The Emission Source of Supernova ASASSN-15nx with a Prolonged Linear Light Curve

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Abstract—An analysis of the spectra for the anomalous supernova ASASSN-15nx with a linear light curve has ruled out the emission mechanisms through radioactivity and shock interaction with circumstellar gas. An alternative mechanism for the emission of ASASSN-15nx based on the interaction of a rotating neutron star magnetosphere with gravitationally bound ejecta material is proposed. In the regime of stationary accretion the neutron star rotation frequency and the rotational energy losses decrease exponentially with time, which can explain the linearity of the light curve. Modeling of the light curve at the initial stage of the luminosity rise in combination with the expansion velocity suggest a low ejecta mass, \( \sim 1 M_\odot \). The shape of the [O I] 6300, 6364 Å doublet profile points to asphericity of the oxygen distribution, which, in turn, provides evidence for a highly aspherical explosion.

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INTRODUCTION

The anomalous type II supernova (SN) ASASSN-15nx (Bose et al. 2018) with a peak absolute magnitude \( M_V \approx -20 \) mag exhibits an unusual light curve characterized by a perfect (according to the authors) linear decline (2.5 mag in 100 days) during a long period, \( \sim 250 \) days. This peculiarity has no counterparts among SNe II, including SNe IIL with linear light curves. Such a light curve cannot result from the radiative diffusion of explosion energy; a long-lasting source of radiation energy is required. Two alternative energy sources are proposed in the cited paper: (i) radioactive \(^{56}\)Ni in an amount of \( 1.6 M_\odot \) at a total ejecta mass of \( \sim 2 M_\odot \) or (ii) the radiation due to the collision of SN ejecta with a dense circumstellar envelope. Both mechanisms operate in SNe and any of them could purport to be the emission source of ASASSN-15nx.

Of course, the hypotheses about the nature of the energy source in ASASSN-15nx requires a verification. The verification of possible spectral effects that should accompany this mechanism comes to the fore. Note that the spectral testing of the proposed emission mechanisms remained beyond the scope of the original paper by Bose et al. (2018). Therefore, it is necessary to make up for the lack of such a study, which is one of the goals of this paper. A study of this kind is the content of the next section. As will become clear, an analysis of the spectra reveals serious difficulties both for the radioactive mechanism and for the mechanism of shock interaction with circumstellar gas. An alternative mechanism that can explain both the luminosity and the linear shape of the light curve under a minimum of assumptions will be proposed.

The explosion time and the distance from Bose et al. (2018) will be used below.

INTERPRETATION OF THE SPECTRA FOR ASASSN-15NX

Line Identification

The spectra of ASASSN-15nx taken between days 53 to 262 after the explosion (Bose et al. 2018) are a set of emission lines against the background of a quasi-continuum formed by a large number of metal lines (Fig. 1). The spectrum is dominated by the H\( \alpha \) line (emission feature \( b \)), the Ca II 8600 Å \((g)\) and O I 7774 Å \((e)\) triplets, the Na I 5892 Å doublet \((a)\), and the [Ca II] 7300 Å doublet \((d)\). The [O I] 6300 Å doublet is also present in the spectrum at a late stage. All these lines lie in the red spectral region that will be the focus of our attention. Some unusual spectral features have been noted previously (Bose et al. 2018), in particular, the two-component structure of the O I 7774 Å profile in the spectrum on day 53. At the same time, the features that, in our

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Fig. 1. The observed spectra of ASASSN-15nx (gray color) for three epochs (days 53, 87, and 165) in comparison with the synthetic spectra. For day 53 the Ca II H, K doublet is presented in the inset. For convenience, the main features in the spectrum on day 87 are marked by letters in alphabetical order. In the spectrum on day 165 the structure of the upper part of the [O I] 6300, 6364 Å doublet profile with two peaks reflects asphericity of the oxygen distribution (see the text).

view, play a key role in understanding the emission mechanism were left out.

Since the line identification procedure requires allowance for the nonlocal scattering of photons in line blends and the Thomson scattering, which can be significant at an early stage, we will rely on the synthetic spectrum in which the described effects are taken into account. The synthetic spectrum model suggests a spherical envelope with homologous expansion, $v = r/t$. The velocity distribution of the line emissivity is specified in a parametric form, $j = j_0/[1 + (v/v_0)^k]$. The local line optical depth is described by the same distribution, but with a slightly different parameter $k$. At a fixed stage the parameters $v_0$ and $k$ are identical, except for the oxygen lines. The continuum emission sources in the model are distributed according to the same law. The electron density distribution is taken to be $n_e \propto \sqrt{\lambda}$, in accordance with the recombination nature of the Hα emission.

