DOI 10.18524/1810-4215.2022.35.268003

THE POSITRONE γ-SPECTROSCOPY OF SYMBIOTIC SYSTEMS

D. N. Doikov

Odessa National Maritime University, Dep. of the Pre-Univ. Training and Dep. Mathematics, Physics and Astronomy, 34 Mechnikov str., Odessa, Ukraine
doikov@mail.bg

ABSTRACT. The γ-spectroscopy of rapid processes in space and Earth atmospheres we considered in this paper. One of considered object is AM Her types cataclysmic systems in soft γ-ray spectra. We calculated intensity of annihilation line who indicates the p-p thermonuclear explosions in a surface of the White Dwarfs (therefore WD). In the presented results we used, that the p-p detonation in degenerate plasma produce positrons. We confirmed that the formed annihilation γ-quants with energy 0.511 MeV is the suitable diagnostic possibility to study the effectiveness of thermonuclear reaction channels during such explosions. Presented application for registration of annihilation quanta shows that in case of AM Her stars system in detectors panel enter flows of the annihilation γ-quants with upper limit 177 $cm^{-1}sec^{-1}$. I noted, that times scale of detonation and γ-flyers are in intervals from 10^{-4} to 10^{-3}sec. These results show the reason for the lack of registration of γ-flares in other types of cataclysmic variables. For example, in this paper considered systems with classical accretion disks named how Periodical Novae. Because these explosion is rare and have specific in geometrical and physical conditions for him monitoring with other strategy of observation. In Earth atmosphere tame scale of formation of secondary positrons is same. We showed, that annihilation of positrons occurs in near Earth surface zone. In this case observatories based in height reaching 2000 and more meters are important, it is advisable to planning the placement of this kind of equipment. It is confirmed, that presented perovskite detectors have the necessary sensitivity and universal spectral sensitivity and the study and modeling of interaction processes allows you to set the operating modes of the interfaces in the monitoring modes of observations. In presented paper has been confirmed, that perovskite materials in form of binary detectors enables simultaneous observations of hard radiation and optical quanta. In this cases observation of CR, micro meteors and other rapid objects in Earth atmosphere greatly expands the possibilities of their study.

Keywords: γ-spectra, p-p explosions in degenerate plasma, rapid γ-flayers, positrons annihilation, White Dwarfs.

АНОТАЦІЯ. Гамма-спектроскопія швидких процесів в атмосферах Землі та Космосу е предметом запропонованої роботі. Розглянуто спектри катаклізмічних системи типу AM Her у м'яких γ-променях. Розраховано інтенсивність потоку квантів які формують анігіляційну лінію, яка вказує на p-p термоядерні вибухи на поверхні білих карликів. По представленим результатам було отримано що фізичні умови детонації у виродженій плазмі доводять до виробки позитронів. Ми підтвердили, що утворені анігіляційні γ-кванти з енергією 0,511 МеВ є придатною діагностичною можливістю для дослідження ефективності каналів термоядерної реакції під час таких вибухів. Вказано на можливість реєстрації анігіляційних γ-квантів від зірок типу AM Her, періодичних і класичних нових. У разі відмічених явищ на панель детекторів потрапляють монохроматичні потоки γ-квантів – продуктів від термоядерних ланцюгів P – P-циклу. Отримано, що верхньою межею потоку від катаклізмові системи AM Her є 177 квантів на $см^{-2}сек^{-1}$. Шкала часу детонації та γ-спалахів знаходиться в інтервалах від 10^{-4} до 10^{-3} сек. Ці результати показують чому зменшується імовірність реєстрації γ-спалахів в інших типах симбіотичних систем. Для поширення кількості об'єктів також розглядалися катаклізмичні системи з класичною дисковою акрецією, які викликають таке явище, як Періодичні Нові. Оскільки ці вибухи є рідкісними і мають специфічні геометричні та фізичні умови для їх моніторингу достатньо розглядати вже відоме сферичне наближення. Це спрощує стратегію спостереження і інтерпретацію отриманих γ-спектрів.

