EXPLOSION OF LOW-MASS NEUTRON STAR IN CLOSE BINARY SYSTEM AND NUCLEOSYNTHESIS OF HEAVY ELEMENTS.

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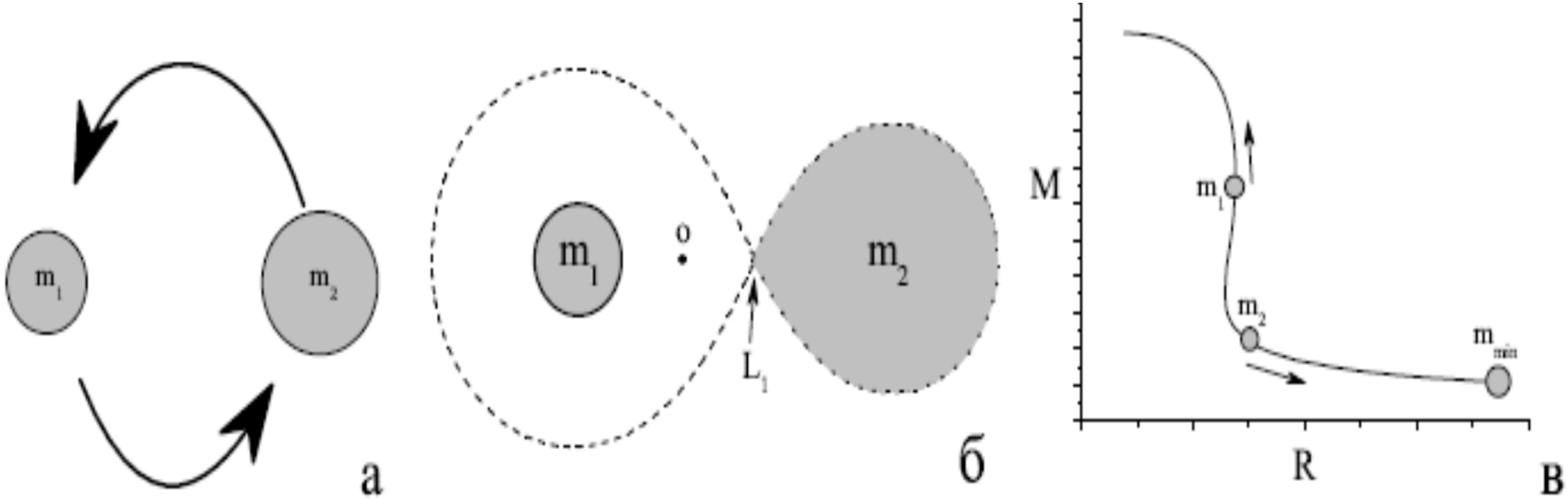
- Introduction, history, conditions
- overview of the r-process sites
- Motivation
- Stripping Model
- Results of nucleosynthesis
- Discussion and Conclusions

Evolution of close binaries.

(*Clark & Eardley*, AJ, 1977; *Yudin et al*., 2020, in press).

First observation of neutron star merger (NSM) and simultaneous registration of the r-elements (GW17082017) confirm the understanding that main r-process scenario is connected rather with neutron-rich jets, ejected during NSM, than with SN-explosion. Practically all calculations of NSM consider usually two neutron stars of close masses, leading to merger in one object. What is happened if system of neutron stars is strongly asymmetrical? And low mass NS is extremely small? We considered NS system, in which m1 > m2. And low mass neutron star (m2) has bigger radii. When approaching each other the low-mass NS fills its Roche lobe and begins to flow onto the more massive companion m1. When low-mass NS dicreases value $m2=Mmin \sim 0.09M_\odot$, it became unstable, and explosion of low mass neutron star m2 is occurred.

Stripping model



а) two NS approaches each other due to gravitational radiation;
б) low mass NS fills Roche lobe and begins to flow onto the more massive companion.;
в) At the diagram M(R) (в) characteristics of stars m1 and m2 changes (see arrows) in time.

Stripping model and observations.

