The synthesis of p-nuclei in supernova explosion

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The model of p-nucleus synthesis in supernova explosion of a massive star is considered. The calculations are made using a fully implicit scheme.The self-consistent nuclear reaction network, which includes more than 4500 nuclei and (n, γ), (p, γ), (α, γ), (p, n), (α, n), (α, p) reactions and their inverse, is solved in order to obtain mass fractions of isotopes. This reaction network is calculated within the whole presupernova star (for all mass coordinates), excluding the iron core. The presupernova model may be arbitrary. In our test calculations, we use a presupernova model from Ref. [1]. Also, from Ref. [1] we get the mass fractions of light isotopes (including Fe and Ni) as well as density and temperature distributions within the star.

The main feature of the model is that the abundance of s-nuclei after the ejection always corresponds to the observational abundance in the solar system (relative to ^{16}O; Ref. [2]). The initial mass fractions of s-nuclei (at presupernova stage) are selected according to the above condition. The initial mass fractions of p- and r-nuclei are set zero. Therefore, the s-nuclei are seed nuclei for p-isotopes.

Our calculations show that the most favorable conditions for p-nucleus synthesis take place in oxygen layers of the supernova. This fact was known long ago (see, for example, Refs. [2,3]). We are able to obtain in sufficient amounts such p-isotopes as ^{113}In, ^{138}La, and ^{180}Ta.

Finally, we find that the calculated abundance of p-nuclei agrees, in general, with the abundance in the solar system.

References

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