Formation of a cylindrical cavity under the action of a narrow beam hard x-ray laser

Khokhlov V A[1,2], **Inogamov N A**[1,3,2,@] **and Grigoryev S Yu**[3]

[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] Dukhov Research Institute of Automatics (VNIIA), Sushchevskaya 22, Moscow 127055, Russia

[@] nailinogamov@gmail.com

The action of a femtosecond x-ray laser pulse with photon energy of 10 keV on lithium fluoride (LiF) is considered. The attenuation depth of such light in LiF D_{att} is 475 μm, which is much larger than the beam diameter d_0 at the target boundary, that is about 1 μm. The beam divergence is small. So at length D_{att}, the beam diameter only slightly increases compared to the input diameter d_0 [1]. In this work, the internal flow in the target initiated by absorption along the beam length far from the surface is analyzed. The problem is analyzed in the cylindrical symmetry approximation—the sought quantities depend on the radius r and time t. This is acceptable because, firstly, the beam is narrow ($d_0 \ll D_{\mathrm{att}}$) and, secondly, the flow is considered far from the target surface. The absorbed energy density is approximately 100 eV/atom or 0.941 MJ/cm^3, the pressure and temperature in the heated substance at the end of the laser pulse are 10 Mbar and 550 kK. Instead of LiF, the equation of state of aluminum is used in the calculations. The point is that, on the one hand, there is a well-developed wide-range multiphase equation of state for aluminum (developed in JIHT RAS). On the other hand, the mechanical characteristics of these materials are approximately the same (bulk modulus, density) [2].

[1] Makarov S *et al* 2023 *Opt. Express* **31** 26383–26397
[2] Khokhlov V A and Inogamov N A 2022 *Vestnik OIVT RAN* **8** 07