To estimate the Thomson optical depth, we used the photometric data and the spectrum on day 53 in
scaled fluxes (Bose et al. 2018). The inferred Hα luminosity is $L = 7 \times 10^{49} \text{ erg s}^{-1}$. In combination with the profile, the Hα luminosity corresponds to the electron density distribution with a Thomson optical depth of the envelope $\tau_T = 1.3$. The derived electron distribution is used in the synthetic spectrum on day 53. The spectrum is simulated by the Monte Carlo method. It should be emphasized that the proposed synthetic spectrum model disregards the emission of a large number of metal lines that produces an irregular quasi-continuum, in particular, in the range 5600–6500 Å (Fig. 1), where the smooth continuum used in the model shows noticeable deviations from the observed quasi-continuum. This fact should be kept in mind when comparing the synthetic and observed spectra.

Let us turn to the two-component O I 7774 Å profile in the spectrum on day 53 (Fig. 1), whose nature was not explained (Bose et al. 2018). The importance of this feature is emphasized by its possible connection with the asymmetry of the oxygen distribution discussed in another section. In fact, the two-component structure of the O I 7774 Å emission bears no relation to the asymmetry, because the red component is formed by the Mg II 7877, 7896 Å emission lines. The presence of these Mg II lines in the spectrum on day 53 together with the model shows noticeable deviations from the observed quasi-continuum. This fact suggests the presence of a large envelope mass, 2 $M_\odot$ (Bose et al. 2018). A direct consequence of this model should be a strong [Co III] 5890 Å emission line on days 70–150, by analogy with the spectra of SNe Ia (see, e.g., SN 2011fe and SN 2014J in Bikmaev et al. (2015)). The 5890 Å line (emission $a$) that could belong to [Co III] is indeed present in the spectra of ASASSN-15nx. The problem with cobalt is that the intensity of this line with respect to the emission in broad Fe II line blends in the range 5000–5500 Å in the spectrum on day 262 (Bose et al. 2018) does not show the expected significant decline due to the decay of $^{56}$Co, an effect present in SNe Ia. This contradiction implies that the radioactive mechanism for the emission of ASASSN-15nx should be rejected.

The fact that the 5890 Å line emission belongs mainly to the resonant scattering of the quasi-continuum emission in the Na I doublet and partly to the He I 5876 Å line emission, which is also scattered in the Na I doublet lines due to the reddening in the comoving frame in a medium with homologous expansion, is beyond question. The nonlocal scattering of the Mg II 5876 Å photons in the Na I doublet lines is taken into account in the presented synthetic spectrum model (Fig. 1). The line emissivity ratio $j(5876)/j(7065)$ adopted in our calculations is 1, 1, and 2 in the spectra on days 53, 87, and 165, respectively.

The Absence of Interaction with the Circumstellar Envelope

An absorption component of the Ca II 3934, 3968 Å doublet is present in the spectra of ASASSN-15nx. Figure 1 (inset) shows the Ca II doublet in the spectrum on day 53 together with the model profile. The model parameters include the emissivity, the line optical depth at the envelope center, and the Ca II doublet photon loss probability $\epsilon_{13} = A_{32}\beta_{23}/(A_{31}\beta_{13} + A_{32}\beta_{23})$, where $A_{ki}$ and $\beta_{ik}$ are the spontaneous transition and local photon escape probabilities, respectively. The indices 1, 2, and 3 correspond to the $^2S$, $^2D$, and $^2P$ terms; the 1–3 and 2–3 transitions mean the 3950 Å doublet and the infrared 8600 Å triplet, respectively. For optically thick lines $\epsilon_{13}$ is determined by the excitation temperature and is 0.7 for $T = 6000 \text{ K}$ (Bose et al. 2018). This value guarantees a significant conversion of the 3950 Å doublet emission into the infrared 8600 Å triplet emission. For this reason, to specify the intrinsic emissivity in the doublet lines, we may proceed from the intensity of the infrared Ca II triplet. However, on day 53 the spectrum at $A > 8000$ Å is absent. Therefore, we use the fact that in the spectrum on day 87 the flux in the Ca II triplet lines is comparable to the Hα flux. On this basis, in the presented model the emissivity in the doublet lines in the spectrum on day 53 is set equal to the Hα emissivity.
The presence of quite a deep absorption of the Ca II doublet implies that the quasi-continuum, against the background of which this absorption line is seen, is formed in the inner envelope. In turn, this suggests that the emission source of ASASSN-15nx is inside rather than outside the envelope. It is the latter that is expected in the SN ejecta—circumstellar material collision mechanism. The internal localization of the energy source rules out the emission mechanism based on the the collision of SN ejecta with a dense circumstellar envelope.

