LIFE'S WAVES IN SPACE-TIME IN AND AROUND US

Franz Halberg University of Minnesota, Minneapolis, Minnesota, USA Life's waves in space-time in and around us



Lower Limit of Normal Range

From

Rhythms: **basic properties of life** *To*

Rhythms -- chronomes, i.e., broader time structures anchored in genomes communicating with chronomes around the biosphere -are life Life's temporal structures consist of chaotic changes and rhythms undergoing trends for a sufficient duration to possibly 1. reproduce, 2. evolve and 3. contribute to an accumulating body of information, the noosphere.

The subtraction and addition approach, carried out both by humans (removing a gland and replacing its hormone) or by their cosmos (removing or damping vs. amplifying a spectral component) reveals life's communications, without and far beyond telephones.

Life, at all levels -- bacterium, single cell, organism, population or ecosystem -involves

 photic, somewhat regularly periodic, and
nonphotic, irregular, aeolian (quasiperiodic) cycles, the still-predictable element of broader time structures -chronomes -- also consisting of chaos and trends.



Red aurora of the great magnetic storm, 31 March - 1 April 2001, in Apatity, Russia (courtesy of Sergey Chernouss and Natalia Belisheva).

WHAT IS LIFE?

The Physical Aspect of the Living Cell

BY

ERWIN SCHRÖDINGER SENIOR PROFESSOR AT THE DUBLIN INSTITUTE FOR ADVANCED STUDIES

> Based on Lectures delivered under the auspices of the Institute at Trinity College, Dublin, in February 1943

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1946

WHAT IS LIFE ? **The Physical** Aspect of the Living Cell by **Erwin** Schrödinger 1946

Last headings from Schrödinger "What is life?", p. 83-86

67. The motion of a clock68. Clockwork after all statistical69. Nernst's Theorem

When does a physical system -- any kind of association of atoms -- display "dynamical law" (in Planck's meaning) or "**clock**-work features"? ...

70. The pendulum **clock** is virtually at zero temperature

71. The relation between **clock**work and organism

"Statistico-determinism" underlies free will.

ARBEITSKREIS: MEDIZIN von Assistent Dr. F. Halberg, Innsbruck Sonderabdruck aus dem: "Jahrbuch der Internationalen Hochschulwochen des Oesterreichischen College **1946**"

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> Arbeitskreis: Medizin VON ASSISTENT DR. F. HALBERG, INNSBRUCK

Franz Halberg: Jahrbuch der Internationalen Hochschulwochen des Österreichischen College 1946, p. 336:

The elements of a body's motion are not the movements of its material points, but the simply **periodic** waves of matter in the overall configuration space.

("Die Elemente der Bewegung eines Körpers sind danach nicht die Bewegungen seiner materiellen Punkte, sondern die einfach **periodischen** Materiewellen im ganzen Konfigurationsraum").



A spectrum covering 18 orders of magnitude in the frequency domain; e.g., myriadennian periods in the extinction of genera

... to aim at a unified, transdisciplinary science, with special methods.

TRANSDISCIPLINARILY APPLICABLE METHODS ILLUSTRATED FOR WOLF'S RELATIVE SUNSPOT NUMBERS (IA-D), TERRESTRIAL TELESCOPE-ASSESSED SOLAR MAGNETISM (IIA-C) AND SOLAR WIND SPEED (IIIA-C)



TIME COURSE IN ABOUT 4 DECADES OF FREQUENCY STRUCTURE OF SOLAR WIND SPEED (SWS), GEOMAGNETIC ANTIPODAL DISTURBANCE INDEX (aa) AND THE HUMAN ESTIMATION OF 1 MINUTE (1-MTE)



TIME COURSE IN ABOUT 4 DECADES OF 1-YEAR SYNCHRONIZED COMPONENT IN DIASTOLIC AND MOSTLY IN SYSTOLIC BLOOD PRESSURE (DBP, SBP) BUT EARLY LOSS OF THIS COMPONENT IN HEART RATE (HR); TRANSYEARS ALSO PRESENT OFF AND ON*