GRAVITATIONAL SIGNAL GW170817 and GRB170817A

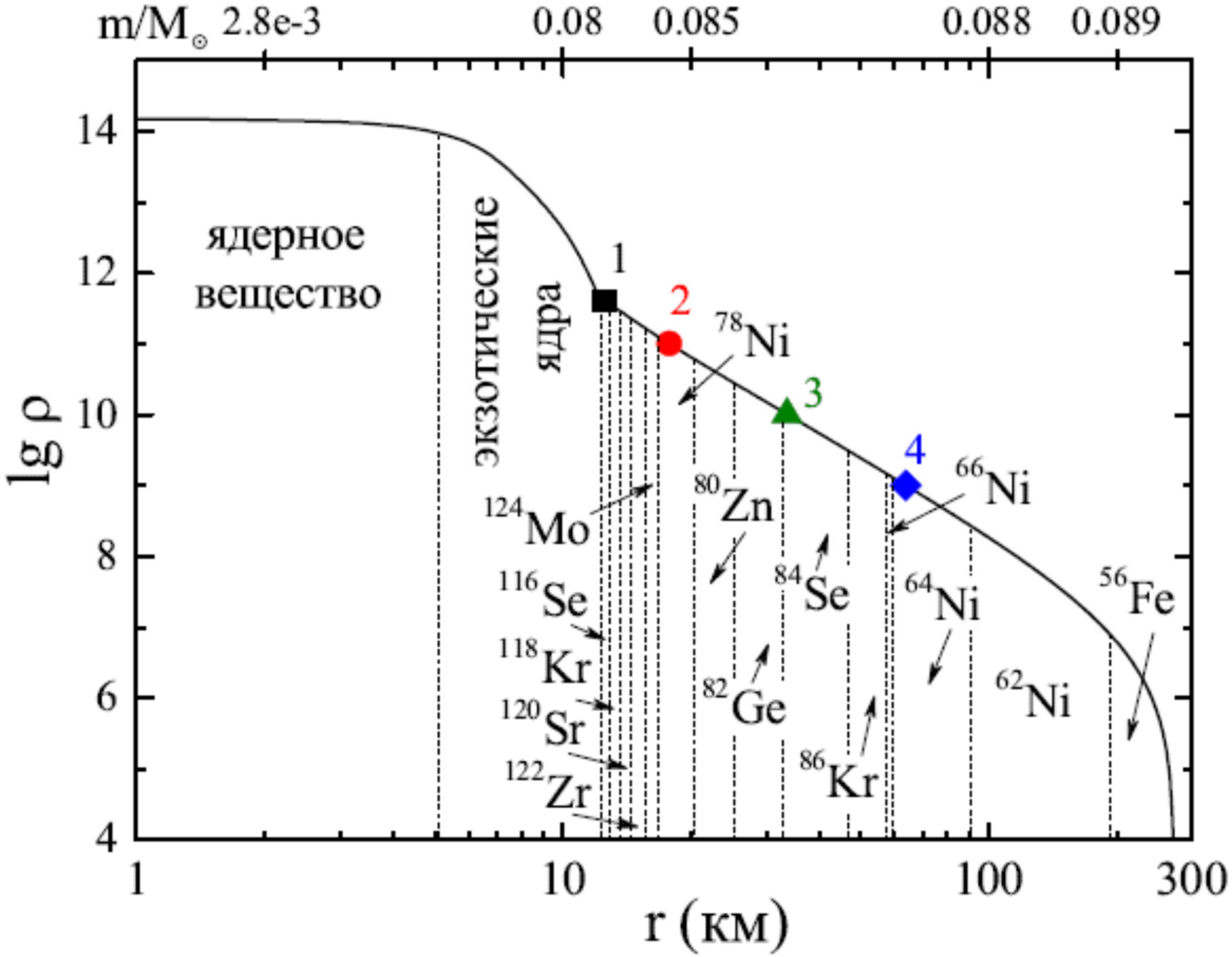
After observation of gravitational signal GW17082017 it was turned out, that a number of theoretical explosion parameters agree very well with the observational ones.

