IN SEARCH OF EQUILIBRIUM IN LASER-PRODUCED CLOUD: ROLE OF PRESSURE, CHEMICAL QUENCHING, AND PLASMA EXPANSION

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The properties of laser plasma vary significantly depending on the pressure and composition of the environment, thus it a promising emission source to imitate of radiation from various objects in atmosphere (meteor wake, airglow) and in outer space. We aimed to register spectra of FeO and CaO bands in laser plasma as close as possible to the ones observed during the Benešov bolide event to reconstruct the composition and behavior of meteor wake.

We fit synthetic spectra of spontaneous vatying temperatures in the region of 1000-8000 K for the infrared system of CaO molecules to those measured in laser-induced plasma. It was found that the excitation (atomic species), vibrational and rotational temperatures of the experimental spectra indicate the absence of local thermodynamic equilibrium (LTE) and does not coincide with each other. The atomic excitation temperature are close to 10000 , vibrational temperature varies in the range of 3500–5000 K, while the rotational temperature is noticeably lower than 2000–3000 K. Moreover, the specific values of rotational temperatures vary greatly from band to band. We also found the valuable deviation of lines wavelengths and transition probabilities between model spectra based on EXOMOL data.

Calculations of the chemical composition of laser-produced clouds formed by laser heating of Fe and $CaCO_3$ targets were performed. Timescales of main reactions with participation of Fe- and Ca- containing species were calculated using rate constants of the reactions. Results of calculations of equilibrium composition of laser-produced and impact-produced clouds are presented. Quenching conditions of chemical reactions in laser-produced and impact-produced clouds are found.

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