Comparison of Transient Plasmas Produced by Nanosecond Laser Pulses and Hypervelocity Impact via Time-Resolved Emission Spectroscopy

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In this work the dynamics of impact plasmas is compared to plasmas generated by nanosecond laser pulses. Impact plasmas are formed during the collision of objects in the velocity range of several kilometers per second which is relevant for aerospace applications. While the laser produced plasmas were widely explored in the past, the knowledge about the dynamics of impact plasmas is less comprehensive. Experiments investigating the impact plasma are carried out using a two stage light gas accelerator, while laser produced plasmas are generated by a nanosecond laser with a pulse duration of 15 ns and a pulse energy of up to 400 mJ. Time resolved spectroscopy is used to determine plasma parameters. With a measurement system consisting of spectrograph and streak camera, the emission spectra of plasma with a lifetime of a few microseconds is recorded time resolved.

For the evaluation of the experimental data, a model was developed to determine relevant plasma parameters like electron density and electron temperature. During expansion plasma conditions are changing from optically thick to optically thin and therefore a noticeable change in spectral characteristic is observable. To obtain plasma parameter for optical thick plasma the radiative transfer is included and a spectrum depending on the electron density and temperature is simulated. For optically thin plasma electron density and electron temperature are determined from the line width and the ratio of line to continuum radiation. The dynamics of laser produced plasma and impact plasma are compared.