

# Self-organizing high energy density plasma via magnetic reconnection in the laser-irradiated rod target

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The interaction between high-intensity laser in the range of  $10^{20-23}$ W/cm<sup>2</sup> and high-Z structured material leads to a high energy density plasma consisting of high energy relativistic electrons, multiply charged high-Z ions, intense X- and  $\gamma$ -rays. In such an exotic state, the secondary interaction between the plasma and the radiation shows specific interesting processes such as multiphoton ionization, photo-nuclear reaction, electron-positron pair creation [1], and so on. Thus it can provide a new platform for studying non-linear quantum electrodynamics and extreme states in astrophysics and for exploring new applications such as heavy ion acceleration [2] and strong  $\gamma$ -ray source, etc. However, before such reaction takes place, the material structure tends to be broken up with the increase of the laser power. Therefore, it is necessary to confine the high energy density state during a certain time period for initiating the interactions of atomic and radiative processes in plasma dynamics.

Here, we propose a self-organized magnetic confinement system composed of an external magnetic field [3] using lattice-like assembled high-Z sub- $\mu$ m rods. In the laser interaction with the system, each rod is ionized to high charge states and then expands to radial direction leading to the compression and reconnection of both the external and self-induced magnetic fields. Magnetic vortexes surrounding the rods through the reconnection process, which is the similar process around geo-magnetosphere, are formed and sustained long after the laser is turned off. It is found that the local magnetic amplitude increases up to 10 times the external magnetic field, and the beta value, which is the ratio of thermal pressure to magnetic pressure, reaches to  $\beta \approx 1$  in the interaction confirmed by our series of simulations. Such a condition is capable to be controlled with the arrangements of the rods and the external magnetic field. We will present the details of the magnetic reconnection and the self-organization processes coupled with atomic and radiation processes.

## References

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