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High frequency gravitational waves generation in laser plasma and vacuum interaction

Gravitational waves have recently been detected on the LIGO-VIRGO interferometers [1]. The gravitational waves predicted by Einstein 100 years ago [2], have become a reality and a new astronomy is emerging. We will discuss the possibility of producing gravitational waves using high power laser beams, during laser-matter interaction, and with the laser light only.
The search for gravitational waves (GW) radiated by extraterrestrial sources is carried out by large gravitational interferometer detectors LIGO and VIRGO. However, these detectors address the low frequency spectral band between 10 Hz and 10 kHz. Recently, astrophysical sources of high frequency gravitational waves (HFGW: $\nu > 100$ kHz) radiation were considered and this renew an interest for a GW Hertz experiment [3], which consists in generation and receiving the GW signal on Earth. One of the first considerations of the gravitational Hertz experiment in laboratory was done by Weber [4] in a low frequency domain. In the high frequency domain the possibilities of GW generation in laboratory were considered by Rudenko [5] and by Chapline [6].
In this work, we present analytical estimations and numerical simulations of generation of the HFGW in interaction of high power laser pulse, with a medium in three different situations. First, during the time of laser plasma interaction, a strong shock driven by the ablation pressure is generated in the bulk material. In this configuration a material is accelerated in the shock front and in the ablation zone. Because of a short laser pulse duration HFGW are generated in the GHz domain. Another configuration is a thin foil accelerated by a high ablation pressure produced by the laser heating and ablation. Finally, a HFGW could be produced with high power laser facilities dedicated to the inertial confinement fusion like the National Ignition Facility (NIF in USA), the Laser Mégajoule (LMJ in France), or the European project for the inertial fusion energy HiPER [7]. The laser driven implosion fusion can radiate HFGWs if the implosion of cryogenic deuterium-tritium (DT) micro-sphere would be asymmetric and produce a quadrupolar momentum. Then the fusion reactions produce in central DT core high velocity jets which radiate HFGW in 100 GHz domain during the plasma expansion. Calculations are performed to estimate the luminosity spectrum and energy of GWs emitted by sources that are technologically available now or may be available in near future [8,9].
Another possibility that has not yet been completely explored with high intensity lasers is the generation of gravitational waves with only electromagnetic fields. Indeed, for example, during the passage of an electromagnetic wave in a constant magnetic field a gravitational wave can be generated. This is the Gertseinshtein effect [10,11]. A generalization of this effect, during the laser pulses propagation must allow the generation of gravitational wave more efficiently.
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