В земній атмосфері ручний масштаб руху космічних позитронів такий самий. У роботі показано, що на першому кроці доцільно спостерігати анігіляцію позитронів в приземній зоні. У цьому випадку в обсерваторіях, розташованих на висоті 2000 і більше метрів, доцільно планувати розміщення такого обладнання для реєстрації позитронів вторинного походження та їх анігіляцію. Підкреслено, що представлені пероксидові детектори мають необхідну універсальну спектральну чутливість на жорстке випромінювання, а дослідження та моделювання процесів взаємодії дозволяє задавати режими роботи інтерфейсів у моніторингових режимах спостережень. Ми отримали, що конструкція таких детекторів у вигляді бінарних девайсів дозволяє одночасно спостерігати жорстке випромінювання та оптичні кванти. У цьому випадку спостереження космічного випромінювання, мікрометеорів та інших швидких об'єктів в атмосфері Землі значно розширює можливості їх вивчення.

Ключові слова: γ-спектри, p-p-вибухи у виродженій плазмі, швидкі γ-спалахи, анігіляція позитронів, білі карлики.

1. Introduction

The registration of the γ-flayers in soft energetic region is actual interdisciplinary problem. For detection of this physical processes are having been developed new generation of the detector of hard radiation in base of perovskite crystal. One of them is CsPbBr3. Him mean atomic mass is 57.3 a.m. Under such conditions, it becomes possible to detect flares in a wide energy range. That is, a constructive possibility has arisen for the simultaneous detection of radiation from an object of interest to us practically from optics to the soft γ-range. In practice, the upper energy limit is limited by the physical thickness of the semiconductor crystal. The accuracy of registration of γ-quanta under such conditions makes it possible to construct profiles of γ-lines with an accuracy of 10 KeV. Progress in the growth of perovskite crystals (in our case CsPbBr3), in particular, an increase in the number of semiconductor layers, makes it possible to increase the accuracy of registration of γ-ray fluxes (Piro, 2012) and to build detailed spectral line profiles. The use of such detectors requires model measurements and model calculations of characteristic fluxes of the hard radiation. This is used as the basis for planning of monitoring of the observations of cosmic and atmospheric flyers of hard radiation. In this paper are presented calculations of possible γ-flares before registering of a sharp increasing of the intensity of optical radiation from cataclysmic variables. The main physical information about γ-ray spectra information from p-p detonation consisting in interval from 0.1 to 10 MeV. In X- and UV- emissions, we have the consequences of the movement of shock waves after near surface detonation in a magnetic column and an accretion disk. The registration of such spectra is more accessible, but it is also determined by a large number of parameters of the cataclysmic system. From γ-ray spectra we have possibility to more adequate investigation of the detonation structure because positrons generated only in one part of the thermonuclear p-p chain. This paper consists Abstract, Introduction, three section, Conclusion and Discussion. In first section we considered physical condition in surface of the WD in cataclysmic systems, bound conditions of the bottom part of the magnetic column in near surface layers. The second section is devoted to the calculation of hydrogen detonation and its consequences. In third section presented synthetic γ-ray spectra of the Cataclysmic systems in hard magnetic fields.

2. Physical conditions in near surface layers of the WD

The surface of the AM Her type WD in bottom part magnetic column consist a hot spot of dense degenerate plasma. The hydrogen-helium (therefore H-He) accretion flows from a star-companion in the bottom part accelerated by the gravitational field up to 10-20 km/sec. This ensures that the temperature of the near-surface layer rises to 10^8K and form hot spot. The H-He mass accumulation due within a few months. The mass loss from star-companion from optical observation has been estimated from ( ) and in bottom limit has $\dot{M} = 10^{-11} M_{\odot}$ or $M_{det} = 10^{18} - 10^{19}$ kg. Full number of the H and He atoms is N_{at} who took part in p-p chain reactions is $N_{at} \approx 10^{44} - 10^{45}$. From polarimetry of the AM Her the strength of magnetic field is $10^6 - 10^7 H$. The simplified model of the WD atmospheres presented in (). The given physical data allow us to conclude that at a certain moment of reaching the critical mass H - He of the mixture leads to its detonation. The radius of the magnetic column bottom $R_{bot} \approx 400\ km$. We have, that full pre exploding accreted mass in cylinder with R_{bot} and height $H_{cyl} \approx 20 - 30\ m$.

