COHERENT LIDARS BASED ON INTRACAVITY HETERODYNING OF ECHO SIGNALS

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This paper presents the development and technical realization of the method of laser sounding of the atmosphere based on the effects of mixing of reference and external fields of scattering inside a laser cavity.

An approximate theory of the method has been developed on the basis of the investigations using the model of a three-mirror laser. The nonlinear effect of a wide-band laser on frequency-dependent external influences of the atmosphere is investigated. It is shown that at synchronous detection of external radiation the spectral sensitivity of a laser receiver is comparable with the sensitivity of the method of intracavity laser spectroscopy and in the case of incoherent reception it decreases by the value $\sim r_{eff}\alpha/\ell$ and in the case of coherent reception the spectral sensitivity decreases by the value $\sqrt{r_{eff}\bar{b}\alpha/2\ell}$. Here α and ℓ are the length of atmospheric path and the cavity length, respectively; r_{eff} is the coefficient of effective scattering, characterizing the energy introduced into the laser cavity, $\bar{b}$ is the coefficient of space-time field coherence in the plane of receiving-transmitting laser aperture. In the narrow-band (gaseous) lasers both the spectral sensitivity and the sensitivity to external influence can be increased due to competition of simultaneously generating transitions connected by the common laser level. The experimentally obtained values of sensitivities to selective and external influences of a CO_2-laser at two-wave generation are 5-8 and 2-3 times greater, respectively, than sensitivities at single-wave generation.

The experiments on comparison of sensitivity of coherent reception at intracavity photomixing of reference and scattered radiation in the case of single-wave CO_2 laser generation and at photomixing directly on a photoreceiver have shown that the sensitivity of intracavity laser reception is more than one order of magnitude higher than that of the commercial cooled receivers and was 10^{-12} W/Hz.

The field measurements of gaseous composition of the atmosphere have been carried out on the basis of a given method of coherent reception using a tunable CO_2 laser.