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Anomalous cosmic ray fluxes in diffusive shock acceleration processes in the heliosphere and in planetary and WR–nebulae

Abstract

Based on the analogy between interacting stellar winds of planetary nebulae and WR–nebulae, on the one hand, and the heliosphere and the expanding envelopes of supernovae, on the other, an attempt is made to calculate the differential intensity of the energetic protons accelerated to energies of 100 MeV by the shock wave. The proposed one–parameter formula for estimating the intensity at 1–100 MeV, when applied to the heliosphere, shows good agreement with the Voyager–1 data, to within a factor of less than 2. The same estimate for planetary (and WR–) nebulae yield a value 7–8 (3–4) orders of magnitude higher than the mean galactic intensity value. The obtained estimate of the intensity of energetic protons in mentioned kinds of nebulae was used to estimate the doses of irradiation of certain substances, in order to show that such accelerated particles play an important role in radiation–chemical transformations in such nebulae.

Keywords: heliosphere, planetary, WR–nebulae, accelerated particles, dominance, hydrogenated amorphous carbon

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Introduction

Flows of fast stellar winds interacting with the surrounding circumstellar medium form structures with (two) shock waves, where it is possible to accelerate protons and alpha particles at least up to energies about 1–100 MeV. These are usual scenario for expanding supernovae remnants,[1] the heliosphere moving relative to the interstellar medium,[2] expanding planetary (PN) and Wolf–Rayet nebulae (WRN) interacting with matter of previous more slow winds[3–6] and references therein). After conversion of the intense slow stellar wind of the precursor AGB star of the nucleus of the planetary nebula (PN) into a fast, but less intense wind in a time of the order of several hundred years, a structure, formally analogous to the heliosphere is established–i.e. regions of the interaction of the solar wind with the surrounding interstellar space.[3,7] The same result is true and for massive WR stars with stellar winds by 2–3 orders of magnitude larger mass loss rates and corresponding timescales.[6] I first consider an approximate formula of accelerated particle fluxes in the heliosphere which is suitable for direct use in the considered scenario of interacting winds in PN and WRN and then apply such a formula to calculate the intensities of energetic particles in the heliosphere and in PN and WRN (Sections 2–3). Some applications of the obtained energetic spectra are discussed in Section 4 and the conclusion is given in Section 5.

Anomalous cosmic rays generated directly in the region of the heliospheric inner shock front from incoming suprathermal particles and their analogs in PN and WRN

There is a large number of analytical and numerical models of the intensity of energetic particles accelerated at the heliospheric shock, taking into account the whole variety of process features, such as the formation of a spectrum of energetic particles, the orientation of the magnetic field vector with respect to the normal of the shock front, the sources of suprathermal particles undergoing acceleration by Fermi–1 and transforming to energetic anomalous cosmic rays, shock compession ratio, etc.[2,8–11] These theories give reasonable values and are consistent in the heliospheric case with direct observational data of the space probes Voyager 1 and 2.[3] On the other hand such theories are too complicated and demand on careful consideration of shock conditions, magnetic fields configurations, diffusion and acceleration characteristic timescales, maximal possible energies to be reached, etc.[2,9,10,12,13] On the other hand one may propose an approximate simple formula to connect a fraction of the flow kinetic energy to be converted to accelerated particles energy fluxes in the range of 1–100 MeV. Such a formula first proposed by Yeghikyan et al.[4,5] for heliospheric conditions is used here to describe particle acceleration under conditions of steady–state interacting stellar winds in PN and WRN.

The point is that with the expansion of the PN (WRN) due to the increase of the PN (WRN) internal border r_i its ability to form energetic particles decreases, as follows from Equation 1,[4,5]

$$\eta\frac{1}{4\pi}\frac{\dot{M}_f V_f^2}{4\pi r_i^2}=\int_{E_1}^{E_{max}} J_E(E)dE\,, \qquad (1)$$

Where $\dot{M}_f$ –the fast stellar wind mass loss rate (g/s), V_f –the fast wind velocity (cm/s), $J_E(E)$ –differential intensity of accelerated particles (erg cm^{-2}s^{-1}sr^{-1}MeV^{-1}) and η –the fraction of fast wind kinetic energy converted into energetic particle energy $E_1 \leqslant E \leqslant E_{max}$ after acceleration by the shock. By the way, according to the standard theory of the galactic cosmic ray origin under supernovae expanding shell conditions, usually $\eta = 0.1 - 0.3$,[1] but according to the exact numerical calculations and comparison with observations this values may be as large as $\eta = 0.5$.[12,13]

