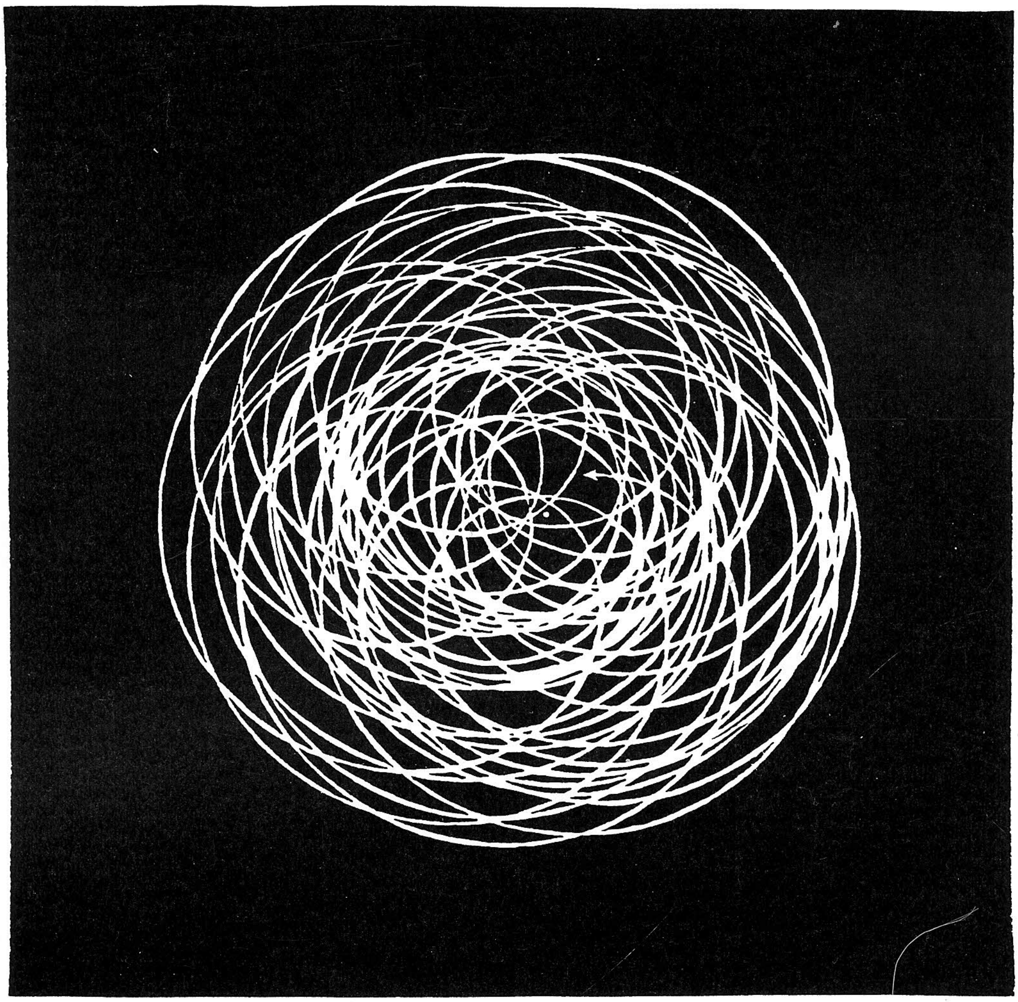
THE BASE DRUM OF THE SOLAR SYSTEM

A Primer of Solar/planetary Relations



by

GÖRAN WINDELIUS & PETER TUCKER

SOLARIS RESEARCH CENTRE

Report 89/3

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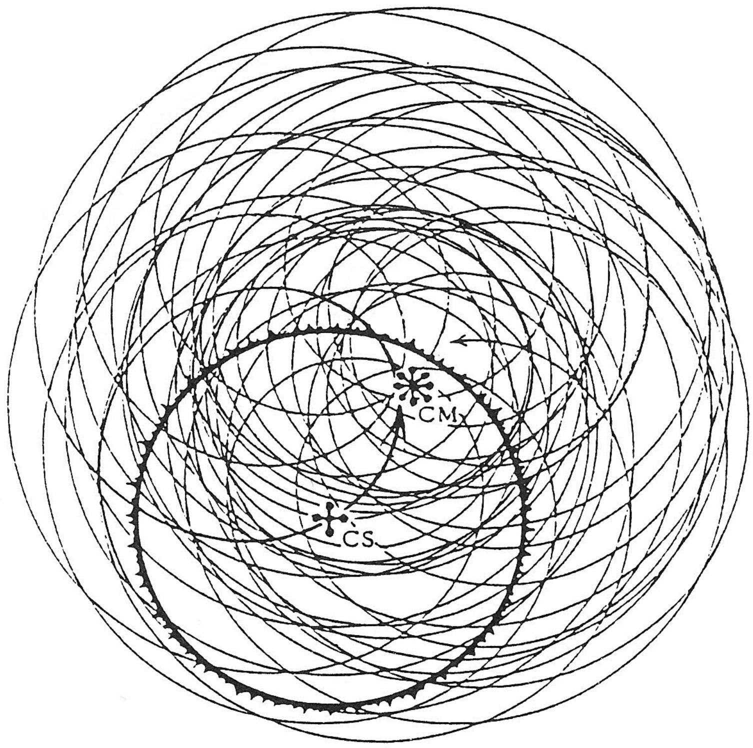