**Oxygen and Helium Abundances**

The high intensity of the O I 7774 Å triple with respect to Hα on day 53, \( F(7774)/F(H\alpha) \approx 0.5 \), suggests a high oxygen abundance. Indeed, at close ionization potentials the hydrogen and oxygen ionization fractions must be comparable and, consequently, at comparable recombination line intensities the numbers of oxygen and hydrogen atoms must be close. Given the effective recombination coefficient for these lines (Pequignot et al. 1991) at an electron temperature of 6000 K (Bose et al. 2018) and assuming that hydrogen and oxygen are not mixed, we estimate the ionized hydrogen and oxygen masses to be 0.03 \( M_\odot \) and 0.12 \( M_\odot \), respectively. The hydrogen ionization fraction is unknown. However, using the fact that the Na I doublet is present, we can argue that it is unlikely to be close to unity. At a hydrogen and oxygen ionization fraction of 0.5 the hydrogen and oxygen masses in the envelope are 0.06 \( M_\odot \) and 0.24 \( M_\odot \), respectively. Although these estimates are quite crude, they suggest a small hydrogen mass in the envelope and a relatively large oxygen mass (at least a few tenths of the solar mass).

The intensity of the sole observed He I 7065 Å line with respect to Hα is approximately 0.1. This is twice that expected for a normal helium abundance and the same hydrogen and helium ionization fraction. In reality, the helium ionization fraction is most likely lower than the hydrogen one and, consequently, the helium abundance relative to hydrogen must be even higher.

**Asymmetry of the Oxygen Distribution**

The profile of the observed [O I] 6300, 6364 Å doublet in the spectrum on day 165 differs noticeably from the synthetic one in the range of radial velocities \( |v_r| < 2000 \) km s\(^{-1}\) (Fig. 1): the observed profile shows a flat top with two peaks, which should not be in the spherically symmetric case. The spectrum on day 262 shows a similar profile with higher-contrast peaks (Bose et al. 2018). This feature of the oxygen doublet profile most likely reflects a deviation of the oxygen distribution from spherical symmetry.

To get an idea of the oxygen distribution, let us consider a model in which there is an additional component in the form of an equatorial ring or polar caps with a constant contrast \( \chi = j/j_s \) in the velocity range \( v_1 < v < v_2 \) against the background of a symmetric distribution of sources with an emissivity \( j_s \propto 1/[1 + (v/v_0)^{k}] \). The angular sizes of the ring and the caps are specified by the cosine of the polar angle \( \mu_0 \): \( |\mu| < \mu_0 \) for the ring and \( |\mu| > \mu_0 \) for the caps. The orientation is specified by the inclination angle \( i \). The doublet emissivity ratio is taken to be 1 : 3, corresponding to optically thin lines. We emphasize that the introduction of a finite optical depth in all cases only makes the agreement between the axisymmetric model and observations poorer.

Our modeling shows that the equatorial ring cannot reproduce the profile. The optimal equatorial ring (ER) model for the profile on day 165 (Fig. 2, Table 1) is characterized by the parameters presented in Table 1. The ring is assumed to be axisymmetric, i.e., the azimuthal asymmetry parameter \( A \) (the ratio of the emissivities \( j \) in the far and near hemispheres) is equal to unity. In fact, the observed profile points to azimuthal asymmetry. However, the emission not only in the far hemisphere, but also near the limb should be suppressed to reproduce the profile in the ring model. Such a deviation from central symmetry is easier to describe in terms of asymmetric polar caps (PC). On day 165 the PC1 model (Fig. 2, Table 1) satisfactorily reproduces the profile with asymmetry \( A = j(\text{red})/j(\text{blue}) = 0.38 \). Two versions of the models with horizontal and inclined continua (PC2 and PC3, respectively) are presented for day 262. The models differ insignificantly and emphasize that the conclusion about the asymmetry of the oxygen distribution is robust.