2.1. The detonation near surface of the WD

In next section we will consider two approaches of the detonation. This is point and cylindrical cases. For astrophysics application we can return to classical picture of the AM Her system. Relation between surfaces of the spot to full surface of the WD is $1.3 \cdot 10^{-2}$. In first approach this is point explosion on the surface of the WD. The velocity of the detonation fronts in degenerate zone is a relativistic. Than time scale of full detonation times is $t_{det} \approx 10^{-3}$ sec. Next step consists testing of Sedov approach with Zeldovich & Raiser correction. To do this, it is necessary to require that the distribution of the thermodynamic parameters of the atmosphere of a WD has a power law. In our case we have hydrostatic atmosphere, but in more deep layers' pressure depends from concentration in the relation $P \propto n^{2/3}$. During the accumulation of the heat from thermonuclear p-p reaction in the upper atmosphere, plasma degeneracy is removed faster than in more deep layers of WD. After this removing begins explosion in form of detonation. In inside part of the column removing of the degeneracy is very possibly relatively other type of symbiotic systems. The time interval between begining of the sharp ignition inside the column is very short. All this argument leads to the substantiation of the use of the Sedov approximation for a point explosion.

3. The point detonation inside magnetic column

In the lust paper (Doikov &Yuschenko, 2021) hase been used only the part of classical p-p reaction in the form important for γ-ray production:

$$p + p \to d + \boldsymbol{e}^{+} + \nu_e \to d + p \to {}^3_2He + \gamma(5.49\ MeV)$$
$${}^3_2He + {}^3_2He \to {}^4_2He + 2p\ (12.86\ MeV) \to (25.7\ MeV) \quad (1)$$

The full number of positrons N_{e^+} and γ-quants from annihilation N_γ is: $N_{e^+} \approx N_\gamma \approx 10^{44} - 10^{45}$. Let D is velocity of the detonation front, than from (] depends from the specific internal and nuclear energy (J/kg)

$$D = \sqrt{2Q(\gamma^2 - 1)} \quad (2)$$

Where Q is the specific internal and nuclear energy (J/kg). The caloric content of such a chain is maximum for all possible reaction channels is near 26 MeV. Even such simple calculations show the relativistic nature of the propagation of detonation fronts. Next, based on the simplicity of the model, we calculate the radiation characteristics of the explosion in the γ-rays. The emissivity the γ-quants after annihilation between electrons and positrons depends from balance of the reaction rates of positron production

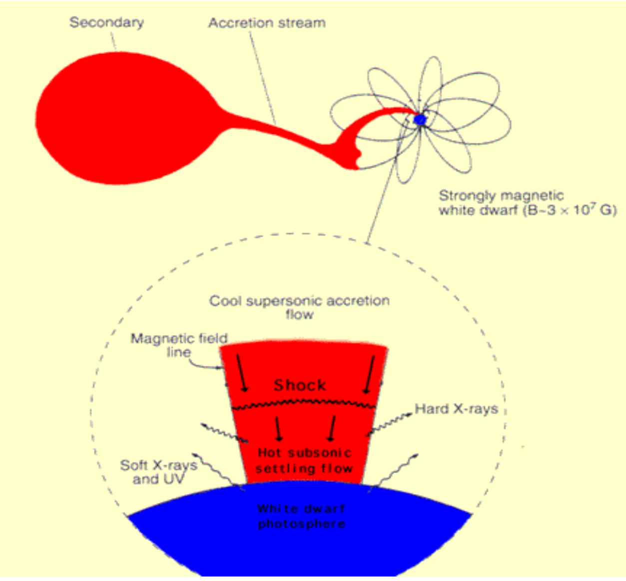

Figure 1: The classical picture of the AM Her polars type binary system (picture has been rewrites from popular internet resource).

and annihilation rates. Confirm that the correspondent γ-quants have energy $E_\gamma = 5.49 MeV$ and him relative intensity I(5.49 MeV) to intensity of annihilation quants I(0.511 MeV) is the foundation of the positron spectroscopy. From section 2.1 we have that the time of the point explosion in the bottom of the magnetic columns of the WD surface has maximum time $t_{det} \approx 10^{-3} sec$. Only in periods of the considered γ-flyers with $E_\gamma = 5.49 MeV$ we have possibility of independent diagnostics of the positron evolution in space and time. We begin from geometric of the point explosion in detonation H-He mixture. In contrast with other type Novae in bottom part of magnetic column the mixing with the lower layers adjacent to the helium zone cannot be expect. Then in combustion layers we expect only annihilation line 0.511 MeV and accompanied him γ-quant.

