

CHEMICAL PHYSICS

OF ATMOSPHERIC PHENOMENA

**Optical Methods for Detecting and Tracking  
Moving Objects in the Atmosphere**

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**Abstract**—Progress in the development of infrared (IR) laser diodes, photodetector elements of matrices in the visible and IR ranges, lidar systems allows the use of optical location methods to detect and track moving objects in the atmosphere. This is primarily related to unmanned aerial vehicles (UAVs), which are widely used in many areas of human activity. This paper describes an experimental setup that makes it possible to detect a moving object in the atmosphere at a distance of more than 1 km, determine the distance to it, and automatically track it. The installation consists of a matrix photodetector of the visible and IR ranges, an active illumination source in the form of an IR laser diode emitting at a wavelength of  $\lambda = 808$  nm with an output power of 30 W, and an IR lidar module with an energy per pulse of up to 15 mJ, emitting at a wavelength of  $\lambda = 1540$  nm. It is shown that a combination of passive and active optical methods makes it possible to detect moving objects in the atmosphere, such as aerosol clouds or UAVs. For the automatic detection of moving objects of various types in the process of image processing in the visible and IR ranges, deep learning methods (convolutional neural networks) are used. With the help of the described installation, the linear dimensions of UAVs were estimated on routes of up to 1 km.

**Keywords:** optical location, detection, unmanned aerial vehicle, lidar, deep learning, atmospheric monitoring

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