Production and magnetic self-confinement of electron-positron plasma by an extremely intense laser pulse incident on a structured solid target

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An all-optical scheme for producing dense relativistic magnetized electron-positron plasmas is proposed [1]. The scheme involves interaction of an extremely intense ($I \gtrsim 10^{23}$ W/cm^{-2}) circularly polarized laser pulse with a solid target with a conical cavity. The proposed scheme solves three crucial problems of creating pair plasma simultaneously. For producing high-energy seed particles a target with a conical cavity is used, from surface of which the laser efficiently accelerates electrons [2]. "Conversion" of seed particles into a pair plasma with peak density exceeding 10^{24} cm^{-3} occurs in a standing wave-like structure formed due to reflection of the laser pulse from the tip of the cavity. The created pair plasma is confined for hundreds of femtosecond in quasi-static magnetic fields generated during the interaction due to the inverse Faraday effect [3]. Thus, the proposed scheme can be considered as a universal tool for studying the properties of electron-positron plasma in a wide range of parameters, including those relevant for laboratory modeling of exotic astrophysical environments.

[1] Samsonov A and Pukhov A 2024 *arXiv preprint arXiv:2409.09131*
[2] Serebryakov D A, Nerush E N and Kostyukov I Y 2017 *Physics of Plasmas* **24** 123115
[3] Shvets G, Fisch N J and Rax J M 2002 *Physical Review E* **65** 046403