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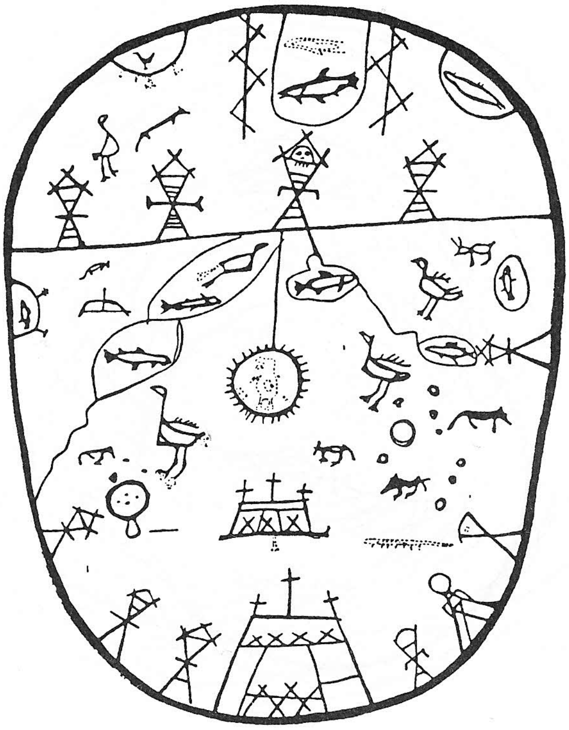

Shaman drum
northern Sweden

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The Base Drum of the Solar System

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Isaac Newton

(1642 - 1727)

De Motu Corporum Sphæricorum viribus centripetis se mutuo petentium.

"Hitherto, I have dealt with the movement of bodies subject to attraction by an immovable centre, although such a force cannot be said to exist in nature. Attraction is always directed towards other bodies, and the effects of attraction are always mutual and equally great according to the third law of motion. When dealing with a case of two bodies, neither the attracted, nor the attracting body can be said to be at rest. According to the 4th. corollary to the laws of motion, both these bodies will move around their common centre of mass, by virtue of their mutual attraction. In cases dealing with several bodies (either commonly attracted by a single body, or mutually attracting each other), these will move in such a manner that their common centre of mass is either at rest, or evenly travelling in a straight line".

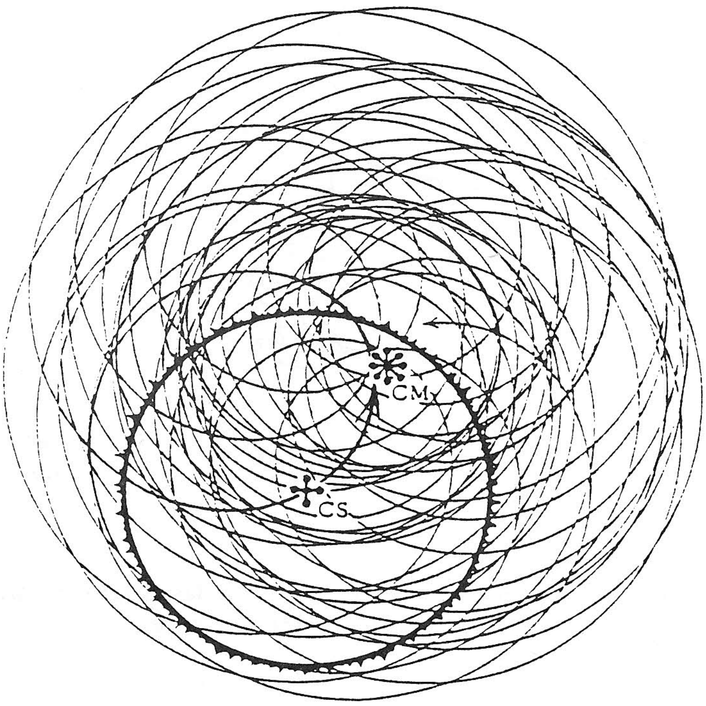
Isaac Newton: "Philosphiae Naturalis Principia Mathematica," Section XI: Relative Movement. On the movement of bodies mutually affecting each other through the medium of centripetal forces. London, 1686.

INTRODUCTION

Contrary to popular belief, the Sun is not the still centre of our rotating planetary world. The hub of the solar wheel is, instead, an invisible point in space that marks the focus of the combined masses of both Sun and planets - the bary-centre of the solar system (CM).

