Experientia 41 (1985), Birkhäuser Verlag, CH–4010 Basel/Switzerland

Mini-Reviews

Editorial Comment

It is the privilege of the Editors of *Experientia* to occasionally publish articles which fall quite outside the mainstream of experimental biological sciences, but which are deemed to serve as stimulants, perhaps even irritants to the scientific community. The following contribution by *F. Schneider* is such a case. While we are fully aware that the experiments discussed here, describing simple biological methods to detect delicate physical phenomena, may not appear to be 'reasonable' science, we believe that one should not discard such ideas out-of-hand simply because they follow paths outside the usual way of thinking. We hope that some of our readers will be stimulated to follow up the author's suggestions. It would certainly be desirable to have independent investigators determine the reproducibility of the unusual phenomena described.

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Biological and physical evidence for gravitational waves

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Key words. Gravitational waves; cockchafer; ultraoptic orientation.

Gravitation has been shown to have the characteristics of waves. This is one of the results of a 27-year research program on the ultraoptic orientation of the cockchafer (*Melolontha vulgaris* F.) and subsequent purely physical experiments. The waves in question may be named gravitational whirl waves (GWW) and must be distinguished clearly from those gravitational waves derived theoretically from the general theory of relativity. In contrast with the latter their existence can easily be demonstrated by appropriate experiments. This statement will have some uncomfortable consequences. Gravitation pervades matter and the gravitational oscillation pattern varies in space and time. No point exists where physical or biological experiments could be executed under really steady conditions.

As early as 1957 there was good evidence that cockchafers perceive magnetic fields[1]. This discovery could be confirmed later on by different authors using other organisms like bacteria, planarians, termites, flies, bees and birds. In the meantime I developed other techniques to study the ultraoptic reactions of *Melolontha* since another kind of subtle but pervasive physical information proved to be superposed on magnetic orientation. The beetles did not prefer a definite position with respect to the magnetic field but varied their angle systematically[2,3]. Then I came to realize that gravitation must be involved. Orientation could be improved significantly when blocks of lead were put near the subjects[4], and the systematic turns continued even in Mu-metal cylinders screening magnetic fields[5,6]. In many instances there was a clear relation between the distance from the underground cellar wall and the direction and speed of turning[5,6].

Owing to some physiological peculiarities, their handy size and the clear marking of the body axis, cockchafers are predestined as appropriate subjects for the study of ultraoptic influences on animals. We dug them out at the end of winter and kept them for several months in a hibernating stage. When they are transferred to the laboratory the abrupt increase of temperature leads to transitory activation but the beetles tend to return to their immobility and retract their antennae. In this critical phase the sensitivity to ultraoptic stimuli reaches its maximum. The transition from the active to the resting stage is not random but it can only proceed at definite moments, at certain points in the room and at definite angles to magnetic and electric fields and gravitational waves. This behavioral conformity with the direction of applied and hypothetical physical influences suggest a clear geometrical structure of appropriate sense organs. On the other hand it makes possible the systematic tracing of hitherto unknown physical actions.

The overwhelming purely mechanical action of gravitation and the well-established field theories referring to this seem to exclude any divergent interpretation. How can the wall of a building, a wall of an aluminium box or a block of lead influence the gravitation field perceptibly, if the effect of 40 kg of lead at a distance of 16 cm is about 10^{-8} of that of the earth? There seems to be no reason for controversy or even for discussion. Are our experimental results from the viewpoint of energetics realistic? But like all scientific theories the theory of more or less static gravitational fields is merely a provisional description of what we believe is happening and existing. This account has been generally accepted for centuries but recent research suggest that it may not represent the whole story. As soon as we think of gravitation as waves and rays with considerable mechanical effects, and if we accept that the powerful terrestrial gravitation wave pattern acts as a carrier of modulations produced by moon, sun and superficial terrestrial structures, these presumed discrepancies between theory and experimental statement dissolve.

