Although the effect of interstellar scattering requires further study, it can nevertheless be stated on the basis of the available data that there are no significant limitations on cosmic interferometry in the decimeter and shorter-wave bands.

In conclusion, we list the main advantages of radioastronomical investigations in outer space, which in our opinion will cause all the major radio telescopes of the future to be constructed outside the earth:

1. Possibility of producing very large mirrors, ensuring an unlimited increase of sensitivity.
2. Realization of very large bases, ensuring a high angular resolution.
3. A sharp decrease of the level of natural and artificial noise and of the influence of the earth's atmosphere.
4. The feasibility of a very prolonged continuous investigation and accumulation of the signal.

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V. L. Indebom and F. N. Chukhovskiĭ. X-ray Optics

X-ray optics of almost perfect crystals, based on the dynamic theory of x-rays, has seen a rapid development in recent years in connection with the appearance of new methods of using crystals in science and engineering, in which more and more perfect single crystals are required. X-ray diffraction study has proceeded from the analysis, in the kinematic approximation, of line shapes on Debye patterns or spots on Laue patterns, to x-ray topographic methods that give a dynamic image of the internal structure of the crystal in one Laue reflection, with a resolution that ensures the display and identification of individual dislocations.

A specific feature of the x-ray diffraction image, unlike the optical or electron-microscope image, is the ratio of the radiation wavelength λ to the interatomic distance d. Whereas in optics $\lambda \gg d$ and in electron microscopy $\lambda \ll d$, for x-rays we have $\lambda/d \lesssim 1$ and accordingly the diffraction angle is of the order of unity. As a result the crystal regions that take part in the formation of each detail of the x-ray image have large dimensions not only in the transmission direction but also in the transverse direction. Whereas an electron-microscope image can be regarded as consisting of points, each of which depicts the structure of the sample along the transmission direction (the column approximation), in x-ray topography the image should more readily be regarded as made up of lines, and to each point in the crystal there corresponds a small strip of length on the order of the sample thickness. Overlap of the geometric and diffraction images, rarely encountered in optics and in electron microscopy, is a general rule in x-ray topography.

The paper considers the dynamic theory of formation of the x-ray image, based on the representation of the x-ray field in the form of spatially-inhomogeneous wave packets. The homogeneous and inhomogeneous fields in an ideal crystal are investigated, the contribution of the Bloch waves of different types are separated (including waves with large free path lengths, causing anomalous transmission of x-rays), influence functions describing the propagation of the local perturbation are constructed, and the images of slits, screens, and various volume inclusions are analyzed. It is shown that the influence function makes it possible to construct directly the wave field for an arbitrary distribution of the incident radiation on the crystal surface, and also to reveal the main details of the image of volume defects of the crystal. In many cases these details are due to the character of the influence functions, and not to the character of the object whose image is produced. A general theory is constructed for the image of a crystal with a known distortion field, and in particular cases are indicated in which simple analytic estimates can be obtained. The geometrical optics of x-rays is discussed. An analogy is established between the ray trajectories and the motion of charged particles in an electric field. The constant field corresponds to homogeneous bending of the crystal, and the vibrational motion of particles in a potential well corresponds to motion of x-rays in waveguides. Conditions are derived for reflection and refraction of rays on going through an interface. A general method is developed for the construction of an analytic solution of the equation for the wave field in a crystal in the geometrical optics approximation. For weakly distorted crystals, the solution of the image problem is given in explicit form. A method is proposed for investigating the asymptotic behavior of the wave field for a two-dimensional distortion field; this method facilitates the analysis of the image for a thick crystal and makes it possible to take directly into account effects of the type of total internal reflection, appearance of waveguides or shadows, etc.

Compared with the theory of the electron-microscope diffraction image, the theory of the x-ray image has made only the first steps. Many devices for the analysis of the image, used in electron microscopy, still have no analogs in x-ray topography. The variety of possible cases and the complexity of the numerical methods for calculating the image make it difficult to compile charts of images of typical lattice defects. Most problems, however, as shown in the paper, admit of effective qualitative and even quantitative investigation leading to a solution of the image-analysis problem in practical cases.