Around this central point, both the planets and Sun revolve, the former following nearly elliptical orbits, currently considered to be more or less rigidly locked onto the Sun, the latter tracing an oscillating path, in which the solar centre (CS) sometimes closely approaches CM, sometimes swings far out onto one side, although never by more than 2.19 solar radii (see fig.1).

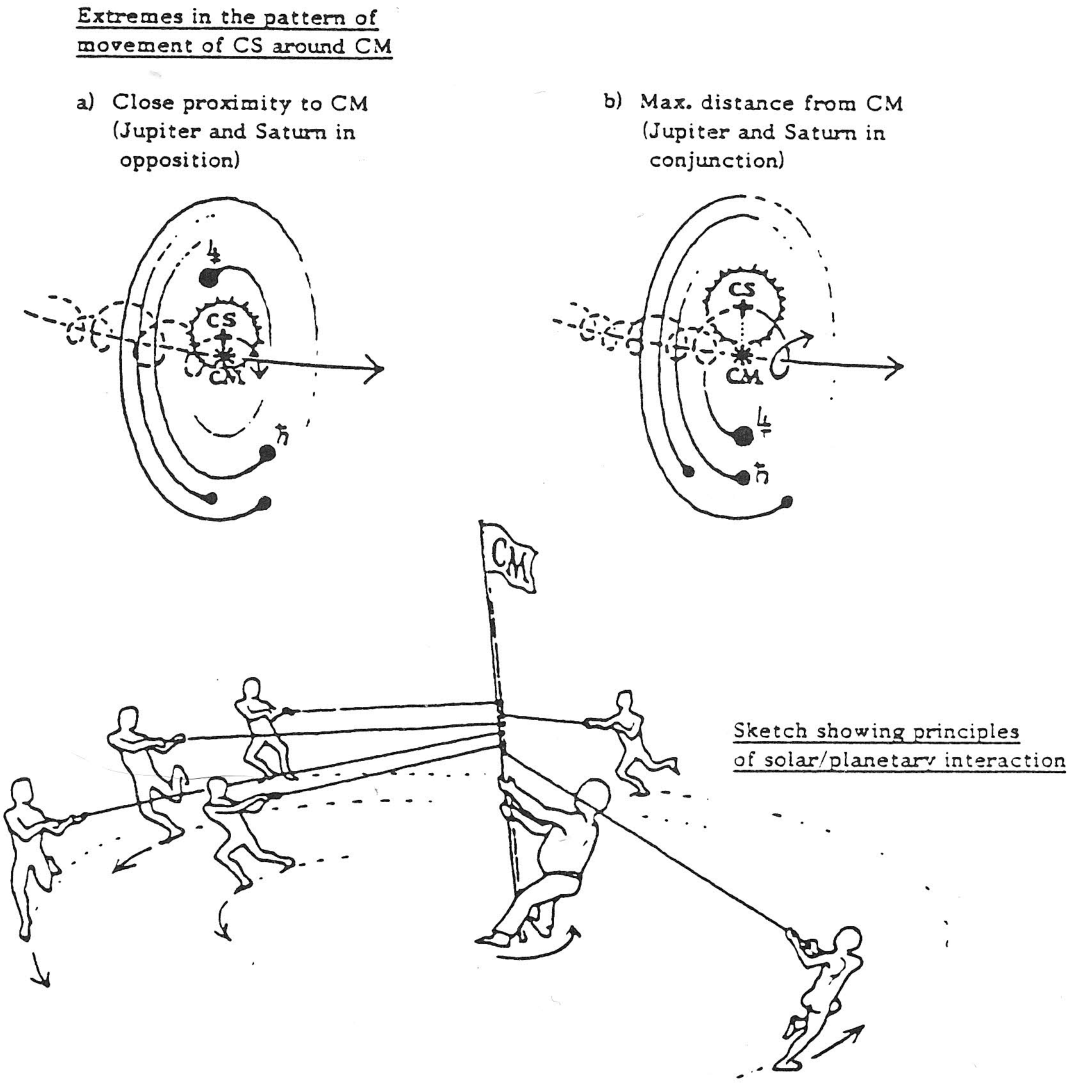
Fig. 1 The pattern of motion of the solar centre (CS) around the centre of mass of the solar system (CM): 1550-2030 AD also showing the position of the Sun in relation to CM, Sept.1988.



after a bary-centric planetary program designed by N. Carlborg, Saltsjöbaden Observatory, Stockholm Univ.

This pattern of solar motion is determined by the movement of the planets, since the inertial motion of the solar body is a response to the shifting direction and strength of the combined planetary vector (see fig. 2). A gathering of the most massive planets on one side of the Sun (a so-called planetary "synod") forces the Sun to swing out from CM, whereas a more even distribution of the combined planetary mass (eg. when Jupiter and Saturn lie on opposite sides of the Sun) allows the solar body to pass close to, and even enclose CM.