3.1. The geometric configuration

For the determine of the fronts in a relativistic shock waves after point explosion in WD it is necessary to specify the structure of the distribution of the gravitational potential with the height of the white dwarf atmosphere. In the first step we estimated boundary conditions for next solving of the transfer energy equation for γ-quanta who formed as a result of P-P reaction. It should be noted that the front of the shock wave, even at the initial moment of the explosion, exceeds at least 10% compared to the front of expansion of the substance. This phenomenon makes it possible to consider the transfer of γ-quanta in matter during its expansion into vacuum. In this case the gravity acceleration is $g \approx (10^7 - 10^8)\ m/s^2$ and maximum vertical height $H_{max} \approx 10^7$m. Initial velocity for unit mass fragments of the WD near surface atmospheres is $V_{atm} \approx (10^7 - 10^8) m/s$. The second cosmic velocity $V_{II} \approx 10^7$m/s and final density is $\rho \approx 10^{-4} kg/m^3$ or numerical density is $n \approx 10^{21} - 10^{22} m^{-3}$. For next calculation we can use this boundary conditions.

3.2. Radiation during explosion

The energy deposition of γ-rays, and the subsequent thermalization of the no thermal electrons are considered in (Cosma & Fransson, 1992) presented estimation for cross section:

$$\sigma_\gamma = A_\iota m_p k_\gamma \approx 2.3 \cdot 10^{-29} m^2 \tag{3}$$

For $A_i = 1.2$ the optical depth τ_γ for γ-rays allows to determine the thickness of the layer that is already transparent to the considered hard radiation. This depth H we can get from formula:

$$\tau_\gamma = n\sigma_\gamma H \tag{4}$$

For first approach $\tau_\gamma = 1$. Than

$$H = \frac{1}{n\sigma_\gamma} \approx 10^7\ m \tag{5}$$

The result obtained leads to the conclusion that 10^{-4} seconds after the explosion, the part of explosive shell is already transparent to γ-rays. It should be noted that the fraction of γ-quanta that exited the transparent part of the explosive shell is sensitive to the ratio of hydrogen and helium content. We think that with the noted set of physical parameters, the share of shells cut out reaches 20% of the total amount of γ-quanta with energies of 0.511 and 5.49 MeV. For the AM Her this flow is no more of 60-80 quantum for each energy in the time interval t_{det}.

4. P-P-detonation and reaction kinetics

The P-P reaction kinetics are investigated more 80-th years. In present time we have semi empirical formulae for P-P reaction rates links, presented in (1) in form (Leng 1978, pp107-118) and (formula 4.47 p.61), Table 42. p. 108 with coefficients $C_i, i = 1,5$). We used only nonzero coefficients. In this cases for the reactions speed we has:

$$N_A\langle\sigma v\rangle = C_1 T_9^{-2/3} exp\left[-C_2 T_9^{-1/3} - \left(\frac{T_*}{T_0}\right)^2\right] \text{x}$$
$$\left(1 + C_3 T_9^{1/3} + C_4 T_9^{2/3} + C_5 T_9\right)\left(\frac{cm^3/sec}{g-mol}\right) \tag{6}$$

where $N_A = 6.022 \cdot 10^{23}$ atoms is the Avogadro number, $\langle\sigma v\rangle$ is reaction rate cross sections. This formula shows number of reacted atoms in unit volume who consists 1 gram-moll per 1 sec. T_0 is temperature, who formally correspondent to the Gamov resonance energy G. For considered thermonuclear reactions we received this energy from formula:

$$G = 2\pi^2 m_{ab} e_a^2 e_b^2 / h^2 \approx 3{,}96 \cdot 10^{-10} erg \tag{7}$$

then $T_0 \approx 2{,}48 \cdot 10^7 K$.The presented information in Fig. 2 shows that reaction rate cross sections $N_A\langle\sigma v\rangle$ depends from initial concentration of the plasma components in pre detonation time. In Bear & Soker (2016) considered possibilities the detonation of the He components, and after this indignation of the hydrogen layers. From this scenario it becomes clear that the energy of the explosion is limited not only

