Supercritical radiation-dominated MHD shock wave in multiwire Z-pinches and spectrum of escaping radiation

Tsygvintsev I., Krukovskiy A., Olkhovskaya O., Gasilov V., Sasorov P.

Keldysh Institute of Applied Mathematics RAS, [pavel.sasorov@gmail.com](mailto:pavel.sasorov@gmail.com)

Dense Z-pinches, formed during implosion of tungsten multi-wire arrays in high voltage multi-MA pulse power facilities like Angara-5-1 (TRINITI) or ZR (Sandia, USA), are perspective sources of pulse electromagnetic radiation with multi-TW peak power in the spectral range 0.1-1 keV of photon energies. It is generally accepted now, that conversion of kinetic energy of the imploding plasma shell during the process of its abrupt stagnation near the axis is responsible for the main peak of this emission. Efficiency of this conversion is higher than 90%. Hence time profile of the radiation pulse is almost independent on physical processes responsibly for this conversion. Nevertheless, reliable rescaling of present results to larger pulse power facilities demands sufficiently detailed understanding of physical processes playing significant roles in formation of soft x-ray emission pulse.

As it was shown in Ref. [1], a harder part of emission spectrum (h > 0.2-0.3 keV) during the process of stagnation of tungsten plasma shell are formed under these conditions in a vicinity of supercritical radiation-dominated shock wave, that arises during this stagnation. Meanwhile, a softer part of this spectrum is formed during the process of damping and reabsorbsion of this harder radiation in an ambient, not compressed yet plasma. It means in particular that main information about physical processes in such dense z-pinches is contained in the spectrum of their emission, and not in its absolute value. Ref. [1], however, did not take into account influence of magnetic field on the structure of the radiation-dominated shock wave.

We take into account in the present work existence of magnetic field in stagnating plasma, whereas initial conditions in the imploding shell are matched with results [2] of 3D RMHD simulation of tungsten multi-wire array implosion. We make use of a 1D RMHD code, that allows us to have sufficiently high spatial numerical resolution at the radiation-dominated shock wave interface, in contrast to the code used in Ref. [2].

We will present in the report results of these simulations, and how magnetic field in the imploding shell influences on this picture. We may say on the whole, that the magnetic field does not change qualitatively the general picture of conversion of kinetic energy of the plasma shell into radiation, regardless of the magnetic field changes plasma parameters at the radiation-dominated shock wave.

References

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