The fact that a significant fraction of the oxygen shows a pronounced angular and central asymmetry of the distribution at velocities 1300–3000 km s\(^{-1}\)

### Table 1. Model parameters for the [O I] 6300, 6364 Å emission

| Model | \( v_1 \) | \( v_2 \) | \( i \) | \( \mu_0 \) | \( \chi \) | \( A \) |
|-------|-------|-------|------|--------|------|------|
| ER    | 1500  | 3200  | 70   | 0.6    | 6    | 1    |
| PC1   | 1400  | 2800  | 20   | 0.6    | 2.8  | 0.38 |
| PC2   | 1300  | 2900  | 19   | 0.5    | 2.8  | 0.7  |
| PC3   | 1400  | 2800  | 19   | 0.5    | 2.8  | 0.6  |
suggests a great asphericity of the explosion that affected significantly the ejected oxygen. Such phenomena in the oxygen doublet profile have not been observed in SNe II and, even if observed, they were associated with the asymmetry of the $^{56}\text{Ni}$ distribution, as, for example, in SN 2004dj (Chugai et al. 2005).

**LIGHT CURVE**

Having excluded the radioactive mechanism and the shock interaction with circumstellar material, let us turn to alternative possibilities: (i) the rotational energy losses of a young magnetar and (ii) supercritical accretion onto a black hole. The emission mechanism of a young magnetar with the luminosity defined by the formula of magneto-dipole radiation has been invoked earlier (Kasen and Bildsten 2010) for the explanation of superluminous supernovae (SLSN). The problem with this mechanism for ASASSN-15nx is obvious: the power law of evolution of the magnetar luminosity is inconsistent with the observed exponential luminosity decline. The mechanism of supercritical accretion onto a black hole cannot be ruled out in principle. It was invoked to explain SN iPTF-14hls (Arcavi et al. 2017; Chugai 2018). An exponential luminosity decline could formally be realized in the case where the accretion rate is proportional to the mass of the gravitationally bound envelope. However, it is not quite clear what physics leads to the required adjustment of the evolution of the accretion rate.

We can imagine yet another mechanism that could naturally explain the exponential luminosity decline. Suppose that the explosion of SN ASASSN-15nx was accompanied by the formation of a neutron star with a strong magnetic field and rapid rotation, but with a relatively low magnetar luminosity. The process that can provide powerful energy release in this case is the accretion of gravitationally bound ejecta material onto the rotating magnetosphere of a neutron star with mass $M$ and rotation frequency $\omega$. The interaction of the magnetosphere with the accreting gas in the regime of a supersonic propeller in this case presumably provides the ASASSN-15nx luminosity. This requires that the radius of the magnetosphere with a magnetic moment $\mu$ for an accretion rate $\dot{m}$, $r_m = (\mu^2/8\dot{m}^2GM)^{1/7}$, be smaller than the light-cylinder radius $r_{lc} = c/\omega$ and larger than the corotation radius $r_c = (GM/\omega^2)^{1/3}$ (Shakura 1975; Davis et al. 1979). The maximum rate of rotational energy loss by a neutron star in the regime of a propeller...
is \( L_p = (1/2)\dot{m}(r_m\omega)^2 \) (Davis et al. 1979). At such a luminosity the spindown of a neutron star with a moment of inertia \( I \) is described by the equation (Shakura 1975)

\[
I\omega = -(1/2)\dot{m}(r_m\omega)^2. \tag{1}
\]

It follows from this equation that a constant accretion rate, \( \dot{m} = \text{const} \), leads to an exponential spindown, \( \omega = \omega_0 \exp(-bt) \), where \( b = 0.5\dot{m}r_m^2/I \). The rate of rotational energy loss in this case is also described by an exponential law, \( L \propto \omega^2 \propto \exp(-2bt) \), which could explain the linear light curve of ASASSN-15nx.

A steady-state accretion rate is a necessary condition for an exponential luminosity decline. Note in this connection that a study of the accretion of gravitationally bound material onto the neutron star after the supernova explosion (Chevalier 1989) actually predicts the possibility of a prolonged (of the order of one year) stationary accretion regime.