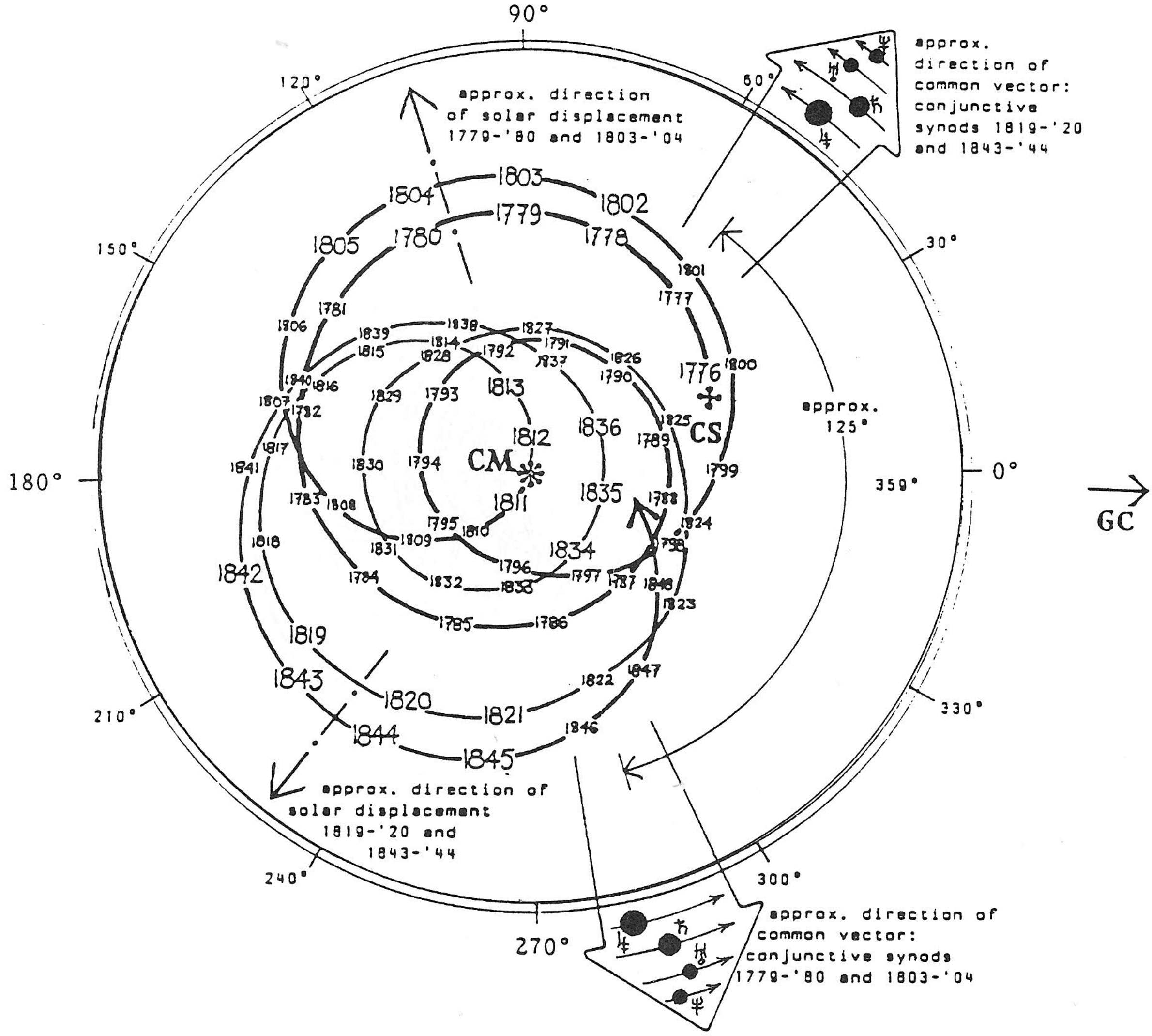
Fig. 2 The influence of planetary movement on the motions of the Sun



That the oscillation of the Sun around CM traces a more or less regular pattern (a wide swing followed by a close passage, followed by a wide swing etc. - each cycle of max./min./max. distance from CM lasting on average ca. 20 years) is a result of the dominant influence of the two most massive planets, Jupiter and Saturn. It is the alternating pattern of conjunctions and oppositions between these two planets that determines the basic phase-structure of the solar oscillation.

That those insignificant specks of matter - the planets - can force the Sun (containing over 99% of the total mass of the system) to dance to their tune, may surprise some readers. The reason for this apparent paradox, however, can be saught in the fact that the planets command over 99% of the total angular momentum expressed by the system (see further in text). In the meantime, one way of appreciating how this planetary influence is exerted is to follow the course of solar movement around CM over a number of decades. An exercise of this nature is provided on the next page (see fig. 3).