In order to explain how the existence of gravitational waves can be demonstrated with physiological methods I must give a very condensed description of the experimental set-up used[5]. Three completely closed rectangular aluminium boxes (24 × 37,5 × 5 cm) were arranged 134 cm apart from each other in a north-south direction. On the north side of each box I set two blocks of lead (each 40 kg). These lead masses equalize the ultraoptic conditions in the three boxes and enable us to treat as a whole the reactions of the chafers in all three experimental units. Each box is charged with about 50 cockchafers. Two strong bar magnets rotating and swinging at random over each box prevent magnetic orientation. When we photograph the chafers at intervals of 10 min we can see that they arrange themselves sometimes in lines, or in a kind of network, and disperse after a while following changing external ultraoptic influences. If we select a moment of relatively high symmetry in the terrestrial and cosmic mass distribution pattern (blocks of lead in the north, moonrise in the east, full moon, i.e. sun and moon in opposition), e.g. the 8 March 1974, 19.13 h, the body axe of the chafers are arranged in an interference pattern from which a wavelength of 108 mm may be derived[6].

The cockchafer must be equipped with a very efficient and exact receptor of gravitational waves. Hundreds of measurements prove it. For the sake of simplicity we shall call it the graviceptor. The graviceptor has not yet been identified anatomically, but we can describe it fairly well functionally. In our experiments the cockchafers try to reduce irritation by gravitational waves to a minimum in order to come to rest. For that they turn their body. The graviceptor must have several sensitive and less sensitive axes relative to a single gravitational beam and all experience lead to the conclusion that these sensitive domains are arranged periodically. But the chafer grapples not only with terrestrial disturbances. In the same way it is irritated by cosmic gravitational waves from moon and sun. Both terrestrial and cosmic beams change their mutual direction continuously. A favorable tranquillizing adjustment may turn out to be the opposite after a while. Phases of mobility and immobility alternate rhythmically, and since we know the change of azimuth of moon and sun in the single periods of activity we can estimate the arrangement of the facets on the graviceptor. If we select a new moon day in late autumn (low orbit of the sun and the moon) and set the chafers separately in dishes and replace them continuously after calming, the maxima of immobilization follow in intervals of about one hour. This circahoral rhythm leads to the hypothesis that the graviceptor is divided into 24 facets in the horizontal plane[7,8].

Quite a different approach furnished a similar result. If we replace the rectangular aluminium boxes mentioned above by round ones and examine the orientation on an appropriate full moon day in July during 2 h at noon (36 photographs, 324 azimuthal measurements, accuracy ± 0.5°) we can exploit these figures in two ways. We separate the azimuthal orientation to terrestrial radiation sources (the two thick cellar walls) from the orientation to the sun and the moon in two diagrams. An argument for this step is the idea that the chafers try to adjust their graviceptor synchronously to terrestrial and cosmic radiation beams and that they try to do their best to reduce irritation even if these two types of waves force them to a compromise. The terrestrial beams shine more or less horizontally on the equatorial facet wreaths of the graviceptor, the cosmic beams steeply on the facet wreaths near the poles. For details I must refer to the relevant paper[9]. The analysis of the results led to a graviceptor model composed of six mutually turned octahedra. The 4 'lying' represent the two equatorial wreaths with 12 facets each, the 2 'standing' provide the 8 facets each of the wreaths near the poles. A regular octahedron represents the normal crystalline form of magnetite, an abundant ferric oxide which many creatures can synthesize in their own bodies. Magnetite has been associated with the magnetic orientation of animals[10]. Possibly it represents a physiological detector of gravitational waves.

We have to take into account that biologists have a dogmatic respect for physical theories, and physicists are not accustomed to changing their view on the evidence of biological experiments. In most cases this attitude seems to be appropriate but in some exceptional instances it is leading to a choking of interdisciplinary cycling and recycling. To bridge this obstacle I have tried to represent gravitational waves with pure physical methods – not in a spacelab project costing millions, but with resources that are available in any private household. The experimental device in use may be called a rotating float or gravioscilloscope. It is screened from any air current and consists of a glass dish filled with water and 1 % detergent. A fine needle of special glass is fixed in the center. It serves as an almost frictionless guide of the round float. An indicator on the float and a scale around the dish permit the reading of turns less than 0.5°. A magnetite crystal or a piece of lead is fixed eccentrically on the indicator and a balancing weight of lead on the other side. At first sight it seems implausible that any torque effects of gravitational waves could be obtained with this simple method, but experiments lasting about two years justified my optimism. Simultaneous oscillations occurred with similar amplitudes up to 135° at two points on the table but also differences in amplitude and even phase-shifting. The systematic temporal and spatial variability of movements was a thrilling reminder of the behavior of cockchafers in a systematically varying gravitational wave pattern.

