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THEORETICAL AND EXPERIMENTAL STUDY OF THE KINETICS OF ELECTRONICALLY EXCITED MOLECULAR NITROGEN IN SPRITES AND DISCHARGE CHAMBER *)

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Sprites are mesospheric discharges that release and accelerate a large number of electrons. Their appearance forms impulses of optical radiation in various spectral regions and the formation of some chemical components.

To study the properties of sprites, a model of the electron kinetics of molecular nitrogen for altitudes of 40-90 km of the Earth's atmosphere under conditions of an electric discharge with a impulse duration of several microseconds was developed. The model includes the kinetics of triplet ($A^3\Sigma_u^+$, $B^3\Pi_g$, $W^3\Delta_u$, $B'^3\Sigma_u^-$, $C^3\Pi_u$) electronically excited states of N_2, taking into account the transfer of excitation energy during inelastic molecular collisions and spontaneous radiative transitions [1,2]. The model allows calculating the intensities of the emission bands of the first (radiative transitions $B^3\Pi_g \rightarrow A^3\Sigma_u^+$) and second (radiative transitions $C^3\Pi_u \rightarrow B^3\Pi_g$) positive systems of N_2 both in the N_2-O_2 mixture and in pure nitrogen during electric discharges. The results of modeling the emission spectra of nitrogen in the bands of the first and second positive systems are compared with the results of experimental measurements at pressures corresponding to altitudes above ground level of 40-90 km. It has been shown theoretically and experimentally that inelastic molecular collisions with increasing density of the medium lead to a significant decrease in the populations of the vibrational levels of the $B^3\Pi_g$ state and a decrease in the emission intensities of the bands of the first positive system of molecular nitrogen N_2.

For experimental studies, two setups with discharge chambers made from quartz tubes with internal diameters of 5 and 8 cm were prepared. Three sections were used in the second setup, which ensures the excitation of low-pressure air and nitrogen with different durations of discharge current pulses, including microsecond and millisecond. Generators operating at different pulse repetition rates were also created. Preliminary measurements of the emission spectra for nitrogen and air in the range of 250-1000 nm were carried out on these setups at pressures corresponding to altitudes above ground level of 40-90 km [3,4].

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