Fig.3 The movement of the solar centre (CS) around the centre of mass (CM): 1776-1848



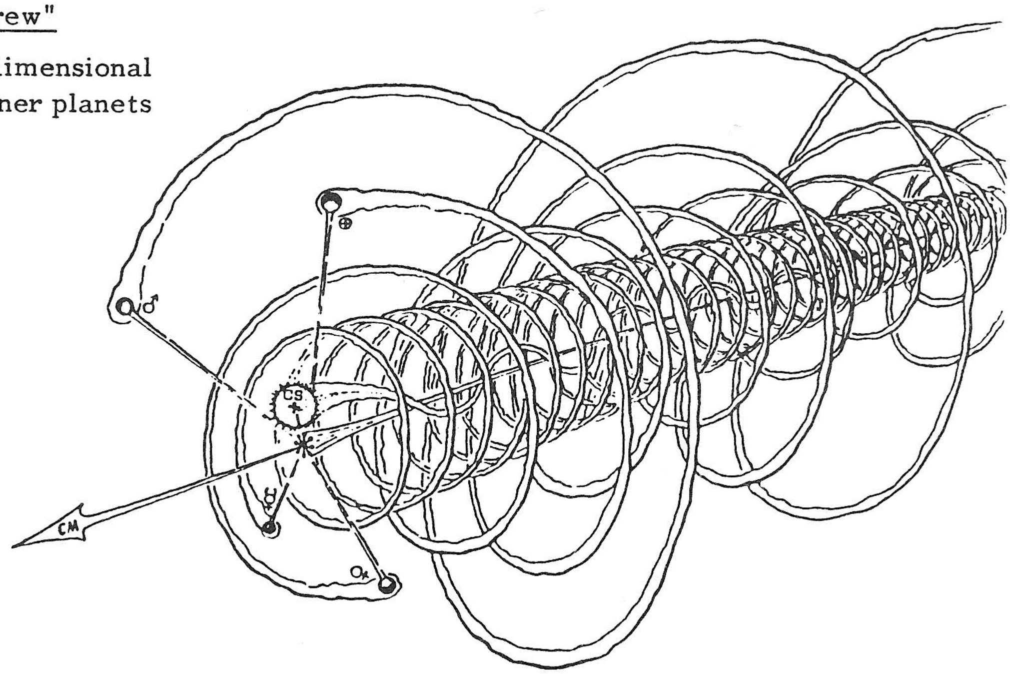
The sequence begins in 1776, with a wide swing of the solar centre out from CM (reaching max. distance in 1779-'80 at approx. 110) under the influence of the first conjunctive synod assembled at approx. 285°.

The solar centre then makes a tighter loop around CM (due to a rather loose oppositional synod), followed by another wide swing (conjunctive synod no. 2, culminating in 1803-'04), immediately followed by a further, very close approach to CM under the influence of a particularly concentrated oppositional synod (CS at min. distance from CM in 1811 - a particularly interesting passage that is dealt with more fully later in this text), before swinging out again under the influence of the first conjunctive synod of the second pair (CS at max. distance in 1819-'20), the common vector of the massive planets then being aligned at approx. 50°, a shift of about 125° from the alignment of the first pair.

Finally, after another relatively tight loop (CS at min. distance in 1834-'35), the solar centre swings out under the influence of the last conjunctive synod, reaching max. distance from CM in 1843-'44, before once again diving in towards the centre.

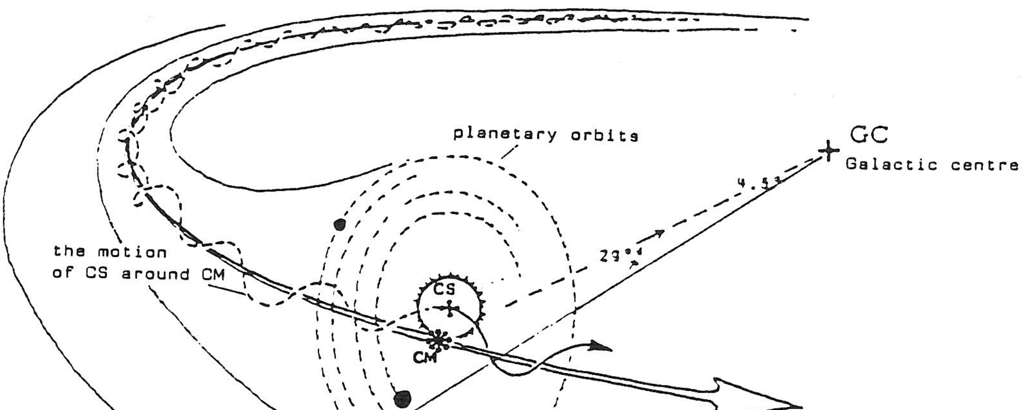
Since the solar system as a whole is not stationary in the galaxy (moving, instead, on an orbital path around the galactic centre, about two thirds out from that centre to the periphery and 4.5° above the galactic plane - orbital period: ca. 225 mill. years), it follows that the movements of both Sun and planets are essentially spiral in nature (see fig. 4).