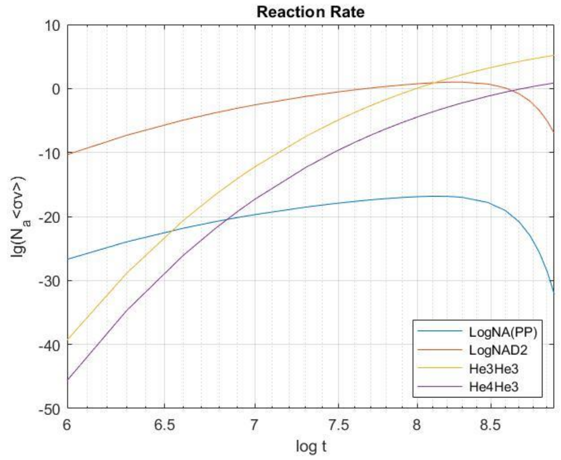

Figure 2: The reaction rates of the P-P reaction links.

by the amount of hydrogen, but by the presence of conditions for removing plasma degeneracy. In case of AM Her type stars H-He plasma accelerated to (10-20) km/sec in fields of hard gravitation potential. In this case, the large mass of the H-He mixture are localized at the base of the magnetic column. The thermalization of the incident directed plasma flow leads to an increase in the temperature of the H-He layer. To answer of the question about detonation, it is necessary to take into account the results presented in Fig. 3 on the rate of thermonuclear reactions, taking into account helium and hydrogen isotopes and correspondent P-P and He links. We emphasize that helium plays the role of detonator, because the densities of the WD atmospheres and the temperatures of the bases of the magnetic columns lead to the considered explosive. The time of complete burnup $\lambda_{3\alpha}$ of helium in the H-He mixture as a result of the 3α-process (Leng, 1978) :

$$3He^4 \rightarrow C^{12} + \gamma + 7{,}274\ MeV \tag{8}$$

is calculated by the semi-empirical formula:

$$\lambda_{3\alpha} = 9.36 \cdot 10^{-10}(\rho X_a)T_9^{-3}\exp(-\frac{4.411}{T_9}) \tag{9}$$

This formula is valid in the temperature range who showed in Fig. 2. The diagnostic importance of positron for spectroscopy in astrophysics is considered of connection with reactions of thermonuclear transformations. His always based an unambiguous correlation between the appearance of a positron and the emission of a γ-quantum of a certain energy. The γ-detector register at the same time, quanta of annihilation origin with an energy of 0.511 MeV, but also precisely defined γ-quants of these reactions. In this case, the unambiguity of the discussed results is high.

5. Symbiotic system with accretion disk

Consistence of the accretion disk around WD with hydrogen leads to the fact that after the accumulation of a critical mass of hydrogen, the H-He mixture explodes in the all near surface zone. The spherical geometry of the explosion leads to lower event frequency. In this case full mass of the exploded H-He layer is much bigger. The positrons arise

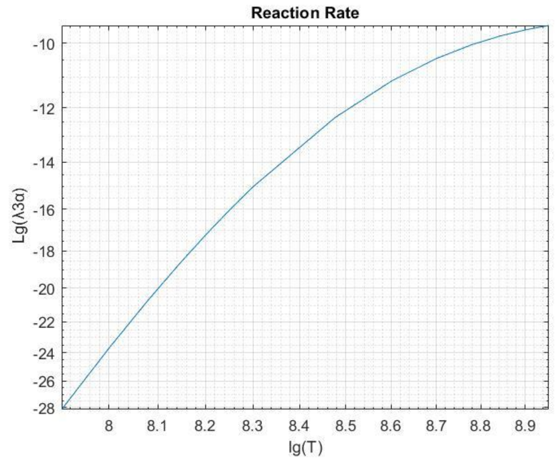

Figure 3: Time scale for 3 α reactions. The λ3α in years. T in Kelvin.

when available formation of the nonstable isotopes with proton exec ^{13}N, ^{18}F, ^{7}Be, ^{22}Na (Shing-Chi&, Thomas, 2022), (Wynn. Abigail at al 2002) In Table 1 is showed accompany γ-quants for considered elements.

Table 1: Synthesis of elements necessary for the production of positrons at energies not greater than 20 MeV.