TIME COURSE IN ABOUT 4 DECADES OF FREQUENCY STRUCTURE OF VIGOR (V), MOOD (M) AND ORAL TEMPERATURE (T)





WE ARE THERE*AND HERE AND



Visible and many invisible 30076-0

Signatures down here photic and nonphotic

THE NORMAL RANGE (left)



HAS MORE THAN CLOCKS (middle): IT CONTAINS CHAOS, TRENDS AND A SPECTRUM OF CYCLES (right)

WN – Wolf relative sunspot numbers, when provided with a negative sign for each odd-numbered solar cycle, yield HALE numbers. SWS = solar wind speed (km/sec). SBP and DBP =Systolic and Diastolic Blood Pressure (mm Hg), HR = Heart Rate (beats/min). Physical data from www.ngdc.noaa.gov. (WN) and omniweb.gsfc.nasa.gov/html/ow_data (SWS); physiologic self-measurements for 39.32 y (HR) or 39.19 y (BP) by RBS, a man 20.5 years old at start of records (5 – 7 daily, N = 11052).

SYSTOLIC (S), DIASTOLIC (D) BLOOD PRESSURE (BP) AND HALE VALUES (HV) DURING 38 YEARS (y)*

* Blood pressures collected by RBS, a MESOR-normotensive man, 20.5-y old at the start of ongoing record of ~5 daily self-measurements; environmental data obtained online from www.ngdc.noaa.gov; curves are sum of 4 cosine components with periods: for HV of 21.6, 13.5, 5.71 and 0.989 y, for SBP of 21.5, 11.2, 6.64 and 1.002 y, for DBP of 20.3, 10.7, 6,57 and 1.008 y. Hale values are Wolf numbers with negative sign for each odd-numbered circadecadal Schwabe cycle.

* SWS: daily data from ftp://nssdcftp.gsfc.nasa.gov/spacecraft_data/omni, N=5272. BP data: daily averages from Dec 1989 to Jul 2006 monitored ~ every 30 min (with gaps) by FH, a man of 70 y at start of records. N = 2447.

** Horizontal lines indicate ordering significance at the 0.001 and 0.05 levels only as a first approximation; until more robust methods become available, that are not dependent upon the assumptions of independence, normality and homogeneity of variance, a transdisciplinary congruence of periods and a "remove – replace" approach remain the criteria of importance. Congruence between components with amplitudes differing from zero with an ordering P betweein 0.001 and 0.05 are questionable.

[¶] CI = 95% confidence interval of τ (of each component fitted separately).

Systematic blood pressure, heart rate, other psychophysiological and archival monitorings serve health care and track solar variability (space weather).

Visible environmental photic cycles (the day & year) coexist and intermodulate with wobbly non-photic cycles, with periods, τ , ranging from about (~) 2 or 4 weeks, the ~5-month τ of solar flares, the ~6-month τ of geomagnetic activity and τ s shorter or longer than a year, not to mention τ_s ranging from decades to millions of years.

Nonphotics are related, among others, to corpuscular radiation, magnetism broadly, gravitation and volcanism; they are coded in genes of populations expressed differently as a function of age in individuals and interact, compete and may be traced by phylogeny and ontogeny.

*Direction of lines based on analysis of 16S rRNA and rooted with paralogous protein sequences after Dr. Bharat Patel, http://trishul.sci.gu.edu.au/~bharat/courses/ss13bmm/archaea.html.

Changing Relative Prominence* of some Components in a Partial Spectral Element of the Postnatal Human Diastolic Blood Pressure Chronome**

* in a healthy boy, born 19.10.1992, whose blood pressure was measured at mostly 30-minute intervals from 20.10 for the ensuing 40 days, and analyzed as a moving spectrum in separate weekly intervals, displaced in 12-hour increments through the data set. An initially greater prominence of infradians (see ~ 1 week c, left), shown by height and color, corresponding to a larger amplitude, contrasts with the prominence of circadians and circasemidians in later weeks of life, while any ultradians with still higher frequencies and any trends and chaos, two other chronome elements, are here unassessed.

