Influence of collective processes on temperature and ion charge state distribution in laser plasmas expanding into vacuum

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Ion charge state distribution in laser produced plasma undergoes changes during its expansion into vacuum. These changes depend to a great extent on a rate of electron temperature decrease. A right computation of electron temperature at a large range of distances from a target requires taking into account not only the energy balance during expansion (particularly, recombination heating) but also the fact that the hydrodynamic approach to plasma consideration becomes not valid starting from some moment.

A 2D3V PIC numerical code merged with Monte Carlo collision has been developed to simulate a late stage of plasma expansion in the kinetic approach. The results of calculation indicate that under some conditions collective processes support rather high level of electron temperature during a whole stage of plasma expansion. It in turn leads to increase in ionization degree and to increase in the number of multiply charged ions in a far region of plasma expansion.

The numerical results are compared with experimental measurements of ion charge state distribution. It is shown that some discrepancies between hydrodynamic model and experimental data which were observed earlier under certain conditions were caused by the underestimation of electron temperature.