1)Так, после пика на кривой GW-излучения антенны LIGO и VIRGO потеряли сигнал, и через 1.7 сек спутники FERMI и INTEGRAL зарегистрировали 2) gamma-ray burst (weak) with energy $W \sim 3 \times 10^{46}$ эрг ($\delta t_{theor}=1.7$с, $W_{theor} = 10^{43}-10^{47}$ эрг)

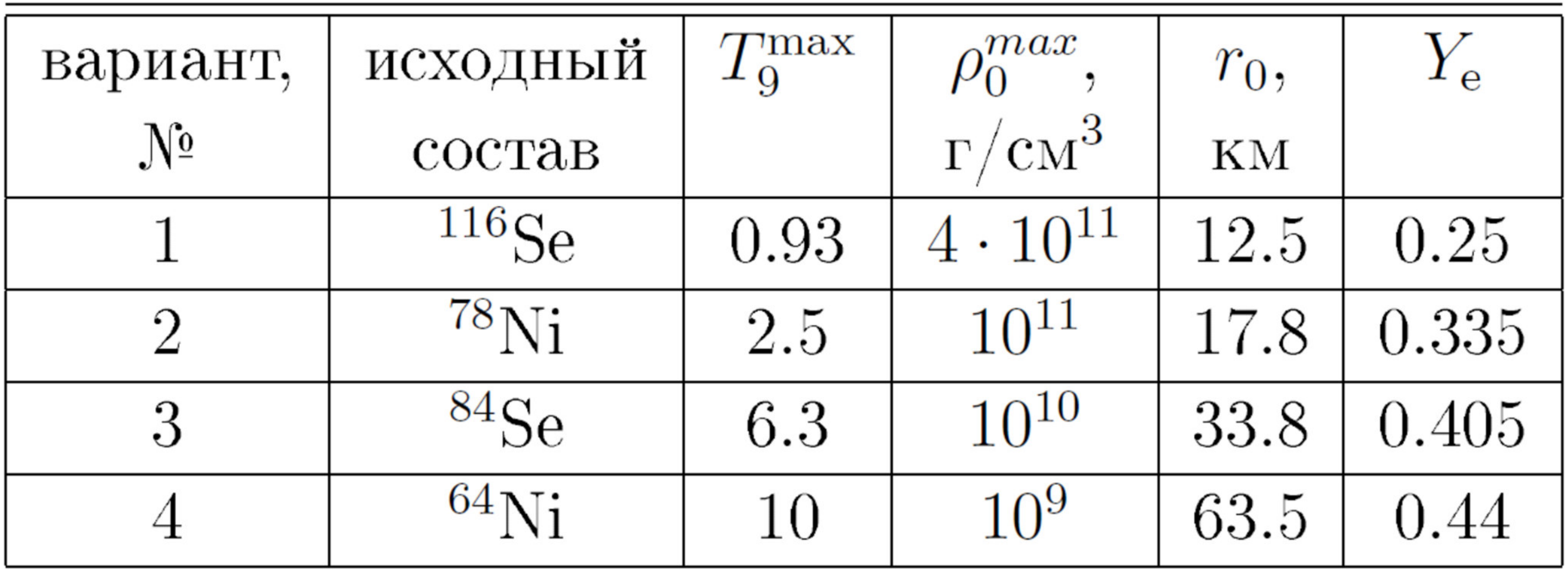
3) Ekin(GRB) $\sim 10^{51}$ эрг (theor. Ekin~ 9×10^{50} эрг);

4) $M_{blue} = 0.016 M_{\odot}$, $V_{blue} \sim 0.3c$, $M_{red} = 0.05 M_{\odot}$, $V_{red} \sim 0.1c$ (theor.: V=~c and 0.1c; $M_{out} < 0.09$).