N/N	Radioactive decay	E_γ KeV
1	${}^{13}_{7}N \rightarrow {}^{13}_{6}C + e^+ + \cdots$	1199
2	${}^{15}_{8}O \rightarrow {}^{15}_{7}N + e^+ + \cdots$	1732
3	${}^{17}_{9}F \rightarrow {}^{17}_{8}O + e^+ + \cdots$	475
4	${}^{11}_{6}C \rightarrow {}^{11}_{5}B + e^+ \ldots$	

In the explosion of classical Novae, the high luminosity in the soft γ range is maintained solely by the decays of the proton-excess radioactive isotopes indicated. This means that in addition to the resulting positrons, an accompanying γ line also arises. The description of the explosion of the near-surface layer of the classical Novae fits into the spherically symmetric approximation similar to the explosion of the Super Nova (SN), but with different boundary conditions. In all the above models has been considered only that allow us to prove the high probability of expansion in outer circumstellar space of γ-quants accompanying the decay. This circumstance is important for the application of positron spectroscopy to this type of objects, highlighting the diagnostic criteria for γ-quanta accompanying the production of positrons during explosive thermonuclear combustion. The optical and γ-flayers are more power and sufficient long in time for observation in relation to AM Her type star systems. However, such events are quite rare in the vicinity of the solar system compared to flares at the polar. If we observe classical novae at a sufficient distance from the terrestrial observer, then its classification is noticeably simplified when γ-quanta emanating from it are detected.

5.1. Positron diagnostics of the accretion disc

In present time during in the AM Her, classic and recurrent Novae explosions no registries γ-flyers. The main reason for this is the time scale of detonation processes that cause explosions. All other intervals of the spectrum of the symbiotic system shine significantly at long times. In optics, the time of an optical flash is near week. The powerful shock waves create an ionization front and destroy accretion disk. The motion of positrons in a plasma differs from their interaction in a neutral gas in that. Positrons travel much longer distances in a strongly ionized gas due to the fact that the annihilation of a positron with an electron occurs only when it is thermalized. The motion of positrons with a plasma differs from their interaction with a neutral gas in that the positrons travel much longer distances in a strongly ionized gas. The reason for this phenomenon is the annihilation of a positron with an electron when both are thermalized. Deceleration and scattering of a positron in a cold accreting gas is more efficient. The probability of positrons transition into the space surrounding the WD is determined by the cross section of annihilation with an electron and ionization energy losses in the substance. In considered physical conditions the cross sections change from $10^{-27}cm^2$ detonation point to $10^{-16}cm^2$ in final points. The pass length for positrons and electrons is same in this condition and determine from:

$$\frac{dE}{dx} = -2{,}54 \cdot 10^{-19} Z^2 N (3ln\gamma + 20{,}2)\ (Ev/cm) \quad (10)$$

Substituting the characteristic parameters of the atmospheres of white dwarfs and their accretion disks, we can draw the following conclusion. Positrons can enter the accretion disk only from the uppermost layers. Getting into the accretion disk, positrons interact with plasma throughout the entire region of its localization. For the commonly accepted densities of the matter of the accretion disk, the ratio 10 shows that the ionization losses of positrons are such that if they leave the near-surface layers of the white dwarf, they will be detected from the presence along the entire accreting region.

6. The Earth atmosphere

The structure of the Earth atmosphere. The structure of the Earth's atmosphere in the first approximation can be given in the form of a barometric formula. In this case, the change in gas concentration with height is given by the following distribution:

$$N = N_0 \exp(-{}^{\mu g H}/_{RT}) \quad (11)$$

where N_0 – is number densities of molecules at sea level. H – atmospheric height relatively this level, μ – is a mean molar mass, T – is atmospheric level temperature, R-ideal gas constant. Substitution of this physical parameters lead to values of free pass length of γ-quants are varied between 1600 - 2000 m. The characteristic times of motion of charged particles through the considered layers are $10^{-6} - 10^{-5}$ sec. The real relaxation time of the heavy elements semiconductor have relaxation time near 10^{-6} sec. In this case we consider it acceptable to use them in the problems under consideration.

In contrast to astrophysical applications, the presence of different types of aerosols should be taken into account in the formation of annihilation lines in the earth's atmosphere. Aerosols often form clouds and other heterogeneous structures. All these circumstances affect the formation of the final annihilation line to a different extent. On the other hand, measurements of positron fluxes of solar and galactic origin show their excess in comparison with the expected calculations.

