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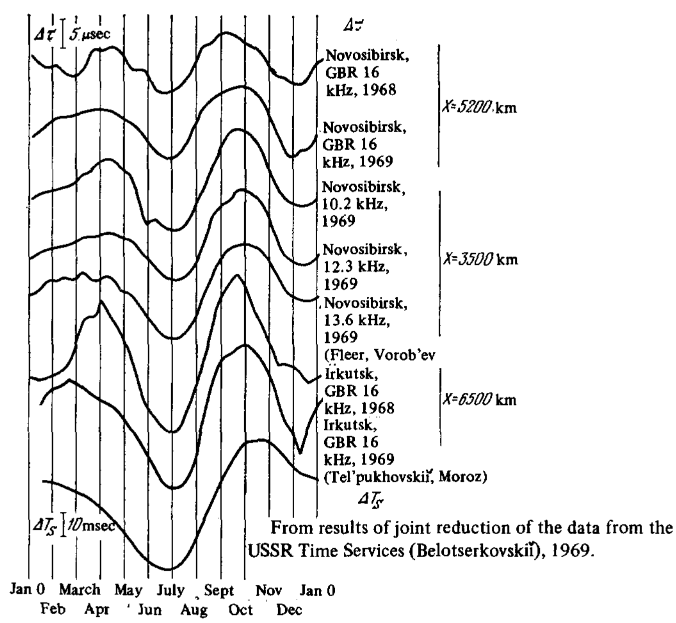
A. G. Fleer, Correlation between Changes in the Phase Velocity of Propagation of Ultralong Radio Waves and of the Earth's Motion about the Mass Center

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 semiannual 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

gravitational perturbations of the earth and of the ionosphere can hardly be regarded as consistent. The point is that the amplitude and phase of the tide-producing forces, the source of which are the moon and the sun, have only secular variations, owing to the stability of the parameters of the motion of the latter, whereas the results presented in this paper point to the existence of short-period variations both in the radio-wave propagation velocity and in the irregularities of the earth's rotation. The magnitude of the short-period variations is commensurate in a number of cases with the magnitude of the observed effect. It is also necessary to bear in mind that the phase of the semiannual wave in both $\Delta\tau$ and ΔT_S remains practically constant in time, although the phase of the 1.0 and 0.33 year waves, in spite of the common source of their perturbations, indicated by the theory of tides, vary. The results of Brouer[6], Munk and Revelle[7], Vestin[8], and Nunk and MacDonald[9] have shown that it is impossible to attribute the fluctuations of the earth's angular velocity to such potential sources of the perturbations of the regular motions as the displacements of the water and air masses. Nor did the calculations confirm Stoyko's hypothesis[10] that there is a functional connection between the changes of the earth's rotation velocity with the secular variations of the geomagnetic field. For most spectral components of the irregularity in the earth's rotation (with the exception of part of the annual wave) it is apparently necessary to seek an argument that can simultaneously be also the argument of the change of the propagation velocity of ultralong radio waves.

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The results of the paper are contained in the following publications:

1. A. G. Fleer, Mutual Correlation of Seasonal Variations of Radio Wave Propagation and the Irregularity of the Earth's Rotation. Abstracts of Papers at the Plenary Session of the Commission on the Study of the Earth's rotation at the Astronomical Council of the USSR Academy of Sciences, Kiev, Naukova Dumka, 1969.
2. A. G. Fleer, Izmeritel'naya tekhnika, No. 4 (1970).
3. A. G. Fleer, Propagation of Ultralong Radio Waves and the Irregularity of the Earth's Rotation, Sb. trudov SNIIM, No. 11, Novosibirsk, 1970.
4. A. G. Fleer and L. Ya. Vorob'ev, Spectral Analysis of the Maximal Diurnal Phase Variation of Ultralong Waves on Different Routes, ibid.
5. A. G. Fleer, Connection between Changes of the Short-period Irregularity of the Earth's Rotation and the Motion of its Instantaneous Pole, ibid.

G. A. Askar'yan, V. G. Mikhalevich, and G. P. Shipulo, Aureole Refraction and Nonlinear Scattering of Powerful Light by Inhomogeneities in Transparent Media

The presence of absorbing particles in transparent media can produce, following passage of intense light, local changes of the refractive index—"aureoles" around the absorbing particles—and produce nonlinear light scattering that depends on the light intensity and on the time. This new nonlinear-scattering effect is of great practical importance, since real media always contain impurity particles (smoke, dust, droplets in air, suspensions in water, etc.).

Nonlinear scattering by particles in a medium was first considered and investigated experimentally in[1], using as an example liquids with inhomogeneities, around which microscopic bubbles were produced. Such inhomogeneities of the new phase have maximum refractive-index drops. The experiments were performed with a free-running ruby laser. The nonlinear scattering and the appearance of centers of nonlinear scattering were revealed by the scattering of the main or of the diagnostic beam. A subsequent article[2] dealt with the effect of such nonlinear scattering in more general form for arbitrary media (solids, liquids, gases) resulting from the formation of thermal and acoustic disturbances. The decreased transmission of light due to the occurrence of such aureoles was considered. In the case of remote reception for pulsed heating, the cross section radii of the scattering aureoles were $r_{acoust} \approx c_S t$ and $r_{therm} \sim \sqrt{\kappa t}$.

Small dimensions ensure rapid production of aureoles within a time $\tau_{acoust} \sim r/c_S$ and $\tau_{therm} \sim r^2/\kappa$; for example, for $r \sim \lambda\!\!\!^{-}$, the appearance of an aureole is ensured even within times on the order of several nanoseconds for $c_S \approx 10^5$ cm/sec and a temperature conductivity $\kappa \sim 10^{-2}$–10^{-3} cm^2/sec.

These investigations stimulated an entire cycle of studies of aureole scattering in both liquids[3,4] (colloidal dye solutions) and solids[5].

We have organized model experiments aimed at the study of aureole refraction by a macroscopic particle in a transparent medium[6]. An infrared beam of a cw YAG-Nd laser with power of several watts was used. The invisible beam was colored red by a low-power He-Ne laser, for ease of observation and registration. An absorbing particle measuring 1–2 mm was introduced into the medium, or else was compressed between two blocks of material, or else was pressed against the surface of the medium. The media employed were various glasses, Plexiglas, water, and others. The absence of nonlinear effects in the absence of the particle was checked. (In particular, in the investiga-