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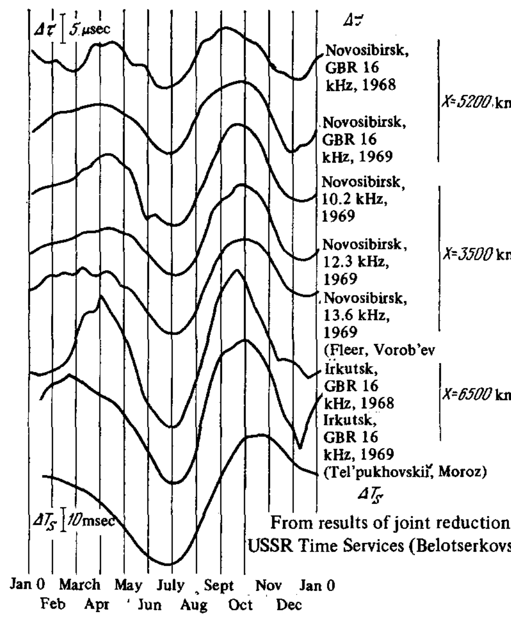
A. G. Fleer, Correlation between Changes in the Phase Velocity of Propagation of Ultralong Radio Waves and of the Earth's Motion about the Mass Center

Investigations of the seasonal changes of the maximal values of the daily phase delays $\Delta\tau$ of ultralong radio waves along different routes of approximately latitudinal orientation had led the author to the conclusion that there exists a correlation between the changes of the difference between the daytime and nighttime values of the phase velocity of ultralong radio waves (ULW) and the changes of the angular velocity of the earth's rotation. This result was obtained by comparing $\Delta\tau$ with the changes of the durations of the days ΔT_S (see the figure). The mean value of the coefficient of mutual correlation of these quantities, in accordance with data of 1969, is equal to −0.63. The spectral composition of the $\Delta\tau(t)$ and $\Delta T_S(t)$ curves is practically the same and is given in the table. The ratio of the amplitudes of waves with different periods inside the spectra of both $\Delta\tau(t)$ and $\Delta T_S(t)$ is the same and agrees with the predictions of the theory of tides. The only exception is the amplitude of the annual component of ΔT_S, part of which is apparently not connected with the effect under consideration. The derivatives of the amplitudes of certain of the investigated components of $\Delta\tau(t)$ with respect to time, according to the data of 1965–1969, correlate well with the analogous values of $\Delta T_S(t)$. The phase of the annual wave and of the wave with period 0.33 year experience identical time variations in both $\Delta\tau(t)$ and $\Delta T_S(t)$ in an interval 2–2.5 months. The phase changes of the investigated components of $\Delta\tau(t)$ and $\Delta T_S(t)$, in accord with the data of 1965, correlate linearly. The phase of the semi-



From results of joint reduction of the data from the USSR Time Services (Belotserkovskiĭ), 1969.

annual component of $\Delta\tau(t)$ lags systematically the phase of the semiannual component of $\Delta T_S(t)$ by approximately 30 days. The derivatives of the phases of the semiannual $\Delta\tau(t)$ and $\Delta T_S(t)$ waves with respect to the time, in accordance with the materials of 1965–1969, are practically equal to zero. The phases of the monthly and biweekly waves in $\Delta\tau(t)$ coincide in the main with the phase of the curve obtained by integrating the time dependence of the inclination of the moon. An attempt was made to observe a correlation between $\Delta\tau$ and ΔT_S for the case of the anomalous change of $\Delta\tau$ in May 1969. The agreement of these changes in time and in sign with the results of direct astronomical determinations made by a number of observatories favors the existence of a correlation.

An investigation of the behavior of the wave with period 0.33 year in $\Delta T_S(t)$, obtained from the reports of the activity of all the time services of the USSR in 1955–1969, has revealed the presence of approximate periodicities of 6.5 and 13 years in the changes of the amplitude and phase of this wave. The connection between the amplitude and phase of the wave with period 0.33 year and the average length of the radius vector of the instantaneous pole of the earth relative to the average pole of the epoch is revealed.

The nature of the experimentally established correlation calls for a clarification. Indeed, an attempt to explain the observed effect as being due to purely

Periods of waves, days

1. Waves predicted or experimentally observed in ΔT_S (Woolard [1], Belotservoskiĭ [2], Korsun' and Sidorenkov [3], Solov'eva and Nikol'skaya [4]	365	321	183	122	91	73	27	13	9	—	—
2. Waves experimentally observed in $\Delta\tau$ in measurements along different routes of propagation of radio waves and at different ULW frequencies in 1968 and 1969 (Fleer and Vorob'ev [5]).	365	—	183	122	91	73	27	13	9	6	4