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High Energy Plasma Photonics

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Ultra-intense laser technologies are opening a variety of attractive fields of science and technology using high energy density plasmas. The critical issues in the applications are control of the intense light and the enormous current and energy densities of charged particles. These applications have been usually limited by high power laser technologies and their optics. However, if we have another device consisting of the 4^{th} state of matter, plasma, higher energy density conditions can be more efficiently generated by this device allowing to explore the more extreme application possibilities. We denote this as "high energy plasma photonic devices." One such attractive device has been demonstrated in the fast ignition scheme of the laser fusion, which is cone-guiding of ultra-intense laser light into high density regions.[1] Another invention as a novel 'photonic-like' device is a plasma fibre ($5\mu\mathrm{m}\phi/1\mathrm{mm}$) created on a hollow-cone target.[2] This device guides and collimates the high-density of MeV electrons generated by ultra-intense laser light in a manner akin to a light control by an optical fibre, enhancing the energy density by more than an order of magnitude and possibly generating of Giga-bar pressures. Such plasma devices hold rich promise for a range of applications utilizing enormous energy-densities of relativistic particles and will trigger a tremendous growth in high energy-density charged particle optics.

[1]R. Kodama et al., *Nature* **412**, 798 (2001) ; R. Kodama et al., *Nature* **418**, 933 (2002).
[2]R. Kodama et al., *Nature* **432**, 1005 (2004).