Now let's check the estimate (1) from data for the solar wind, comparing the calculated values with the measurements of the Voyager 1 probe.[14] Assuming

$$J_E\left(E\right)=J_E\left(E_1\right)\cdot\left(E_1/E\right)^{\gamma},J_p\left(E\right)=J_E\left(E\right)/E_1, \quad (2)$$

Where $E_1=1\,\text{MeV}$, $\gamma=2-4$ for the particles differential intensity at $E=E_1$ (in units particles $cm^{-2}s^{-1}sr^{-1}MeV^{-1}$),

$$J_p\left(E_1\right)=\frac{J_E\left(E_1\right)}{E_1}=\frac{\gamma-1}{E_1^2}\eta\frac{1}{4\pi}\frac{\dot{M}_fV_f^2}{4\pi r_i^2} \quad (3)$$

Taking $\dot{M}_f=2\cdot10^{-14}M_\odot/\text{yr}$, $V_f=400km/s$, $r_i=100au$, $\eta=0.1$, at $\gamma=2,3,4$ gives $J_p\left(E_1\right)\simeq0.8,1.6,2.4$ particles $cm^{-2}s^{-1}sr^{-1}MeV^{-1}$, correspondingly, which with the accuracy of the factor 2 is coincident with Voyager 1 data of ≈1.4.[14,15] Of course, in a rigorous theory it is necessary to calculate the characteristic acceleration time depending on the compression parameters in the shock wave and compare it with the characteristic diffusion time, for which it is necessary to have independently calculated values of the diffusion coefficients as functions of the energy. Corresponding estimates and discussion are given in Yeghikyan et al.[3,5,6] and may be summarized as follows: for a characteristic dynamical time in PN of 1000 years only a soft part of the spectrum (1–10 MeV) is formed, while in 100000 years, characteristic for WRN the complete spectrum in the range of 1–100 MeV is resulted. Because of very steep spectra in both cases the most important contribution into irradiation processes is related with the flux values near 1 MeV, At last but not least corresponding diffusion coefficient values are not larger than $10^{23}-10^{24}\,cm^2/s$ for energies of 1–100 MeV.[16]

Energetic particle intensities in the PN and WRN

Now let's calculate differential intensities of energetic protons under conditions of young PN. Taking $\dot{M}_f=4\cdot10^{-9}M_\odot/\text{yr}$, $V_f=1000km/s$, $r_i=10^{16}cm$, $\eta=0.1$,[17] then the equation (1) is used where already the concentration of fast wind near the shock wave is determined by the ratio $n_1=\dot{M}_f/\left(4\pi r_i^2V_fm_p\right)$. Resulted values would be typical for young PN. According to the evolutionary models of PN[18] in the earlier time the fast wind should be slower and the mass loss rate higher, so with corresponding input of the data $\dot{M}_f=4\cdot10^{-7}M_\odot/\text{yr}$ and $V_f=100km/s$ results would be the same.

It should be stressed here that the average galactic value of $J_p\left(E\right)$ at $E=1$ MeV, is about of $2\cdot10^{-4}$ particles$\cdot cm^{-2}\cdot s^{-1}\cdot sr^{-1}\cdot MeV^{-1}$,[15] which means that at the inner border of young PN the estimated intensities of energetic particles are more than 7 orders of magnitude higher than the average galactic intensity. It is not surprising because, for example, at the heliosphere caused by the much less intense solar wind one can see such dominance by more than 3 orders of magnitude.[15] So, the young PN are locally intense sources of soft energetic particles and it is interesting to speculate about their probable observational consequences in PN.

We now turn to the calculation of the differential intensity of the energetic protons under the conditions of the WRN. We ta $\dot{M}_f=10^{-5}M_\odot/\text{yr}$, $V_f=1500km/s$, $r_i=3\cdot10^{18}cm$, $\eta=0.1$.[19] On the inner boundary of the nebula (1 or 10 pc), the intensity of the energetic particles (1000 *or* 10, *particles* $\cdot cm^{-2}\cdot s^{-1}\cdot sr^{-1}\cdot MeV^{-1}$ respectively) by more than several orders of magnitude, (7 or 5) exceeds the mid–galactic one. Thus, WRN also can be a powerful local source of energetic particles (with not very high energies) and it would be interesting to investigate their possible observational manifestations in the nebula itself.