Fig. 4
"The Solar Screw"
Schematic 4-dimensional view of the inner planets and Sun



Strictly speaking, therefore, it is only the bary-centre (CM) that keeps faithfully to the line of orbit of the solar system (see fig. 5). However, since there are indications that the solar system gradually rises and falls in the course of its galactic trajectory, it may well be that CM also moves in spiral.

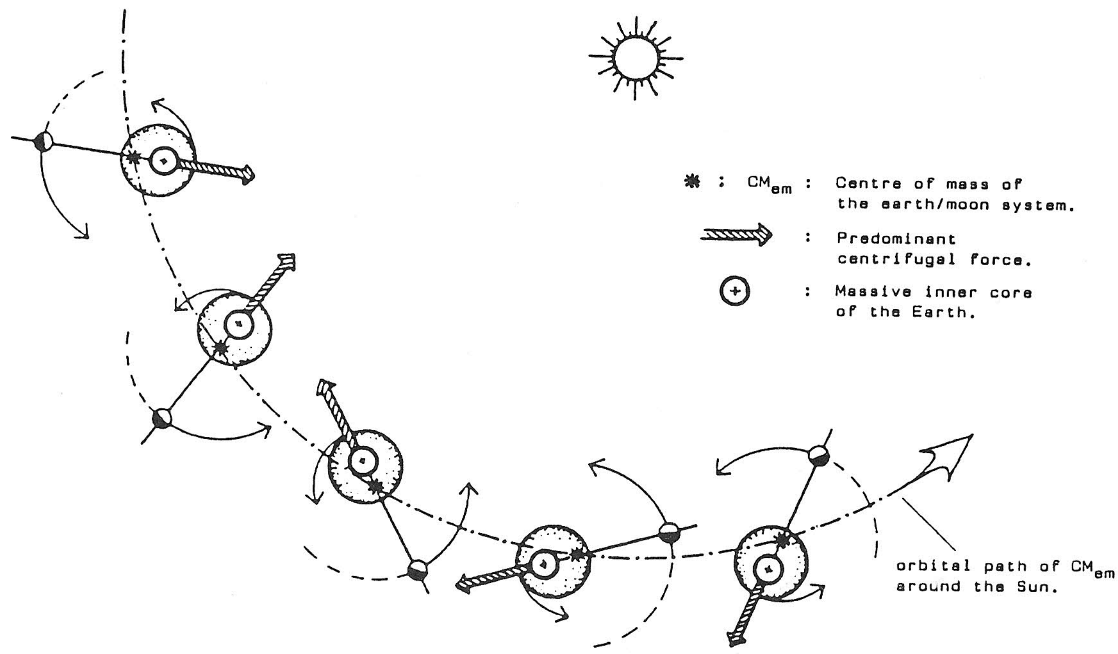
Fig. 5 Relationship between the solar centre (CS), the centre of mass of the solar system (CM) and the galactic centre (GC)



nb.
for the sake of clarity the spiral paths of the planets and the 30° forward tilt of the plane of the planetary orbits from the vertical plane of the galaxy have been omitted in the diagram.

These principles even apply within the earth-system. The Earth and the Moon also have a common bary-centre (located approx. 3/4 of the way out from the centre of the Earth to its surface), around which both bodies revolve, like a very unevenly weighted dumb-bell (see fig. 6). At the same time, the Earth revolves around its own axis (as do all planets and the Sun). This axis pierces the CM of the Earth - the focal point of the Earth's mass, located at the centre of the planet. This point is the primary centre of our world; it is the very "common ground" beneath our feet.

Fig. 6 The movements of the earth-moon system



Nevertheless, we also owe loyalty to all those other centres: first and foremost, to the bary-centre of the earth-moon system, secondly, to the centre of mass of the solar system, and finally, to the galactic centre.

The well-oriented human-being should thus at any time be able to point out the direction of these different centres in relation to his or her own position on Earth. Whether we are aware of the fact or not, they are vital for our very existence. In a sense, we are engaged in a constant dialogue with each one of them simultaneously, the nature of this dialogue determining, in large part, the conditions under which we live. Although this fundamental fact of life can as easily be taken for granted as the rising and setting of the Sun, it is one which cannot, at least, be ignored in a scientific description of our place in the universe.

The basic physics of the relationships described above had already been established by Isaac Newton in the 17th. century (see quotation from Principia Mathematica at the beginning of this introduction). But it was not until the latter half of this century that Newton's principles were applied to the case of the Sun. In the 1960's, P. José, an astronomer at NASA, succeeded in defining the inertial motion of the solar body in mathematical terms, thus enabling us for the first time to accurately plot the theoretical path of the Sun both forward and back in time.

Aided by this capacity, much has been done since then to explore the consequences of Newton's fundamental insights into the true nature of solar/planetary relations - in particular by T. Landscheidt in W. Germany and R.W. Fairbridge and others in the USA. We ourselves have been working for some years in this field.


CM

THE BASE DRUM OF THE SOLAR SYSTEM

Angular momentum in the solar system

The solar system is that part of the universe to which we and the Earth belong, being our immeditate superior in the hierarchy of forces and energies that constitute the galactic reality.