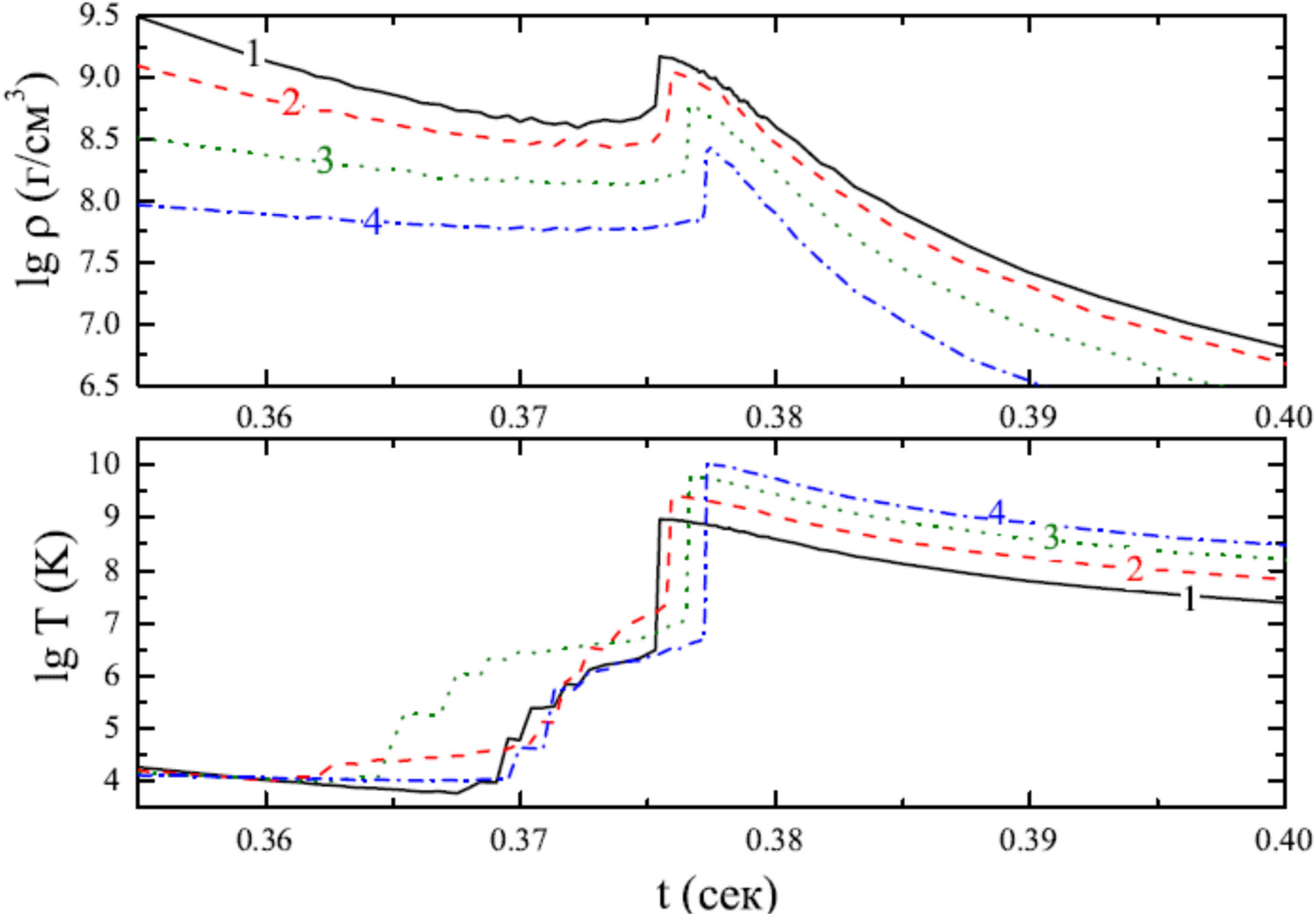
Structure of low-mass NS.