Dust processing in PN and WRN by energetic particles

A point which may be discussed concerning the high fluxes of energetic particles in PN and WRN is connected with irradiation of complex chemical species, like water, fullerenes etc. Molecules of water are observed in PN both in the gas phase (water "fountain" and related masers in young PN)[20–22] and in the solid phase (emission from crystal water ice).[23–25]

Here one may be only concerned with a simple estimation of the flux $F\left(E\right)$ of accelerated particles in the range of 1–100 MeV, dominant in the ionization of molecular hydrogen. Assuming $r_i=10^{16}\,cm$ $\dot{M}_f=1\cdot10^{-9}M_\odot/\text{yr}$, $V_f=2000km/s$, one can write for the intensity $J\left(E=1\text{MeV}\right)=1.0\cdot10^4$ particles $\cdot cm^{-2}\cdot s^{-1}\cdot sr^{-1}\cdot MeV^{-1}$ at $dE=1\,\text{MeV}$.[4,5] Thus, even with a conservative choice of fast wind parameters $\dot{M}_f$ and V_f the obtained estimate of the intensity at the inner radius of the young PN is about 7–8 orders of magnitude greater than an average value in the ISM $J\left(E=1\,\text{MeV}\right)=2.0\cdot10^{-4}$ particles $\cdot cm^{-2}\cdot s^{-1}\cdot sr^{-1}\cdot MeV^{-1}$.[15]

Because the flux of H_2 ionizing energetic protons, the ionization rate ζ and the cross–section σ of the interaction at a given value of energy E are connected with the evident relation $F\left(E\right)dE=\zeta/\sigma$,[26] it is clear that the ionization rate at such PN, $\zeta\left(PN\right)$ should be larger as well, than $\zeta\left(GCR\right)$ –the average for the ISM, so $\zeta\left(PN\right)=5\cdot10^7\cdot\zeta\left(GCR\right)$. The radius of a molecular part of the young PN envelope should be at least a few of $r_i=10^{16}\,cm$ with a number density of $n\sim10^6\,cm^{-3}$.[17] This corresponds to the column density of nebular matter of about $10^{22}\,cm^{-2}$, and the flux of energetic protons may be decreased, by 1 order of magnitude due to ionization energy losses[27,28] and reflection from magnetic irregularities, depending on the magnetic field strength ($1-10\,\mu G$), by 1–2 orders[29,30] and, additionally by 1 order because of r^{-2} behavior in the postshock region.[15] Thus at the outer part of the (young) PN the differential intensity of energetic particles may be $J\left(E=1\,\text{MeV}\right)=1-10$ particles $\cdot cm^{-2}\cdot s^{-1}\cdot sr^{-1}\cdot MeV^{-1}$ which will be used below.

It is also interesting to recall that a 0.8 MeV proton beam irradiation of a mixture of $H_2O:C_2H_2$ ices at doses of 5–25 eV/18 amu (0.28–1.4 eV/amu) leads to the formation of $CH_2=CH\left(OH\right)$–vinyl alcohol, and a saturation occurs already at a dose of 0.22 eV/amu.[31] One can estimate the irradiation dose of water ice by energetic protons on the basis of a simple relation:[27]

$$\left(n\cdot M\left(n\right)\right)\cdot dD_p/dt=\int_{E_1}^{E_2}F\left(E\right)\cdot S\left(E\right)\cdot dE, D_p=\left(dD_p/dt\right)\cdot t \quad (4)$$

