# Research Report

## Simulation and Paralleling of the Interaction of Intense Laser Pulses with Dense Plasma

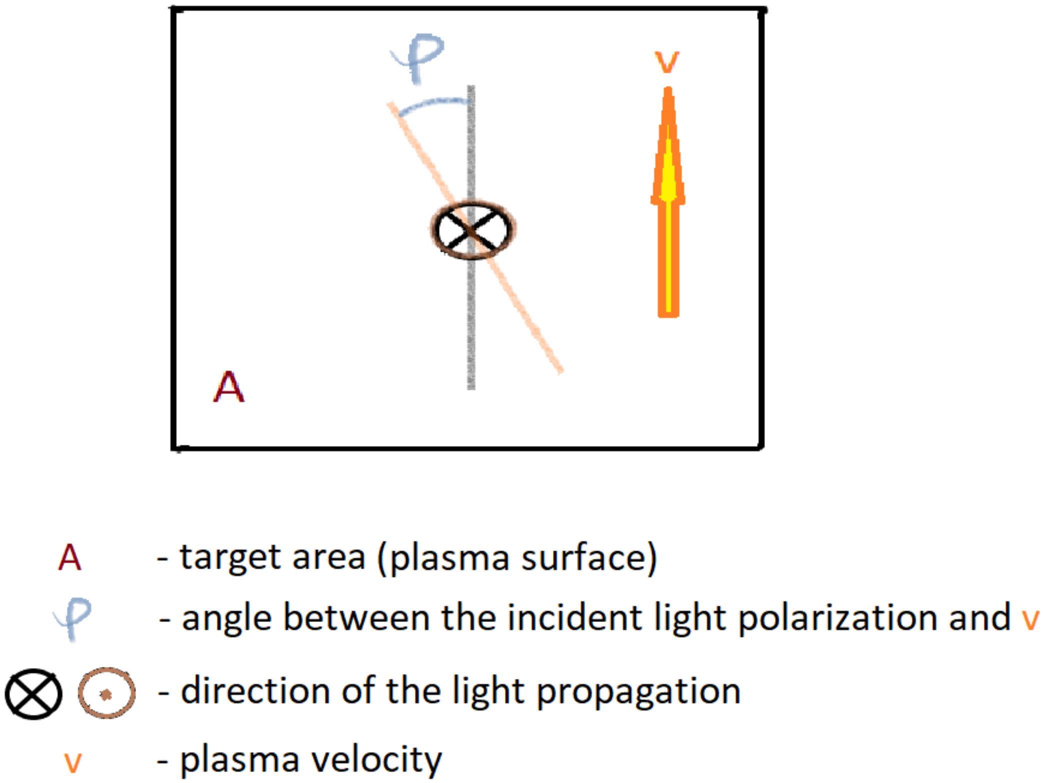
Vladislav Lukoshkin

January 2019

## 1 Problem Statement

In current work we set the numerical experiment on the interaction of a strong laser pulse with a solid-state target. The energy enclosed in light is above the relativistic threshold (orders of GeV). and so, is believed to be enough to transform the affected surface of a target into fully ionized plasma. The angle at which the light hits the surface is arbitrary and may differ from the case of perpendicular incidence geometry. Thus, in general, we have to deal with a 2D problem, however, for the case of a flat static target it is worked around and may be treated as 1D (with respect to the light propagation) by appropriate changing the reference frame with Lorentz transformations. Doing this, we arrive at the following problem formulation shown in the figure 1. Linearly polarized laser pulse is perpendicularly reflected from the surface of moving plasma. For the reflected light the Stokes parameters, which describe its polarization state, are computed using the program written earlier by S.Rykovanov. From these values ellipticity is calculated and further the dependence of reflected light ellipticity from the energy of the incident light and the angle between its polarization and the plasma velocity is studied. An ellipticity value of 0 corresponds to linearly polarized light, 1 - to the circular polarization.

Figure 1: Geometry of the experiment




## 2 Achieved Goals

There are several points accomplished during the project

- analyzing the foreign code (jupyter notebook)
- creating the wrapper above the program for calculating the average and maximum ellipticity over the chosen region
- computing a large number of points in parallel on the Pardus cluster for the next stage of project (3D visualization)
- 2D visualization of the results

# 3 Skills Learned

- naive parallel computing (”full parallelism”)
- basics of working on a cluster

# 4 Results

The results presented below are computed on a grid of 1000 nodes for $\phi \in [0, 2\pi)$ (angular partition is about 60 points) and consts (light amplitudes) in set$(0.1, 1, 2, 5, 10)$. The chosen range spectrum is $[2, 5]$. One can already notice that the surges ”direction” changes with the laser pulse energy to the opposite and sinusoidal form of the mean-max ellipticity is inherent only to some range of energies. So, from obtained plots some interesting inferences can be made. However it is beyond of the scope of this research.

Figure 2: Mean-max ellipticity vs. angle between the incident light polarization and the "plasma velocity" (for different amplitudes of the falling light - "consts")