flights over mountainous regions, which detected a decrease in radiobrightness due to the lower temperatures of areas at high elevations above sea level[5,6].

In 1973-1974, aircraft instruments registered radiobrightness contrasts caused by the appearance of foci of geothermal activity in the Kamchatka region. The performance of measurements in several bands of the spectrum makes it possible to obtain estimates of the geothermal gradient and the strength of the heat source.

Local heating foci due to forest and peatfield fires can be detected by the radiothemal survey through clouds and smoke.


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**Yu. M. Chesnokov and V. A. Kottsov.** Selection of Spectral Sensitivity for Optical Systems Used in Studying the Earth from Space. The spectral brightnesses of elements of the earth's natural landscapes are recognition criteria for these elements. The choice of spectral sensitivity in a surveying system determines the use that is made of the spectral differences between the objects photographed, assuming that they are spatially resolved.

Since technical difficulties impose limits on the spectral and spatial resolution possibilities inherent in the optical systems, the problem of optimizing parameters arises. We treat the surveying system as an analog device that performs integral conversions on the optical-characteristic fields of the objects. By evaluating the resulting image in terms of the object brightnesses, we can discuss the performance of the surveying system within the framework of a linear theory.

When spatial resolution conditions are met, the spectral sensitivity of the surveying system can be optimized on the basis of analysis of a priori data on the surveyed objects for a specified optimality criterion. To this end, let us introduce the object-space concept. It characterizes the object uniquely for a given range of wavelengths and, in the general case, is a Hilbert space. Each of the objects on the landscape is represented in the object space by a vector whose position is determined by the brightness distribution over the spectrum, while its norm is given by the integral brightness in the specified spectral band.

The construction of a set of images consists in mapping of a finite number of surveyed objects represented in an infinite-dimensional space onto a finite-dimensional image space. Each image is formed by a scalar product. At unit sensitivity of the surveying system, formation of an image means projection of the vector characterizing the surveyed object onto the spectral-sensitivity vector of the surveying system. The number of independent surveying-system channels determines the number of dimensions of the image space.

We choose the spectral response curve of the surveying system on the basis of an optimality criterion. This criterion may vary depending on the nature of the problems to be solved[1]. For example, to distinguish an object against its background, given the maximum signal/noise ratio, it is necessary to perform a mapping onto a vector collinear with the object-difference vector.

In view of the variety of natural objects and the many purposes for which the results of a space survey will be used, we choose an optimality criterion in the statistical sense. We find the spectral characteristics of the surveying system to represent the maximum differences with a minimum number of channels. Generality of problem formulation implies the criterion of maximum brightness dispersion, and the results in different channels should yield different information. The Carounin-Loew expansion[2] can be used as a solution for choosing the spectral sensitivity of the surveying system in the sense of the brightness dispersion of the images obtained.

The set of objects composing each of the landscape types is limited, and the effects of the set of miscellaneous factors make it possible to regard the spectral brightness of each of the objects as a realization of a random process. After consideration of the mean spectral-brightness value of the ensemble of objects, the Loew expansion makes it possible to obtain an optimum finite-dimensional basis for representation of the ensemble of objects. The norm of the error for representation of the individual realizations, averaging over the ensemble of objects, will be minimal. Geometrically, the expansion can be represented as successive determinations of pairwise orthogonal vectors in the direction of maximum dispersion. The instrumental and methodological errors determine the error norm obtained and limit the required number of channels.

A priori optimization requires knowledge of the spectral brightnesses of the objects under survey conditions. The optical characteristics of the objects have not yet been studied adequately for final solution of the problem. About 2000 spectral response curves suitable for the design of surveying systems have been obtained for natural-landscape features on the territory of our country, but the flora of the USSR alone runs to 15,000 species of plants. For joint analysis, we used only data obtained by a single instrument under metholgically comparable conditions. The mean standard atmosphere was used in the calculations.