□ 0-0.622 □ 0.622-1.244 □ 1.244-1.866 ■ 1.866-2.488 ■ 2.488-3.11 ■ 3.11-3.732 ■ 3.732-4.354 ■ 4.354-4.976 ■ 4.976-5.598

Maps of spectral mechanisms serve to optimize individuals' and populations' performance and health maintenance. A remove-and-replace approach (of the testes and the adrenals) led to endocrinology and to chronobiology.





SCN ablation compatible with persistence of many circadians



Acrophase Chart of Several Clock Genes in Different Tissues of Mice after 3 Days in Continuous **Darkness (DD)**

Summary of 24-hour cosine fits





Sequence of events of different clock genes: Heart























Addition of magnetic activity by magnetic storm







ST = 2 days of the second part of a moderate double magnetic storm, Q = 2 days of magnetic quiet, gauged by the geomagnetic equatorial disturbance index Dst in nT (plotted, top) of -115 and -80 and Kp (a planetary magnetic disturbance index of slightly above 6 in arbitrary units in each storm (Kp not shown).

* HALO = hours after light on. Vertical lines straddling bars are 95% confidence intervals. P < 0.05 in each comparison, except for ϕ in hypothalamus.





























Life can be viewed as a set of superficially transient self-sustaining organized structures in time, communicating with their very broad cosmos.

Rational countermeasures to sudden cardiac death, suicide and terror, i.e., for preventing society's ills, are the promise of looking at life as time structures.

The now-possible detection of variability disorders for the prevention of severe diseases such as strokes were within the scope of last Tuesday's lecture by Prof. Kuniaki Otsuka.





Modified from Figure 1 (Phoenix Architecture) in Adams C Privacy requirements for low-cost chronomedical systems. Int Conf on the Frontiers of Biomedical Science: Chronobiology, Chengdu, China, September 24-26, 2006, p. 64-69.





NEARTRANSYEARS AND A NEARCISYEAR AROUND (1 - 3) AND IN (4 - 9) ORGANISMS



1-2 = data from OMNI 2; 3 = first 131 years (y); 4, 5 = sectoring, i.e., probable mutations and/or other genetic changes; 6 = Circadian acrophase of oxygen production during 14 y; 7 = ~half-hourly records during more than 6 y; 8 = daily excretion for 15 y of urinary steroidal metabolites (17-ketosteroids, CH);






There is nothing over which a free man ponders less than death: his wisdom is, to meditate not on death but on life

Spinoza, *Ethics,* P. IV, Prop. 67 (Cited by Schrödinger, "What is life?", p. viii)

(Homo liber nulla de re minus quam de morte cogitat; et ejus sapientia non mortis sed vitae meditatio est)



Chronomics, the study of time structure

1. Differentiates MESORhypertension from new vascular variability disorders (VVD) or a syndrome (VVS), features of prehypertension, prediabetes and a premetabolic syndrome a basis for an individual's nowfeasible **PREHABILITATION**;

2. found intermodulations among seen photic and nonphotic components in and around us, coexisting and competing and even replacing each other as a function of geographic location; 3. maps mechanisms, e.g., of myocardial infarction, sudden cardiac death, suicide, proselytism, crime and terrorism, for any congruence and for consequences of subtraction and addition of environmental "everyday" cycles and of extremes -- magnetic storm vs. magnetic quiet;

4. eventually to develop countermeasures to undesirable effects, for prehabilitation, prevention of societal disease, of "infections of minds" (such as crime and terrorism).

All on the basis of chronomics: a "microscopy" and "telescopy" in time providing indispensable control information.

REMOVE AND REPLACE APPROACH APPLIED TO TERRORISM

