Relativistic Catoptrics

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With his colleagues, S V Bulanov formulated the concept of relativistic plasma mirrors, which can be called Relativistic Catoptrics (from Greek: *κάτοπτρον* katoptron, "mirror"). In the seminal paper published in 1905, A. Einstein used an example of the light reflection from a mirror moving with arbitrarily large velocity to illustrate the basic principles of the special theory of relativity. Nowadays, the electromagnetic field intensification and the frequency upshift during the light reflection from the relativistic mirror are attractive for research on the development of sources of high-brightness radiation with tunable parameters required by various applications, ranging from relatively moderate radiation intensity to those devoted to quantum field theory. In this regard, a question emerges on whether or not it is possible to prepare a relativistic mirror of high enough quality for efficient reflection of light, which can move with a velocity large enough for increasing the light frequency up to the level corresponding to photon energy in the x-ray range. We can find the answer to this question using knowledge in the physics of nonlinear processes in relativistic laser plasmas. Relativistic flying mirrors in laser plasmas are thin, dense electron or electron-ion layers accelerated by high-intensity laser pulses to velocities close to the speed of light. In the head-on-collision configuration, the reflection of the electromagnetic wave from the relativistic mirror leads to the frequency of the reflected wave multiplied by a factor proportional to the square of the mirror Lorentz factor. The expected radiation intensity will reach the level at which the effects predicted by nonlinear quantum electrodynamics start to play a key role. In the co-propagating configuration, the radiation pressure of the electromagnetic wave transfers energy to the mirror, *i.e.*, to the charged particles, providing a highly efficient acceleration mechanism. Here, we overview theoretical and experimental results obtained recently in studying the relativistic mirrors emerging in intense laser-plasma interactions.