The crossover between the kinetic and hydrodynamic stages under relativistic laser exposure

Khokhlov V.A.[1], **Bukharskii N.D.**[2], **Makarov S.S.**[2], **Korneev Ph.A.**[3] **and Inogamov N.A.**[1,@]

[1] Landau Institute for Theoretical Physics of the Russian Academy of Sciences, Akademika Semenova 1a, Chernogolovka, Moscow Region, 142432, Russia
[2] Joint Institute for High Temperatures of the Russian Academy of Sciences, Izhorskaya 13 Bldg˜2, Moscow, 125412, Russia
[3] Lebedev Physical Institute of the Russian Academy of Sciences, Leninsky Avenue 53, Moscow, 119991, Russia

[@] nailinogamov@gmail.com

The effect of a relativistic pulse (I=10^{18} W/cm^2, 32 fs, 800 nm) with very high contrast (i.e., without preplasma) on solid aluminum is considered; paper will be published in JETP Lett. v. 124, No. 11. A non-trivial transformation of the flow is described: from a practically collisionless plasma with field ionization in a skin layer 10 nm thick, on the one hand, to a hydrodynamic regime with mean free paths of the order of interatomic distances and a formed shock wave (SW), on the other hand. At the beginning of the hydrodynamic regime, the SW has an amplitude of 70 Mbar and completely ionizes the aluminum L-shell. Thus, at this stage, the situation is close to the Hugoniot adiabats with shell oscillations effects. Such adiabatic processes were first studied by Soviet scientists in the 1980s (see corresponding Refs and quantum simulations of shell oscillations effects in Kadatskiy, Khishchenko. J. of Phys.: Conf. Series, 653:012079, 2015). Ionization is important for the formation of a densification and the emergence of a SW during the transition from kinetics to hydrodynamics. First, ionization significantly increases the bulk modulus of aluminum. Therefore, the densification forms in the region of incomplete ionization. Second, the electron mean free path and the thermal conductivity coefficient are small in this region. Therefore, the electron pressure gradient pushing densification is greater in this region.