Where $F\left(E\right)=4\pi J_p\left(E\right)$, $S\left(E\right)=dE/dx$ –energy losses of particles in the path x (in units keV/μ), and $\rho=n\cdot M\left(n\right)\cdot1\,\text{amu}$. For energies $E_1=1\,MeV$, $E_2=100\,MeV$ $S\left(E\right)$ can be calculated by the SRIM computer program,[32] for example, $S\left(E=1\,\text{MeV}\right)=26\text{keV}/$

for water ice. Water is observed in young PN in the solid phase.[23-25] Assuming that water ice is present in ice mantles of dust particles coming with the cold AGB wind, adopting in the maximum ice concentration region behind the photo dissociation front $\zeta = 10^{-12} - 10^{-13}\, s^{-1}$ and choosing a conservative case $F(E) = F(E = 1\,\text{MeV}) \cdot E^{-2}$ one finally obtains $D_p = 0.14 - 1.4\text{eV} / \text{amu}$ for 1000 years. Here the contribution of α –particles was taken into account by multiplying the approximate dose of protons by 2, since the loss of α –particles is on the order of magnitude greater,[33] while the abundance is on the order of magnitude smaller. In a hydrogen–deficient case the estimates would be, of course, different. With this caveat, one should note that the dose of energetic particles is at about the threshold of radiation–chemical transformations of ices. Thus, some chemical species under PN conditions practically have time to form from ice mixtures with dominant water ice.

At last, but not least, it is interesting the radiation chemical transformation of more complex systems already formed in the AGB wind, for example, the HAC (hydrogenated amorphous carbon) on the surface of dust grains, or PAH (polycyclic aromatic hydrocarbons), sometimes mentioned as possible sources of the observed fullerene. In short, the infrared observations of recent years registered PAH, and even fullerenes C_{60}, C_{70} in the spectra of several PN, including 11 out of 338 observed by *Spitzer*.[34] These authors interpret the observations as follows: the most likely places of formation of such compounds are the outflows of cold carbon stars in the AGB phase transition to the PN, but little details are known. In particular, it is unclear whether they are present initially in AGB winds, but not observed, due to the lack of appropriate sources of excitation, or they form during the process of transition to a PN phase. There is a point of view that fullerenes are formed by the UV destruction of hydrogenated amorphous carbon (HAC) and/or the dehydrogenation of large PAH molecules in the early PN stages, when there is the intense UV irradiation.[34-36] We would like to note that similar transformations are known also under corpuscular irradiation[26] and one should now just estimate a dose needed.

First of all, one can recall the well–known laboratory data on the stability of C_{60} and C_{70}. It is known that the oligomerization of molecular crystals with a dominant concentration of C_{60} (fullerite, the density of 2 g/cm^3) starts with an irradiation dose of ionizing radiation (γ –rays or α –particles) equal to 2.6 $MGy = 2.6 \cdot 10^{10}\,\text{erg} / \text{g} = 20\text{eV} / \text{amu}$, while the amorphization begins with 250 MGy ($2000\text{eV} / \text{amu}$), i.e. approximately at 100 times greater values.[37] On the other hand, unlike the above scheme with ices, there is no need now to link the region of their maximum concentration close to the outer radius, where, as is already mentioned, the possible maximum value of ζ do not exceed $\zeta \simeq 10^{-12}\, s^{-1}$. On the contrary, the processes of decomposition of HAC covered dust systems and/or the PAH defragmentation with the formation of fullerenes can be considered, starting from the inner radius, where the rate may be as large as $\zeta \simeq 10^{-9}\, s^{-1}$. Energy losses in the case of fullerite should be less than or comparable to the losses in the graphite (the density is 2.26 g/cm^3), and 2 times more than in a water ice while the particles flux may be 3 orders of magnitude larger, so that the possible maximum dose will be $D_p = 2 \cdot 1.4 \cdot 10^3 = 2800\text{eV} / \text{amu}$ in 1000 years, that is larger than the amorphization dose. The dose of HAC decomposition and/or PAH dehydrogenation is most likely less. Thus, in general, the dose can be expected in the range of 20–2800 eV/amu over a considerable part of the PN volume. Of course, these qualitative assessments could not substitute for a rigorous theory, necessary for the simulation of the real abundance of fullerenes in the given PN. For that it is necessary, as already mentioned, to adequately describe the transfer of energetic particles in the medium (probably, with a magnetic field) of known geometry, and enable the time–and spatial dependent ζ incorporation in physical–chemical models of PN. Also it is necessary the correct description of HAC and PAH complexes transformations. Thus, in the models of physical–chemical plasma calculation in PN in general, and in the fullerene formation problem under PN conditions in particular, it appears mandatory to consider the factor of high fluxes of energetic particles, causing significant radiation–induced chemical transformations. It is also necessary to experimentally confirm the similarity mechanisms of the fullerene–type systems origin both under the UV and corpuscular irradiation of potential targets, but better, at their joint impact.