These forces and energies, when they act within the solar system, express themselves as a multitude of oscillations, vibrating at different amplitudes and frequencies on different levels - from the microphysical level of the atom, to the level of the cell and bio-organism and, finally, the macrophysical level of the Sun and planets.

On all these levels, a higher amplitude is generally accompanied by a lower frequency. Higher frequencies, on the other hand, always represent greater energy than lower frequencies - provided the amplitude remains the same (as with coloured light: ultra-violet wave-lengths express greater energy than infra-red).

All oscillations within the solar system follow a simple, basic principle: those of lower amplitude (higher frequency) must adjust themselves to those of higher amplitude (lower frequency). The latter are regulative in function on account of their greater effect. If this were not so, the system would soon cease to exist; it would break apart through lack of coordination (as would an orchestral piece, were the individual instruments to ignore the beat established by the conductor).

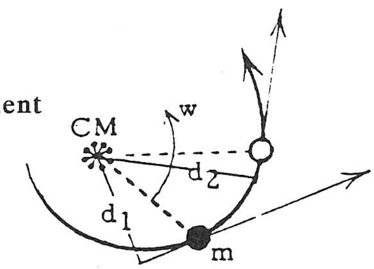
Different forms of orbital movement around a focus (centre) are the primary characteristic of our own and presumably all other solar systems. Such orbital motion is one of the prerequisites for the appearance of oscillations at really large magnitudes within a macrophysical system.

The amplitude of the oscillation expressed by a body in orbital movement around a centre is determined by changes in the amount of movement (**angular momentum**) that gives rise to that oscillation. Angular momentum (**L**) is defined as the product of three measurable quantities:

i) the mass of the body (**m**)

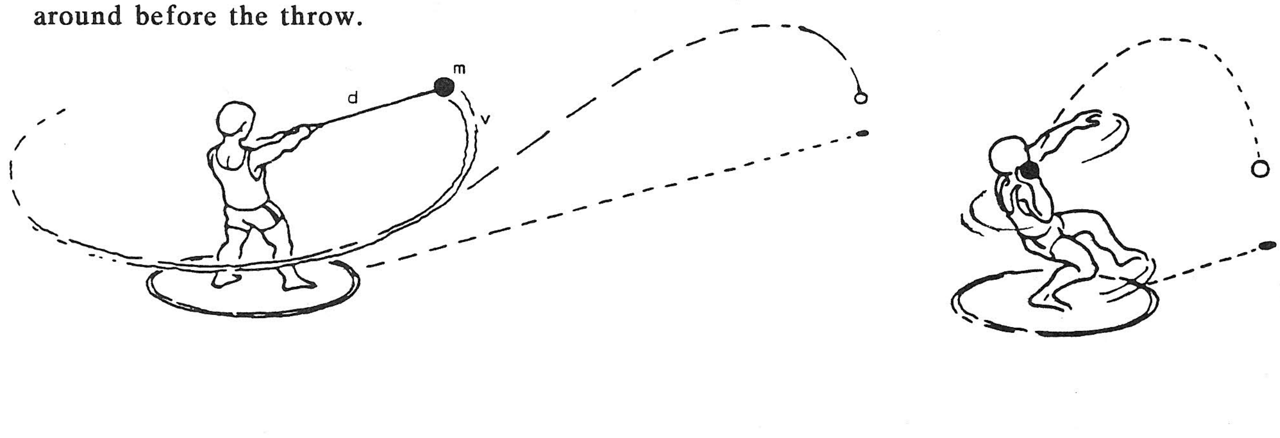
ii) the right-angled distance squared between the focus of the movement and the direction of movement of the body (**d^2**).

iii) the angular velocity of the body (**w**).



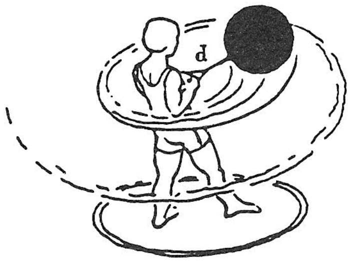
$$L = md^2w$$

The angular momentum expressed by a body in movement around a central focus can be considerable, as can easily be appreciated when the athlete in the first sketch below releases the weight, allowing it to fly free under the impetus of the forces built up during the swing. The weight will fly far further than will the similar weight cast by the athlete in the second sketch, although the latter does his best to build up an angular momentum by whirling around before the throw.



In the first case, it can be generally said that the longer the cord (d), the greater the mass (m), or the higher the speed (v), the greater the angular momentum and the further the weight can be cast.

In the case of the Sun and the planets, the former has an enormous mass (over 99% of the total mass inherent in the system), but a very short radius from the centre (as in the sketch on the right), while the planets have relatively small mass, but move at great distances from the centre (as in the first sketch on the previous page).



These extreme values for the planetary radii are crucial, since it is on their account that the planets together - despite their relatively insignificant mass compared with that of the Sun - are able to command over 99% of the angular momentum expressed by the system as a whole.