The complex processes of propeller-generated energy conversion into the observed optical radiation remain beyond the scope of this scenario. A multidimensional picture including an accretion flow and ejected plasma is presumably formed inside the expanding envelope. This plasma forms a hot (\( \sim 5 \times 10^9 \) K) bubble. The hard (\( \sim 5 \times 10^9 \) keV) X-ray emission from the hot bubble is most likely the mediator of energy transfer to the cold SN envelope, but the contribution of accelerated relativistic particles is not ruled out. When calculating the bolometric light curve, we assume that all of the power being released by the propeller mechanism is put into the SN envelope. Table 2 presents the optimal set of parameters to describe the linear light curve: the neutron star radius, the moment of inertia, the magnetic moment, the initial rotation period, and the accretion rate. The magnetic moment corresponds to the strength of the dipole equatorial magnetic field on the neutron star surface, \( 3 \times 10^{13} \) G. The total mass involved in the accretion flow with the above accretion rate over 250 days is \( 1.6 \times 10^{-3} M_\odot \).

The presented model does not depend on the mass \( M_{ej} \) and kinetic energy \( E \) of the ejecta. To determine them, let us consider the model of homogeneous ejecta that takes into account the radiation diffusion and can be used to describe the initial stage of the luminosity rise. The optical bolometric luminosity is calculated via the thermal energy of the ejecta in the form of radiation \( E \) and the characteristic photon diffusion time in the ejecta, \( L_{bol} = E/t_c \). The time \( t_c \) is taken to be equal to the average photon residence time in the homogeneous ejecta in the problem with an instantaneous central source (Sunyaev and Titarchuk 1980), \( t_c = R/2c \propto 1/t \), where \( R \) is the ejecta radius, \( \tau \) is the optical depth of the ejecta, and \( c \) is the speed of light. The evolution of the radiation energy is defined by the energy equation,

\[
dE/dt = -E/t - E/t_c + L_p \tag{2}\]

The first, second, and third terms on the right-hand side describe, respectively, the adiabatic losses, the radiative diffusion, and the injection of energy into the ejecta with the power of the propeller mechanism. The opacity is assumed to be constant and corresponds to Thomson opacity with the number of free electrons per baryon \( y_e = 0.2 \). As an illustration, under equilibrium ionization in homogeneous ejecta with a mass of \( 1 M_\odot \), a kinetic energy of \( 10^{52} \) erg, and H, He, and O mass fractions \( x_1 = 0.1, x_2 = 0.1, x_8 = 0.8 \) near the peak (14 days) at an effective temperature of \( 10400 \) K, \( y_e = 0.16 \). With a slightly different composition \( (x_1 = 0.1, x_2 = 0.4, x_8 = 0.5) \) we get \( y_e = 0.18 \). With the correction for deeper layers, where the ionization is higher, the adopted \( y_e = 0.2 \) is acceptable. It should be noted that the presented initial luminosity model disregards the narrow peak \( \sim 1 \) h in duration associated with the shock breakout. Apart from the observed bolometric luminosity, the V-band photometric data normalized to the bolometric luminosity in the region of overlap between the observations are present in Fig. 3. These data give a rough idea of the fast luminosity rise at the earliest stage. Figure 3 shows the model with a mass of \( 3 M_\odot \) (Fig. 3a) and energy \( E = 1.7 \times 10^{52} \) erg and the model with a mass of \( 0.5 M_\odot \) (Fig. 3b) and energy \( E = 1.5 \times 10^{50} \) erg. Both models reproduce the initial stage of the luminosity rise.

The uncertainty in choosing the ejecta mass and energy is removed if the observational constraints on the expansion velocity are taken into account. The data on the evolution of the photospheric radius for ASASSN-15nx at the initial stage (Bose et al. 2018) yield an estimate of the photospheric expansion velocity at the initial stage of \( \sim 10^4 \) km s\(^{-1}\). This value coincides with the maximum expansion velocity observed in the H\(\alpha \) wings on day 53. The models presented in Fig. 3 are characterized by a maximum expansion velocity of \( 31000 \) km s\(^{-1}\) for \( M_{ej} = \)
Fig. 3. The bolometric light curve of ASASSN-15nx (crosses) and the model light curve (solid line) in two versions: with an ejecta mass of 3 \( M_\odot \) (a) and 0.5 \( M_\odot \) (b). The circles indicate the \( V \)-band photometric data normalized to the bolometric luminosity; the triangle corresponds to the upper flux limit in the \( V \) band. The magnetar luminosity is indicated by the dotted line.