Because of the high values of the fluxes of energetic particles in the WRN, it is interesting also to estimate the radiation doses of certain substances in such nebulae. For the flux of accelerated particles we have expressions (1), in the energy range 1–100 MeV, which is important in the irradiation of substances, as well as in the ionization of molecular hydrogen. Assuming $\dot{M}_f = 10^{-5} M_\odot / \text{yr}$, $V_f = 1500 km / s$, for the differential intensity of the energy protons at $E_1 = 1\, MeV$, one can write for two values of the internal radius $r_i = 1 - 10\,\text{pc}$:

$$J_p(E_1) = 10.0 - 10^3 \frac{\text{particles}}{\text{cm}^2 \cdot \text{s} \cdot \text{sr} \cdot \text{MeV}}. \quad (5)$$

Thus, for standard values of the WR parameters of nebulae, the obtained intensity estimates on the inner boundary of the nebula are 5–7 orders of magnitude greater than the mid–galactic one:[15]

$$J_p(E_1) = 1.0 \cdot 10^{-4} \frac{\text{particles}}{\text{cm}^2 \cdot \text{s} \cdot \text{sr} \cdot \text{MeV}}. \quad (6)$$

Further, $\zeta(WR) = 10^5 - 10^7 \zeta(GCR)$. It is clear that such estimates are meaningful only when the WRN itself contains a molecular gas or is close enough to some molecular cloud, such as WR 7 (NGC 2359).[38,39] In particular, for this nebula, the column density is of the order of $10^{20}\, \tilde{n}\grave{\imath}^{-2}$ (ibid), whence it follows that protons with energies of 1 MeV and more practically do not lose energy for this path,[27,28] and the flow decreases because of the divergence according to the law r^{-2}.[15] The effect of the magnetic field (if present) can be twofold: on the one hand, the protons can be reflected from the magnetic inhomogeneities, and, depending on the strength and geometry of the magnetic field ($1 - 10\mu G$), the flux can decrease by 1–2 orders of magnitude.[29,30] On the other hand, nonthermal protons of relatively low energies can possibly be accelerated to 1–10 MeV in the presence of magneto hydrodynamic turbulence with a certain spectrum (the Fermi–2 process).[40] Thus, in this case, the actual particle flux at the outer boundary of the nebula can be reduced, at most, by 2–3 orders of magnitude, to the value

$$J_p(E = 1\,\text{MeV}) = 0.1 - 10 \frac{\text{particles}}{\text{cm}^2 \cdot \text{s} \cdot \text{sr} \cdot \text{MeV}}.$$

It is known that in many WR nebulae dust is observed, the origin of which is still discussed,[19,41-43] but most likely dust is formed in the conditions of colliding winds of massive pairs.[44]

It is possible to calculate the radiation dose of dust D_p by energy protons in WRN in time t by means of (4), where again $F(E) = 4\pi J_p(E)$ and $S(E) = -dE/dx$ is the energy loss of the particle passing the path dx (in $\mathrm{keV}/$) in a dust particle with a concentration n and a molecular weight $M(n)$ (accordingly, the amount of energy dE absorbed by the dust particle is positive). $S(E)$ in the energy range 1–100 MeV can be easily calculated using the Bethe–Bloch formula, for example, using the computer program SRIM,[32] in particular, $S(E = 1\,\mathrm{MeV}) = 52\,\mathrm{keV}/$ for graphite with a density of 2.26 g/cm^3 ($1.13 \cdot 10^{23}\,\mathrm{atom/cm^3}$), and $S(E = 10\,\mathrm{MeV}) = 9.3\,\mathrm{keV}/$, $S(E = 50\,\mathrm{MeV}) = 2.5\,\mathrm{keV}/\mu$. For hydrogenated amorphous carbon (a: C–H) with a density of up to 2.4 g/cm^3),[45] the energy loss is approximately 1.06 times greater, $S(E = 1\,\mathrm{MeV}) = 55.1\,\mathrm{keV}/$. Then, choosing the not very steep type of the spectrum, $F(E) = F(E = E_1 = 1\,\mathrm{MeV}) \cdot (E/E_1)^{-2}$ one can get $D_p = 1.5 - 150 eV/amu$ for the values of the inner boundary of WRN $\grave{e}_i = 10 \quad 1\,\mathrm{pc}$, respectively, and for a characteristic time interval of 100000 years. If there is a hydrogen deficit in the stellar wind, that is, with predominating helium the value obtained should be multiplied by 10, since the energy losses of the α particles are an order of magnitude larger,[32] and the doses will be of 15–1500 eV/amu.