7. Discussion

The study of the thermonuclear processes in astrophysical and Tokamak plasma demands new generation of spectrometers of the hard radiation. In order for their diagnostics to be accurate with respect to the physical parameters of the system and to have a correct spatial distribution, it was necessary to develop new spectroscopy methods. Before the development of the corresponding equipment, it was necessary to understand in what time intervals and at what characteristic energy flows the terrestrial observer or satellite would receive the required information. Another important reason for the research disclosed in this paper was to determine the reason for the absence of γ-bursts for fast thermonuclear processes. The author came to the conclusion that calorimetric reassures of the explosions near WD surface can only be attributed to fast thermonuclear processes. For registration and further studies of possible γ-flares, binary or, even better, multichannel detectors in the γ- and optical ranges are needed. Such a choice of the observation technique makes it possible to record not only the fact of a γ-flare, but also the relationship of this event with the physical conditions both on the surface of the WD and in the magnetic column or the surrounding accretion disk. To register the described events, monitoring observations are required. The technical aspects of this monitoring are discussed in (Doikov M., 2022).

Technical requirements for monitoring equipment. Let's consider the list of physical parameters necessary for solving the problem of monitoring, registration and accumulation of spectroscopic information about γ-flares in cataclysmic systems These is flyers time τ_{fl}. In this paper we confirmed that $\tau_{fl} \approx \tau_{det} \approx 10^{-3} sec$, Upper level of the γ-flows is 170 quants per 1 cm^2 for each energy 0.511 and 5,672 MeV during in full flyers period for AM Her. Therefore, the relaxation times of the elementary pixel of the recording grating is no more 10^{-5} sec. In paper (Doikov M., 2022; Liu, Wu, Wei at all, 2022) discussed detectors, who consists heavy elements. These devices are relevant to the considered spectral properties during the thermonuclear explosions.

The many fast processes with a powerful energy emission are of nuclear origin. The main indicator of these processes is the presence of characteristic γ-lines. Many of these lines lie in the soft γ and hard X-ray ranges. Predict and prepare systematic observations of space and atmospheric objects considered in the article.

To achieve the set goals, it was necessary to develop and, in some cases, adapt the codes serving the new generation detectors – peroxides. In our case this is semiconductor CsPbBa3. One of them crystal is many layer sandwich who work how spectrometer. In more deep layer we fix more energetic γ-quants. In combination with optic peroxide we have dual detector. In present work we calculated intervals of energies and times for using of this peroxide detector.

The nuclear processes in Earth atmosphere caused by cosmic rays (CR) who detects by peroxides consists γ-spectrum and ionizations traces together. Thus, the use of this type of crystals is one of the most promising areas of instrumental support for spectral studies.

Interaction between supersonic solar winds and meteors flows shows spectra only in optic- and middle IR-spectra from dusty plasma can be registered by a new generation of peroxide detectors.

8. Conclussions

The positron spectroscopy of γ-flayer in Symbiotic system is unique method of differentiation and determining the role of the corresponding reaction channels during transient explosions. Despite the transience and irregularity, the processes under consideration provide valuable information about the physical conditions in the atmospheres of white dwarfs that are part of Symbiotic system.

It has been shown that at the base of magnetic columns, based on the available data, there is a high probability of positron formation and the subsequent formation of annihilation lines. Together with the γ-quanta accompanying the formation of positrons.

The escape of positrons into the surrounding space makes it possible to expand the time frame for observing annihilation lines formed by the interaction of positrons with electrons of the substance of the accretion disk.

It has been found that the simultaneous measurement of γ-lines accompanying different chains of reactions leads to the selection of the most probable thermonuclear reactions.

References

Bear E., Soker N.: 2016, *RAA*, **16**, 114.

Doikov D.N.,Yuschenko A.V.: 2021, *Odessa Astron. Publ.*, **34**, 40.

Doikov M.D.: 2022, *Odessa Astron. Publ.*, **35**, in press.

Fangze L., Rong W., Jing W., Wanyi N. et al.: 2022, *ACS Energy Letters*, **7 (3)**, 1066-1085.

Kozma C., Fransson C.: 1992, *Ap.J.*, **390**, 602.

Lang K.R.: 1978, *Astrophysical Formulae*, Springer Verlag, **2**, 107 (in Russian).

Piro A.L.: 2012, *Ap. J.*, **759**, 83.

Shing-Chi L., Thomas S.: 2022, *Astro-ph ArXive*, 2112. 06893.

Wynn J.-G., Abigail V.P. et al.: 2020, *Ap.J.*, **896**, 165.