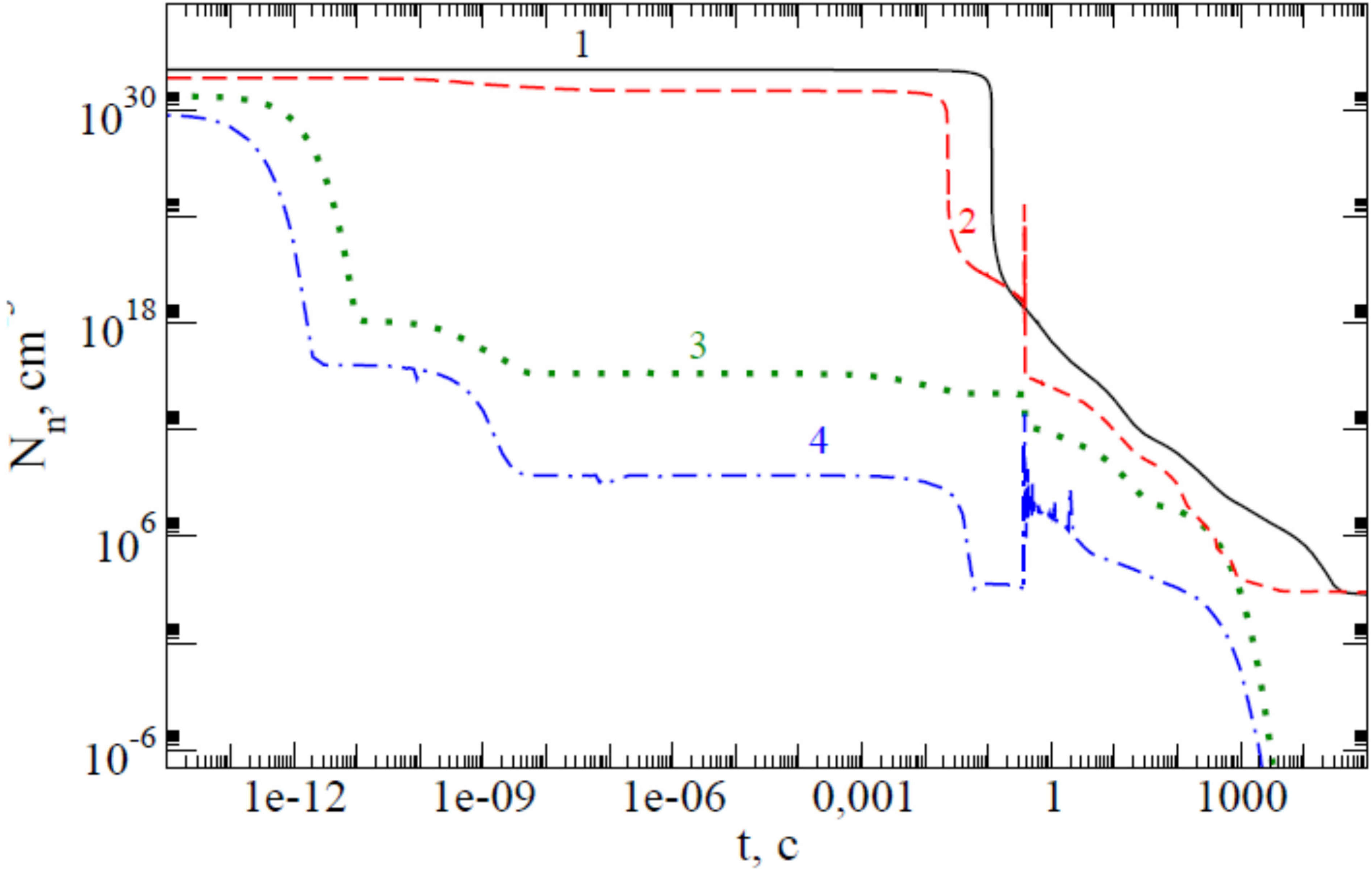
Parameters of trajectories along which the nucleosynthesis was calculated