In some cases, characteristic PAH emission lines are also observed with dust.[46] There is a point of view that further UV irradiation of PAH followed by dehydrogenation can even lead to the formation of fullerenes,[34-36] which are observed in different (but WR–radiation–like) objects, for example, in PN.[36] Therefore, we also estimate the radiation dose for such systems (HAC, fullerenes) under WRN conditions, since, as a rule, in radiation–chemical transformations of complex compounds, electromagnetic and corpuscular irradiation are equivalent, and this fact must be taken into account.[26] From the standpoint of irradiation of fullerenes, laboratory data on the stability of C_{60} and C_{70} are interesting: oligomerization of molecular crystals with a dominant content of C_{60} (fullerite, density 1.7 g/cm^3) begins with radiation doses (γ–rays or α–particles) of the order of 2.6 $MGy = 2.6 \cdot 10^{10}\,\mathrm{erg/g} = 20\,\mathrm{eV/amu}$, whereas for amorphization a large dose of 250 MGy (2000 eV/ amu) is needed approximately 100 times larger.[37] Thus, the dose of fullerite irradiation in WRN (at the inner boundary) is comparable with the dose for graphite (1.5–150 eV / amu for 100000 years), and for HAC it is somewhat larger. The dose of HAC decomposition and defragmentation of PAH is obviously less than the laboratory values of the doses of amorphization of fullerene and are comparable to the real values of the doses obtained in WRN on the inner boundary in which, as already noted, doses in the range of 1.5–150 eV/amu can be expected (15–1500 eV/amu in case of hydrogen deficiency). Thus, in the nebulae, not only dust, but also PAH (which are observed in some cases), and even fullerenes, whose manifestations are worth searching in the observed spectra, can form. A detailed analysis of the described phenomena based on the kinetics of processes is beyond the scope of this article and will be given elsewhere.

Conclusion

In this paper the differential intensities of protons accelerated to energies of 1–100 MeV under the conditions of shock waves of interacting stellar winds forming PN and WRN were calculated. The estimates were based on the formula (1), which relates the fraction of the kinetic energy of the expanding shell converted to the energy of accelerated particles. It is interesting to note that under the conditions of the heliosphere, estimates coincide with the Voyager 1 data at 1 MeV[14] to within a factor of less than 2, if a flow kinetic energy conversion factor $\eta = 0.1$ is chosen in Equation 1. Because of the steepness of the spectrum, the exponent does not have a special significance when calculating radiation doses, because the contribution of more energetic particles is usually small. In addition, for the characteristic time of a young PN for about 1000 years, only the soft part of the spectrum, 1–10 MeV, will be formed. Estimated fluxes of energetic particles in PN are more than 7 orders of magnitude larger than an average ISM value at 1 MeV. This may cause serious consequences concerning dust processing by energetic particles. An important example is the value of the doses of irradiation of water ice and fullerite, exceeding the known laboratory data on destructive threshold of the dose values. In conclusion, the importance of taking energetic particles into account in the physico–chemical modeling of PN is emphasized, because the local hydrogen ionization rate is 7–8 orders of magnitude higher than the mean galactic rate. In particular, it is shown, that under high flux irradiation by energetic particles complex species may be formed from ice mixtures with dominant water abundance during characteristic time of young PN of 1000 years. Besides, irradiation by such particles should be taken into account when modeling of fullerene–like systems in PN.

The accelerated particle fluxes at the inner boundary of the WRN exceed the mean galactic value at 1 MeV by more than 4 orders of magnitude. This may have interesting consequences in assessing the effects of particle dust irradiation in WRN. Important examples relate to the irradiation of systems such as graphite and / or HAC and PAH, with possible decomposition and defragmentation, as well as fullerite, with calculated doses being of the same order as laboratory ones, causing important radiation–chemical transformations. In conclusion, we emphasize that increased fluxes of energetic particles must necessarily be taken into account in physical–chemical modeling of WRN nebulae.

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Conflict of interest

Author declares there is no conflict of interest.

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