METHODS FOR ESTIMATING THE OPTICAL CONSTANTS
OF ATMOSPHERIC HAZES BASED ON COMPLEX OPTICAL
MEASUREMENTS

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The methods of multifrequency laser sounding (MLS) are
the most effective remote methods for investigating the atmos-
pheric aerosols, since they have made it possible to obtain
complete information on aerosol microstructure and the effecti-
ve methods for estimating the aerosol optical constants can be
developed.

The MLS data interpretation consists in the solution of
the set of equations containing those of laser sounding and
equations for polydispersed optical characteristics. As a rule,
the laser sounding equation is written in the approximation
of single scattering and the equations for optical characteris-
tics are written assuming that the atmospheric aerosol is for-
med by spherical and homogeneous particles.

The above assumptions correspond to the characteristics
of atmospheric aerosol only in a certain approximation. However,
an analysis of equations in this case is very useful, indica-
ting the peculiarities of interpreting the MLS data in most ge-
neral cases. Moreover, such analysis allows the development of
general methods for interpretation of optical measurements on
the basis of simple examples.

The above set of equations of the MLS method has two pecu-
liarities. The first one is associated with the solution of in-
correct inverse problems and is studied completely at present.
The second one is typical for interpreting the optical measure-
ments and is due to indeterminacy of equations relative to op-
tical constants.

To remove the indeterminacy of equations the authors have
suggested the method of optical sounding of atmospheric aero-
sol, consisting in a joint use of a multifrequency lidar and
a spectral photometer in common geometrical scheme of the opti-
cal experiment. The method is used for investigating aerosols
in the cases when absorption by particles is small and indica-
tes the minimum necessary for interpretation of a series of measure-
ments. The scheme is given in Fig.1. The spectral photometer 3,
the light source 4 and the reflecting screen 5 are intended
for measuring the scattering radiation coefficients within the
atmospheric layer from the lidar 1 up to the scattering volume 2.

The basis of the method is the numerical solution of equ-
ation $f(m, \lambda) = \tilde{\beta}_{sc}(\lambda)$, where $\tilde{\beta}_{sc}(\lambda)$ is the value of the
scattering coefficient measured with the photometer, and $f(m, \lambda)$
is a certain additional function calculated in the process of
the MLS data interpretation. The function $f(m, \lambda)$ in the sche-
me of the MLS data inversion gives the predicted values of
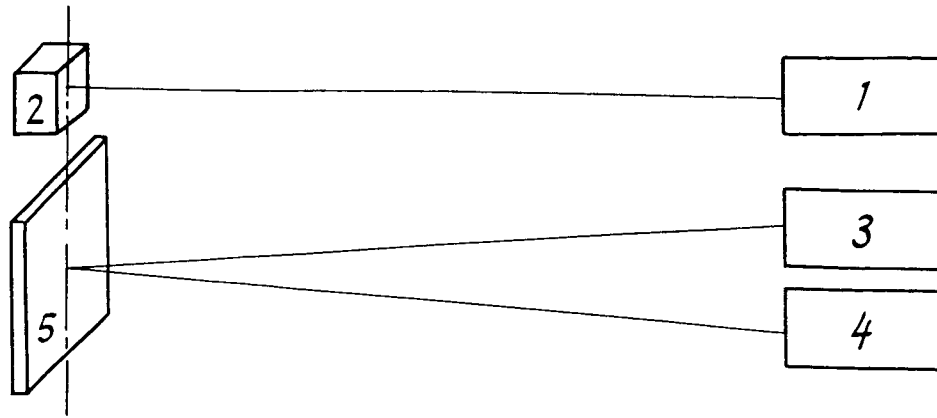$\beta_{sc}(\lambda)$ with variable m. This function can be called conditio-

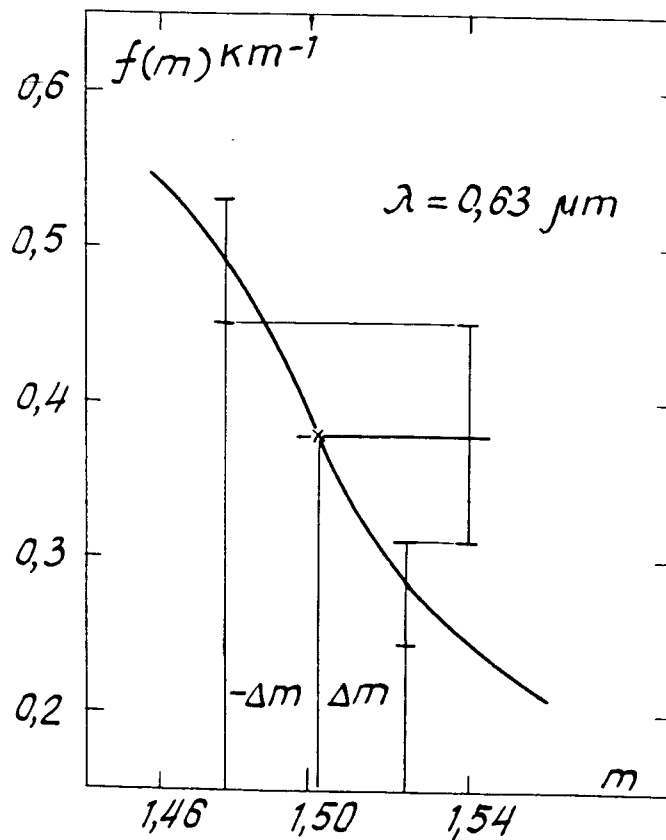Fig.1. Scheme of the complex optical experiment on investigation of atmospheric aerosol parameters.

Fig.2. Example of determining m using the solution of equation $f(m, \lambda) = \tilde{\beta}_{3c}(\lambda)$ when interpreting the MLS data.

nally as a correction function, since it allows not only de-
termination of optical constants but also calculation of the
distribution function, representing more completely the aero-
sol microstructure.

An example of determination of optical constants using
the above method is given in Fig.2. The correction function
for the 0.63 μm wavelength was calculated while interpreting
the data on three-frequency laser sounding (λ = 0.53, 0.69
and 1.06 μm). The value of the extinction coefficient measu-
red with the photometer (straight line) allows the determina-
tion of m ≃ 1.50. If the lidar measurements are made with an
error ± 10% and the photometer measurements error is ± 20%,
then, as follows from the figure, the error Δ m in the deter-
mination of optical constants is equal to ± 0.025. The decre-
ase of the photometric measurements error up to ± 10% results
in Δ m = ± 0.012.

The method developed by the authors was used when soun-
ding the surface aerosol. The obtained values of optical com-
ponents and the data on aerosol microstructure for a number
of measurements are in agreement with the results of direct
measurements.