3 \( M_\odot \) and 7100 km s\(^{-1}\) for \( M_{ej} = 0.5 \ M_\odot \). Both model velocities differ noticeably from the observed one, \( \approx 10^4 \) km s\(^{-1}\), toward higher and lower values. Therefore, an acceptable SN ejecta mass estimate should lie within the range 0.5\( M_\odot < M_{ej} < 3 \ M_\odot \). The optimal light curve model with a maximum velocity of 10 300 km s\(^{-1}\) is characterized by the ejecta mass \( M_{ej} = 0.7 \ M_\odot \) and the kinetic energy \( E = 4.5 \times 10^{50} \) erg. Despite the approximate description of the initial stage of the light curve, it can be argued that the ASASSN-15nx ejecta mass is probably close to 1 \( M_\odot \) and the kinetic energy lies within the range \( E = (0.5 - 1) \times 10^{51} \) erg.

It should be noted that the requirements imposed on the model that must be fulfilled for the mechanism considered to be able to provide an exponential light curve, in particular, the constraint on the magnetosphere radius \( r_c < r_m < r_{lc} \) and a relatively low magnetar luminosity, are actually fulfilled in the model considered.

**DISCUSSION AND CONCLUSIONS**

An analysis of the spectra for the unusual supernova ASASSN-15nx with a linear light curve (on the logarithmic scale) reliably rules out the radioactive emission mechanism and the mechanism of shock interaction with a dense circumstellar envelope. The alternative mechanism proposed here suggests that a neutron star with a strong magnetic field and fast initial rotation loses its rotational energy through the interaction of its magnetosphere with gravitationally bound ejecta material in the propeller regime. In the case of a stationary accretion flow, the rotational energy losses decrease exponentially with time, which explains the linearity of the light curve. Deviations from the regime of stationary accretion should naturally cause deviations from the linear luminosity decline, which could probably be observed in other supernovae of this category.

Our modeling of the initial stage of the light curve, at which a fast luminosity rise is observed, in combination with the ejecta expansion velocity leads to an SN ejecta mass estimate that turns out to be low, \( \sim 1 \ M_\odot \). Interestingly, the behavior of the \( B - V \) color points to a low ejecta mass. According to Bose et al. (2018), \( B - V \) rose with time in the same way as in the case of SNe IIP. However, whereas in the case of SNe IIP the rise continued monotonically up to 100 days, in ASASSN-15nx it ended on day 50. Since the behavior of \( B - V \) reflects the envelope cooling in the photospheric regime, this means that in ASASSN-15nx the duration of the photospheric phase is half that in the case of SNe IIP. Hence it follows that at comparable expansion velocities the ejecta mass for ASASSN-15nx is considerably lower than that for SNe IIP. Given the neutron star mass and the ejecta mass, the presupernova mass before its explosion was \( \sim 2 - 2.5 \ M_\odot \). It is important to emphasize that the hydrogen mass accounts for less than 10% of this mass.

The difficult question about the genesis of ASASSN-15nx arises. In a single-star scenario such a presupernova must be a helium core with the remnants of a hydrogen envelope. At a helium core mass of \( \approx 2.5 \ M_\odot \) the presupernova must be a product of the evolution of a star with a main-sequence mass of \( \sim 10 \ M_\odot \) (Nomoto 1984). This scenario, however, does not predict an oxygen layer above the collapsing
core and this contradicts the presence of at least a few tenths of the solar mass of synthesized oxygen in ASASSN-15nx.

We can imagine an alternative evolutionary scenario for ASASSN-15nx that includes a close binary star consisting of a massive ONeMg white dwarf (primary component) and a low-mass star with a CO core at the AGB stage. The evolution of such a binary system through the common envelope phase could lead to the merging of the stellar CO core with the massive ONeMg white dwarf followed by the collapse of the ONeMg white dwarf initiated by an electron capture. The advantage of this scenario is that it can explain the presence of a neutron star and a significant oxygen mass at a low ejecta mass. The oxygen in this scenario results from the tidal disruption of the CO core of the secondary component. The remnants of the hydrogen—helium envelope of the secondary component could explain the presence of a small hydrogen mass in ASASSN-15nx. The ASASSN-15nx explosion asphericity could be the result of fast rotation due to the merging.

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