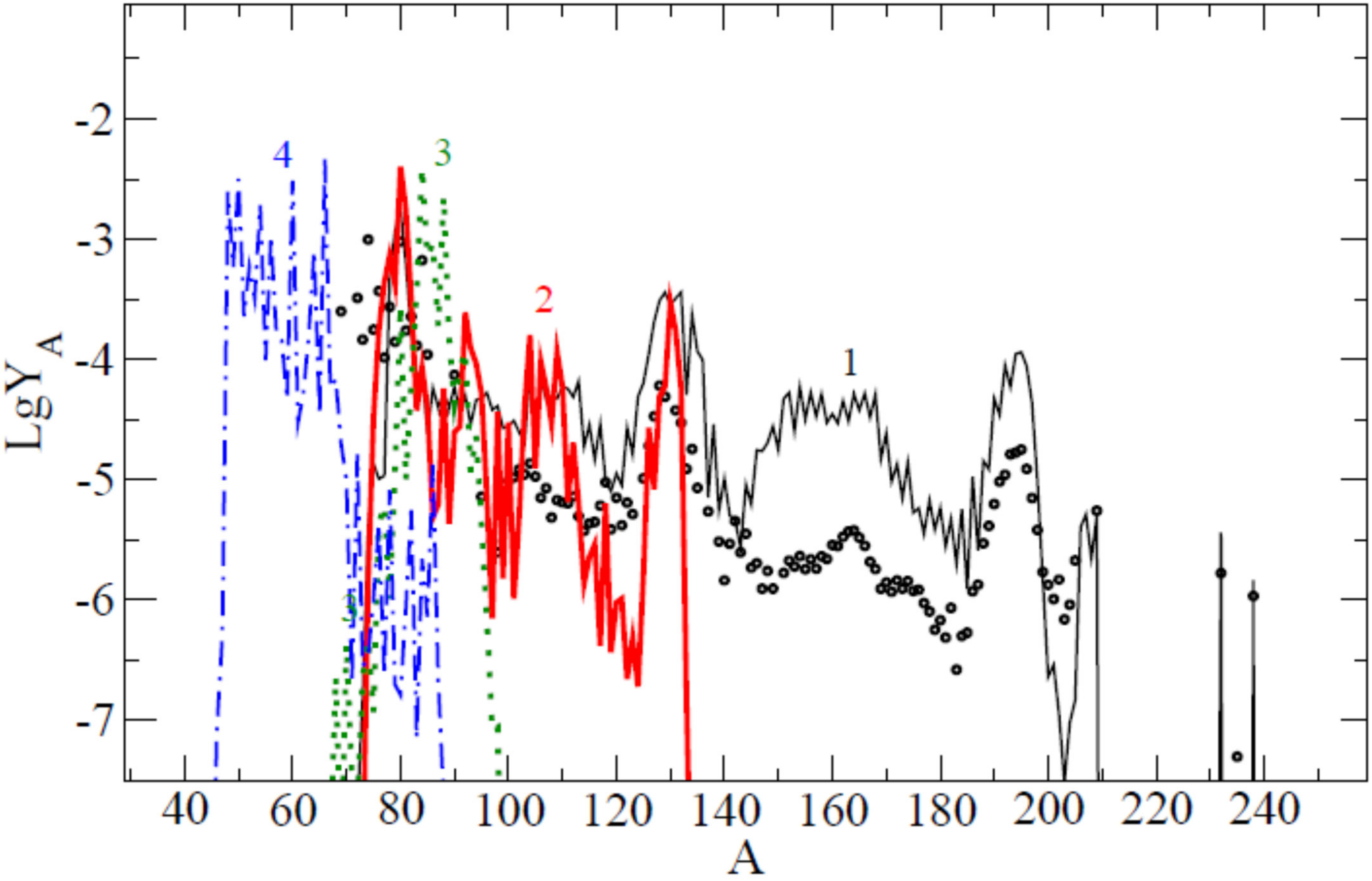
вариант, №	исходный состав	T_9^{max}	ρ_0^{max}, г/см^3	r_0, км	Y_e
1	^{116}Se	0.93	$4 \cdot 10^{11}$	12.5	0.25
2	^{78}Ni	2.5	10^{11}	17.8	0.335
3	^{84}Se	6.3	10^{10}	33.8	0.405
4	^{64}Ni	10	10^{9}	63.5	0.44


9.5
9.0
8.5
8.0
7.5
7.0
6.5
lg ρ (г/см^3)
1
2
3
4
0.36
0.37
0.38
0.39
0.40
10
9
8
7
6
5
4
lg T (K)
4
3
2
1
0.36
0.37
0.38
0.39
0.40
t (сек)

EVOLUTION of Nn along the trajectories



ABUNDANCE OF HEAVY ELEMENTS Y_A AT THE END OF NUCLEOSYNTHESIS



CONCLUSIONS

The original results obtained from our nucleosynthesis calculations in the scenario for the evolution of two NSs with significantly different masses show that in the stripping scenario during the evolution of two NSs part of the crust and mantle matter is neutronized strongly enough for the r-process to proceed in it during the explosion and expansion with the production of a large amount of heavy elements. The abundance curve of the heavy nuclei Y (A) produced during low-mass NS disruption, on the whole, agrees well with both heavy-element abundance observations and heavy-element abundance calculations for a classical NS merger. For some trajectories the heavy-element abundance combines the abundance of the “heavy” fraction of the elemental abundance typical for the ejection in the NS merger scenario and the “light” component forming in the winds from a hot massive neutron remnant in the same NS merger scenario.