Recent observations provide a key to this activity of the gravioscilloscope. The terrestrial gravitation consists obviously of a pattern of (spiral-?) whirlwaves. If the axis of the float corresponds with the center of such a whirl the indicator rotates continuously clockwise with a velocity of up to 360°/half an hour. The background force of such a spectacular rotation is evident. It must surmount inertia and friction of the loaded float and the adhesion of the polarized magnetite crystal to the earth's field. Outside of the center of the whirl the indicator takes a tangential direction. At the boundary between two whirls irregular

activity or a turn of about 180° may be observed. Therefore we have again good reason for concluding that all the activities of the gravioscilloscope and the systematic variations in the ultraoptic orientation of *Melolontha* are a consequence of the continuously shifting of the GWW-pattern.
Magnetically polarized magnetite crystals yielded five times surprising results at new moon and full moon. The curves indicating the direction of the float at intervals of 5 to 2½ min showed double spikes at the moment when the sun passed a height of +60, 45 and 30° and the moon + or −60, 45 and 30°. The instrument reacts even with a torque to differences of less than 0.2° in sunheight and the beam of the moon is quite efficient after passing the earth. It is a task of future research to decide whether this reaction is connected with the cubic lattice of the magnetized magnetite crystal or with geometrical characteristics of the gravitational waves.
A detailed description of the experimental methods and results is in preparation.

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0014-4754/85/111362-03$1.50 + 0.20/0

Features and principles of ultrasonic spectroscopy of aqueous solutions of nucleic acids and their derivatives

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Key words. Ultrasonic absorption; relaxation processes; kinetic constants; polynucleotide chains; nucleic acids.

The development of the principles of ultrasonic spectroscopy of biological macromolecules, such as nucleic acids, was initiated because of the necessity of studying the acoustic properties of biological media at the molecular level, and because of the opportunity to investigate chemical and physical reactions with relaxation times comparable to the period of the ultrasonic waves, viz., 10^{-9} to 10^{-7} s. The physical mechanisms of absorption considered significant relative to aqueous solutions of nucleic acids and their derivatives are: viscoelastic relaxation[11,17], rotational isomerism[2,12,18], proton exchange reactions[15,22,23], breakdown-formation of hydrogen bonds[7], hydration equilibria[16,20], and base stacking[10,13,18]. These investigations generally showed that the frequency dependencies of the ultrasonic absorption coefficients of these solutions exhibit broad distributions of relaxation processes in the range 1–100 MHz. This finding imposed limitations on the unequivocal interpretation of the ultrasonic absorption mechanisms in biomacromolecular solutions and accounts for the predominantly qualitative nature of analyses of the spectroscopic data. Nevertheless, analysis of the experimental material does permit us to establish principles and describe the main features of these preparations, in the megahertz frequency range. An effective approach, which reveals the predominant molecular mechanisms contributing to ultrasonic absorption in DNA, RNA nucleoside and nucleotide solutions, involves changing the physicochemical conditions of the sample during the acoustic measurements and enables the usual correlation between the absorption coefficient and particular intramolecular alterations to be estimated.
Only for purine nucleoside solutions (adenosine, guanosine) can the observed relaxation processes be described by single characteristic times, viz., 4.6×10^{-9} to 5×10^{-9} s associated with the reversible transition among two rotational forms[2,12,19] and 14.6×10^{-9} s for self-association of N^6, N^6-dimethyladenosine in water (at 25°C). The kinetic constants of the forward and reverse reactions and the equilibrium constants of syn-anti transition