffini教授和清華大學丘數學科學中心主任教授。

在王瑜博士的陪同下，ICRANetRuffini教授也參觀了上海的李政道研究所，並在幾天前在北京向林家翹講座提交報告主題。 在訪問研究所期間，Ruffini教授還有機會看到2015年頒發的MG14獎給李政道教授，由於他在白矮星上的重要工作激勵。

Prof Remo Ruffini with the MG14 Award delivered in 2015 to T. D. Lee.
Remo Ruffini教授在2015年向李政道頒發了MG14獎。



Professor Remo during his seminar at the Tsung-Dao Lee Institute in Shanghai, 14 August 2018.
Ruffini教授於2018年8月14日在上海李政道研究所舉辦的研討會上。

報告細節:
http://www.icranet.org/documents/Abstract+2GCNs.pdf

5. Ruffini教授於2018年9月3日至4日訪問了LAPP和特別研討會

在2018年9月4日，雷莫·魯菲尼教授，ICRANet主任，在阿訥西，法國，在那裡他被邀請在總監喬瓦尼·拉曼納教授給一個研討會訪問LAPP。在此次研討會上，題為 Our predicted Supernova denominated on 27 August SN2018fip and conceptual inferences" (https://indico.in2p3.fr/event/17864/), Professor Ruffini illustrated how a sequence of fortunate events occurred after the 28 of July, when GRB190728A was observed by SWIFT and Fermi satellites. With his collaborators, they have identified this source as a member of the X-ray Flash (XRF) subclass of gamma-ray bursts (GRBs) in which a supernovae (SN) ejecta hypercritically accretes onto the neutron star (NS) companion leading to a more massive NS (MNS) and to a νNS-MNS binary. On the other hand, in the GCN23066 on 31 July 2018, they predicted the occurrence of a SN, indeed observed on 15 August (GCN23142). The significance of this result in discriminating the 8 different GRBs subclass has been analyzed.

6. Ruffini教授訪問哈薩克斯坦，並於2018年9月6日至8日在ICRANet簽署了3份新的合作協議

從6日到2018年9月8日，雷莫·魯菲尼教授，ICRANet主任，訪問哈薩克斯坦。他的使命的第一天，他去了納扎爾巴耶夫大學在阿斯塔納，他的報告“GRB180728A, our predicted Supernova denominated on 27 August SN2018fip and conceptual inferences”，並會見了副校長的創新和研究，Kanat Baigarin先生。同一天下午，他遇到了意大利大使H.E.帕斯誇萊D'Avino，他有在科學領域上的意大利和哈薩克斯坦之間的合作多和有趣的可能性進行富有成果的討論。在訪問期間，魯菲尼教授還與L.N.簽署了合作協議。國立歐亞大學（ENU）在阿斯塔納，與它的校長，Battashevich葉爾蘭Sydykov教授在一起。在此協議框架所設想的主要關節活動包括：促進在相對論天體物理學領域理論和觀測活動;教師，研究人員，博士後研究員和學生的機構交流;促進技術發展;組織研討會，會議，研討會，培訓和研究課程以及聯合出版物。

第二天，魯菲尼教授飛抵阿拉木圖，他在早上有，伴隨著Abishev麥迪奧（法拉比哈薩克斯坦國立大學）教授，與成吉思Omarov教授，國家空間研究中心和技術總裁（會議NCSR）。在此之際在科學和教育與NCR合作備忘錄 - 哈薩克斯坦被Omarov教授，中心的總裁，和魯菲尼教授，ICRANet的董事簽署。它自簽署之日起有效期為5年。在該協定框架內設想的主要合作形式包括：交流科學專業知識，開展聯合研究活動，共同參與研究補助金，交流科學材料和經驗。

經過了簽字儀式魯菲尼教授參觀費先科夫天體物理研究所（FAPHI），並有機會觀察老爺嶺隕石，鐵隕石覺得向下Sikhote - 阿林山脈，在俄羅斯東南部，於1947年。雖然大鐵隕石落在了在過去，他們先前見證過並且碎片已經恢復。在這個研究所，魯菲尼教授討論了公眾研討會“GRB180728A，我們的超新星計價預計在8月27日SN2018fip和概念的推論”。

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

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

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

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

此外，Ruffini教授會見了哈薩克斯坦物理學會（KPS）主席Tolegen Kozhamkulov院士，當時，KPS校長與Remo Ruffini教授代表ICRANet簽署了合作協議。本協定框架內設想的主要聯合活動包括：促進相對論天體物理學領域的理論和觀測活動; 教師，研究人員，博士後研究員和學生的機構交流; 促進技術發展; 組織研討會，會議，研討會，培訓和研究課程以及聯合出版物。

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

訪問影片：
https://www.youtube.com/watch?v=f_w5-UZ1-sQ&t=16s

新聞連結：
http://www.kaznu.kz/en/3/news/one/14314/

https://www.inform.kz/ru/kazahstanskie-astrofiziki-sovmestno-s-ital-yancami-budut-izuchat-chernye-dyry_a3390191

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

(in russian)

合作協議：

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

7. ICRANet科學訪問

- 從2018年9月16日至30日，來自阿爾巴尼亞地拉那大學的Klaudio Peqini教授訪問了佩斯卡拉的ICRANet中心。 在訪問期間，他有機會討論他的科學成果，並與ICRANet和世界各地的其他研究人員進行了富有成效的思想交流。

- 2018年9月24日，Sang Pyo Kim教授（韓國崑山國立大學）於9月22日至25日訪問了佩斯卡拉的ICRANet中心，並舉辦了題為“在Sitter空間中進行QED現象”的研討會。在那次他解釋說，在dS空間中均勻電場和平行磁場的QED動作由兩部分組成：真空極化和真空持續，是假想部分的兩倍。真空持久性與dS空間中自發對產生的施溫格效應有關。我們在電磁場中獲得了一對生產率，其與Minkowski時空極限中的已知Schwinger結果一致，並且在零電磁場極限中具有dS空間中的Hawking輻射。使用zeta函數正則化方案，我們計算感應電流並檢查磁場對當前操作員的真空期望值的影響。我們討論了施溫格效應作為磁致發生的可能情景。我們採用Schwinger和DeWitt引入的in-out形式，並應用gamma函數正則化來在dS空間中的適當時間積分錶示中找到單循環QED動作。單環有效動作成為著名的海森堡 - 歐拉 - 施溫格在Minkowski時空極限中的作用，並在零電磁場極限中產生單環重力作用，這是Heisenberg-Euler-Schwinger QED的非微擾模擬。行動。最後，我們討論了QED真空極化在宇宙學和天體物理學中的物理意義。

8. 白俄羅斯“科學與創新”期刊的特刊

繼白俄羅斯國家科學院ICRANet和白俄羅斯國家科學院於1988年4月組織的第三屆Zeldovich會議之後，白俄羅斯國家科學院出版的白俄羅斯科學流行期刊“科學與創新”編寫了一期特刊“宇宙如何思考”致力於天體物理學和宇宙學。

在本期特刊中提出的文章中

有三篇由ICRANet科學家編寫：

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

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

9. Recent publications

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

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

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

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

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

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

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

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

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

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

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

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

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