Effect of RADIATIve PROCESSES ON IGNITION of deuterium-tritium plasma containing inert impurities

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The degree of influence of radiative processes on the ignition of deuterium-tritium (DT) plasma depending on the fraction of inert impurites contained therein is theoretically studied. Analytical criterion of inertial confinement fusion (ICF) target is supplemented with taking into account the absorption of thermal plasma emission in the ignition region. The influence of radiative processes is theoretically and numerically investigated on the ignition of DT-plasma containing a significant fraction of impurities, which occurs either as a result of mixing the DT-fuel with the material of ICF-target ablator or when a solid non-cryogenic fuels such as DT-hydrides of light metals are used [1]. Analytical approximation is concluded of the numerically found dependence of radiation energy losses in a spherical target on the ratio of its radius R to the mean free path of the radiation in a plasma containing the inert impurities λr~T7/2<μ>2/ρ2R<Z2><Z> (ρ and T are the plasma density and temperature); <Z>, <Z2>, <μ> are the average values of charge, square charge and atomic weight [2].

Due to the quadratic dependence of the absorption coefficient on the plasma density, the taking into account of thermal radiation effect increases the number of ignition criterion parameters: the plasma density ρ is added to the traditional parameters of the ignition criterion of transparent plasma – areal density ρ*R* and temperature *T*. It is shown that the taking into account of a thermal radiation absorption reduces the negative effect of a presence of inert impurities on the parameters of fast ignitied ICF targets with increasing the density. In the case of DT-fuel mixed with an ablator’s material, when the mass fraction of impurities may be several tens of percent, the taking into account of absorption effect can lead to a 30 ÷ 50 percent reduction in the ignition energy, and in the case of BeDT or NT3BD3 plasmas, when the mass fraction of impurities greater than the mass fraction of DT-isotopes, this effect can lead to reduce the ignition energy by factor 2-3 compared with the calculations in the approximation of a transparent plasma.

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References:

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