ON POLARIZATION CHARACTERISTICS OF AN LD–LIDAR

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This paper presents the method of rotation of polarization plane of an incoming radiation in autodyne lidar by inserting a λ/4 plate into an optical channel. This addition allows us to detect the polarization characteristics of a target and makes autodyne lidar signals more informative.

As is well known,[1–3] reception of radiation reflected from a target by a transmitting laser in laser detection (LD) lidars has a number of advantages, namely, high limiting sensitivity, narrow band, collocated lidar configuration, and therefore small overall dimensions as well as simplified aiming at a target.

An original schematic solution proposed in Ref. 2 involves reception of radiation reflected from a window of the GL–501 type active element of a CO_2–laser oriented at Brewster's angle, has a simple construction with the minimum number of optical parts, and provides protection of a receiver of radiation against overloading due to abrupt changes of radiation power of a CO_2–laser in the processes of wavelength tuning and aiming of lidar.

At the same time the obvious fact should be noted that the use of the window oriented at Brewster's angle as a beam splitter permits the detection of only the depolarization component of radiation reflected from target that substantially reduces the real sensitivity of LD–lidar and makes the signals less informative.

In the present paper we propose to rotate through 90° the plane of polarization of the radiation reflected from a target and thereby to detect a polarized component along with recording of depolarized component according to ordinary scheme, what makes the signal more informative.

To do this, we propose to insert into optical channel a converter of linear polarization of the CO_2–laser radiation to circular polarization in the form of a λ/4 plate. Such a modification allows us to study the polarization characteristics of a target.

Block diagram of the modified LD–lidar is shown in Fig. 1.

The tunable CO_2–laser consisting of the GL–501 type active element *1*, the difraction grating *2*, the tuning mirror *3*, and the diaphragm *4* has an output linearly polarized radiation due to the window oriented at Brewster's angle inserted into the active element. The linearly polarized radiation is directed to the λ/4 plate *5*, converted to circular, and directed to the receiving–transmitting telescope of the Cassegrain type *6* and *7* and further to the target *8*. A part of radiation is directed from the window of the active element through the lens *9* to the receiver *10*.

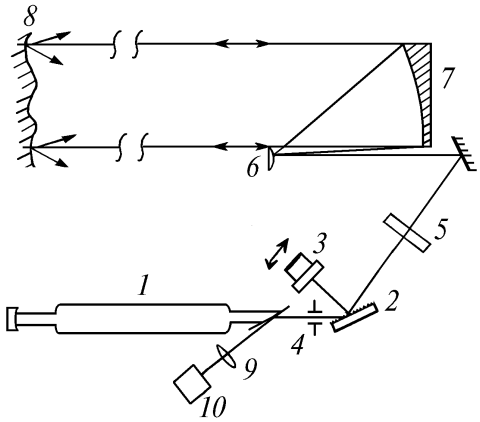

FIG. 1. Block diagram of the modified LD–lidar.

The circularly polarized radiation reflected from the target is collected with the receiving–transmitting telescope *6* and *7* and passes once again through the λ/4 plate *5*. Due to the double passage of radiation through the λ/4 plate, the phase difference reaches half the wavelength, and the polarization plane is rotated through 90°.

Such a scheme of application of the λ/4 plate is widely used in heterodyne lidars operating with one telescope in collocated configuration.[4]

So the radiation, whose polarization plane is perpendicular to the polarization plane of the output radiation, is incident on the window of the active element. A part of radiation is reflected on the photodetector, while its another part passes through the active element of the laser and after many–fold amplification is also incident on the photodetector.

As is clear from the above discussion, such a scheme of LD–lidar, retaining the advantages of its prototype, can provide an increase in sensitivity due to an increased part of reflected radiation being amplified in the active element and polarized in the plane which provides its more effective splitting on the photodetector. The most important advantage of such a scheme is that it allows us to study the polarized and depolarized components of the reflected radiation.

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Preliminary tests of the LD–lidar embodying the above–described scheme have shown its efficiency. In this case the $\lambda/4$ plate inserted into the channel at least does not reduce the signal of the photodetector, because the losses due to the plate are apparently compensated by an increase in the power of the linearly polarized reflected signal.

Thus,this modification allows us to study the polarization characteristics of a target. To do this, the $\lambda/4$ plate is inserted into the channel or is removed from it, and polarized or depolarized component of the reflected radiation is recorded. This essentially extends the range of application of the LD–lidar.

REFERENCES

1. A.P. Godlevskii, E.P. Gordov, A.Z. Fasliev, Ya.Ya. Ponurovskii, and P.P. Sharin, Appl. Opt. **26**, No. 8, 1607–1612 (1987).
2. E.P. Gordov, A.P. Godlevskii, A.I. Zhiliba, and P.P. Sharin, Atm. Opt. **3**, No. 1, 20–25 (1990).
3. V.E. Zuev, A.P. Godlevskii, Yu.D. Kopytin, S.V. Lasarev, and P.P. Sharin, Opt. Commun. **62**, No. 6, 370–373 (1987).
4. G.N. Pearson and B.J. Rye, Technical Digest Series **12**, 64–65 (1991).