Analytical and Numerical Approaches of Bubble Wakefield Acceleration

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The particle accelerators are the most promising and useful devices for mankind. Plasma based accelerators are fascinating as there is no problem of electrical breakdown and these can generate large accelerating fields [1 – 2]. Laser wakefield acceleration is one of the techniques that employs plasma and high intensity laser pulses. Here plasma electrons are expelled by the short intense laser pulse and an electron wave is excited in the plasma which acquires high electric field. This field is used for the particle acceleration. When the laser intensity exceeds some limit, plasma electrons can be expelled by the ponderomotive force of the laser pulse in such a manner that the electrons free region can be created, which is called ions cavity and the situation corresponds to bubble regime [3]. On the other hand, the electrons in plasma wakefield acceleration are expelled by space charge force, creating a blow out or ions cavity in underdense plasma.

In the present work, we focused on the laser generated bubble in underdense plasma. For this, we used different Gauge conditions and obtained wakefield potential for controlling the bubble shape for electrons acceleration with the help of d’Alembert differential equations in electromagnetic field. We also carried out analytical calculations for finding the different shapes of the bubble, enabling us to realize longitudinal and ellipsoid bubbles instead of spherical bubble regime on which people have generally worked on. In addition, we considered the presence of residual electrons in the bubble regime and found that the shape of the bubble can be controlled by the bubble velocity. We also found electric and magnetic fields for different gauge conditions. We use a numerical method to find the trajectory of trapped background plasma electrons in bubble regime [4].

References