To choose the spectral response curves, we analyzed various ensembles of natural objects on a computer. These included various classes of natural objects, the most important rock-forming minerals, arable lands, deciduous forests in various phases of vegetation, etc. The dispersion drops off rapidly, so that it is possible to limit the expansion to 3-5 terms. Joint analysis of the results indicated that the spectral sensitivity functions are quite smooth and change sign, requiring piecewise realization by zones 60-100 mm wide. The shapes and positions of the zones are different in different ensembles. Broad zones correspond to high dispersions. Similar ensembles of objects give similar basic functions for different landscapes. The various ensembles contain functions of typical form that characterize the factorial dependence.

Recognizing the statistical nature of the selection, we made a joint evaluation of the results to satisfy various problems represented by different initial ensembles. A surveying-system variant with piecewise realization by multizone photography was used on the Soyuz 12 and Soyuz 13 spacecraft. A posteriori optimization by the method of principal components for combinations of photographing zones yields a result that is comparable with respect to the positions and sign changes of the zones. Different optimum zone combinations correspond to different landscapes on the photographs, but similar landscapes produce a stable combination of zones. Inadequate correction for the real atmosphere, the differences between the a priori and a posteriori ensembles, and the possibilities of technical realization make it impossible to require full identity of the results. Photometric evaluation made it possible to establish double the brightness dispersion in the synthesized image.

The problem of optimizing the parameters for optical systems for study of the earth requires broad investigation of the optical characteristics of natural objects and selection of sound criteria. Work in this area will result in the development of controllable surveying systems with strongly condensed information.

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**R. I. Personov.** The Sharp Narrowing of Spectral Bands of Organic Molecules Under Laser Excitation.

1. It is known that the electron-vibrational spectra of polyatomic organic molecules in solutions are generally diffuse, consisting of one or more broad bands (with widths in the hundreds of $cm^{-1}$). The question as to why these spectra are diffuse is of fundamental theoretical and applied importance. It is important to understand whether the diffuseness of the spectrum is due to broadening of intramolecular levels or to interaction with the environment. Do the broad bands have unresolved internal structure? Is there some method by which this structure could be resolved?

In 1952, Shpol'skiĭ, Il'ina, and Klimova[1] observed that, when placed in solvents of a certain type (in crystallized short-chain n-paraffins) at low temperatures, many organic compounds produce luminescence and absorption spectra that consist not of diffuse bands, but of large numbers of narrow lines ( a few $cm^{-1}$ in width). The narrow lines in the Shpol'skiĭ quasiline spectra correspond to vibronic transitions in impurity molecules in which the vibrational state of the n-paraffinic matrix does not change[2]. These phononless lines (PLL) are accompanied by broad phonon wings (PW) and can be regarded as optical analogs of Mössbauer resonant $\gamma$ lines (as is done in the case of other mixed organic and inorganic crystals[3]).

However, the possibility of obtaining quasiline spectra in specifically chosen n-paraffin matrices does not resolve the general problem of the origin of the diffuse spectra in arbitrary solvents, in which the bands usually remain diffuse all the way down to helium temperatures. The present paper is concerned with the results of experimental studies of this problem (conducted during the past few years at the USSR Academy of Sciences Institute of Spectroscopy's Laboratory of Electron Spectra). They are based on the observed phenomenon in which fine structure appears in the fluorescence spectra of complex molecules in frozen solutions under monochromatic laser excitation[4a].

2. It was established in [4] for various aromatic hydrocarbons, porphyrines, and dyes that on transition from ordinary methods of luminescence excitation (mercury and xenon lamps) to excitation by narrow (~0.1 $cm^{-1}$) gas-laser lines in the region of the 0-0 transition (and the lowest vibron transitions) and at sufficiently low temperatures, the emission spectrum undergoes an abrupt transformation: instead of a few diffuse bands it consists of a large number of narrow lines. The narrowest lines are a few tenths of a $cm^{-1}$ in width. As an example, the figure shows segments of the fluorescence spectra of solutions of four substances (the first three in ethanol, the fourth in paraffin oil) under excitation by broadband sources (dashed) and under laser excitation (solid lines) at 4.2°K[4b,c;5]. The effect in which the fine structure of the spectrum appears under laser excitation is observed in a very wide variety of solvents (crystalline and vitreous, polar and nonpolar). Analysis indicates that the narrow PLL correspond to electronic vibrational transitions in the molecules of the dissolved