The remaining percentage of the total momentum is commanded by the Sun itself, divided between the spin momentum (L_s) expressed by the rotation of the Sun around its own axis, and the orbital momentum (L_o) expressed by the oscillating movement of the solar body. The spin momentum varies slightly - although by exactly how much is hard to tell - and controls roughly 0.6% of the total momentum. The orbital momentum, on the other hand, varies considerably, alternating between practically no share at all of the total momentum, up to as much as ca 0.4% of the total momentum in extreme cases (see further below).

Despite the tiny percentage of the whole expressed by L_o, however, this momentum plays a particularly vital role in the solar/planetary process.

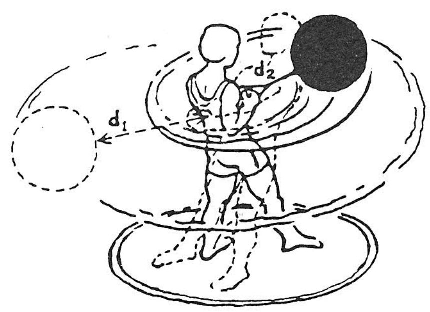
As has been pointed out earlier, the fact that the planets are of different masses and move at different speeds and distances from CM results in constant change in the distribution of the planetary masses around the system. The oscillating movement of the Sun around CM continually compensates for this shift in static equilibrium, thereby upholding the stability that the system as a whole always strives to maintain.

The oscillating movement initiated by the planets obviously implies a process of alternating increase and decrease in the distance from the solar centre to CM (see analogical sketch below).

It also involves both increase and decrease in the orbital velocity of the solar body (**from less than 1 m/sec. to above 15 m/sec.**), and continual change in the value of L_o. Although these changes in distance and speed are relatively small, the great mass of the Sun ensures that the effect in terms of kinetic energy will be quite considerable.

The force that produces these changes is termed: **torque** (τ). This expression is equivalent to the first derivate of L: ($dL/dt = \tau$), and describes the rate of change of the solar orbital angular momentum.

($\tau = dL/dt$)



$d_1 > d_2$

Exchange of momentum between the Sun and planets

The precepts of celestial mechanics dictate that there must exist continuous, though minute, transfers of momentum between the various rotating bodies of the solar system. On the one hand, between L_o and L_s, and on the other, between L_o/L_s and the sum total of the different planetary momentae (L_p). In general, it can be said that change in one kind of momentum varies inversely with change in another. For instance, a decrease in L_o could be expected to lead to an equal and opposite increase in L_s and/or L_p, whereas an increase in L_o would lead to an equivalent decrease in L_s and/or L_p. This represents a simple application of the law of conservation of angular momentum: the total angular momentum expressed by a system always remains constant.

In summary, it can be said that the planets - in addition to those normal changes in orbital velocity and distance to the Sun occasioned by the eccentricity of the planetary orbits (these changes having the effect of keeping each planet's angular momentum generally constant) - will be forced to undergo further, minute, but significant corrections in their orbital speeds in order to balance the sometimes quite drastic shifts in the values of L_o and L_s.

These relatively small accelerations and decelerations in the orbital speeds of the planets (which are not accounted for in the simultaneous equations upon which the traditional ephemeris are based - see Appendix 1) are sufficient to balance the sometimes quite drastic shifts in the values of L_o caused by the oscillating motion of the Sun. This is because the planetary momentum as a whole so much dominates over the solar momentum.

In other words, since the Sun commands incomparably the largest mass in the system (ca. 1000 times that of Jupiter, the largest planet), and the angular momentum of the various planets remains more or less the same (according to Kepler's and Newton's laws, related such that the product of d^2w strives to remain constant), the oscillation of the central body - the Sun - around CM will be the oscillation with the highest amplitude in the system. This oscillation therefore causes the greatest, regularly occurring redistribution of the given and constant amount of angular momentum expressed by the system as a whole.

For that reason, the curve showing changes in the Sun's orbital angular momentum - the L-curve - represents a fundamental oscillating pattern of dominant importance for all processes within the solar system (see fig. 7).

Abandoning our habitual perception of time for a moment, this latter point can be illustrated by a simple analogy.

If the estimated life-span of the Sun (ca. 6 billion years) is equated with our own average life-span (ca. 75 years), it will be found that during its existence the Sun will have completed the same number of oscillations around CM as the number of breaths taken by a human-being throughout a typical life. In both cases, the amount will be approx. 300 million, that is, if the average period of a solar oscillation is estimated at 20 years (which should lie near the actual value) and the human respiratory oscillation under conditions of deep-breathing is estimated at 8 seconds.

From this point of view, the L-curve can be regarded as a "pneumogram", illustrating in graphic form the pattern of "solar breathing", thereby providing valuable information on the state of the Sun, as well as indicating periods of stability and instability within the solar system as whole, and therefore also within its different constituent parts (including processes within the earth-system, such as the climate).

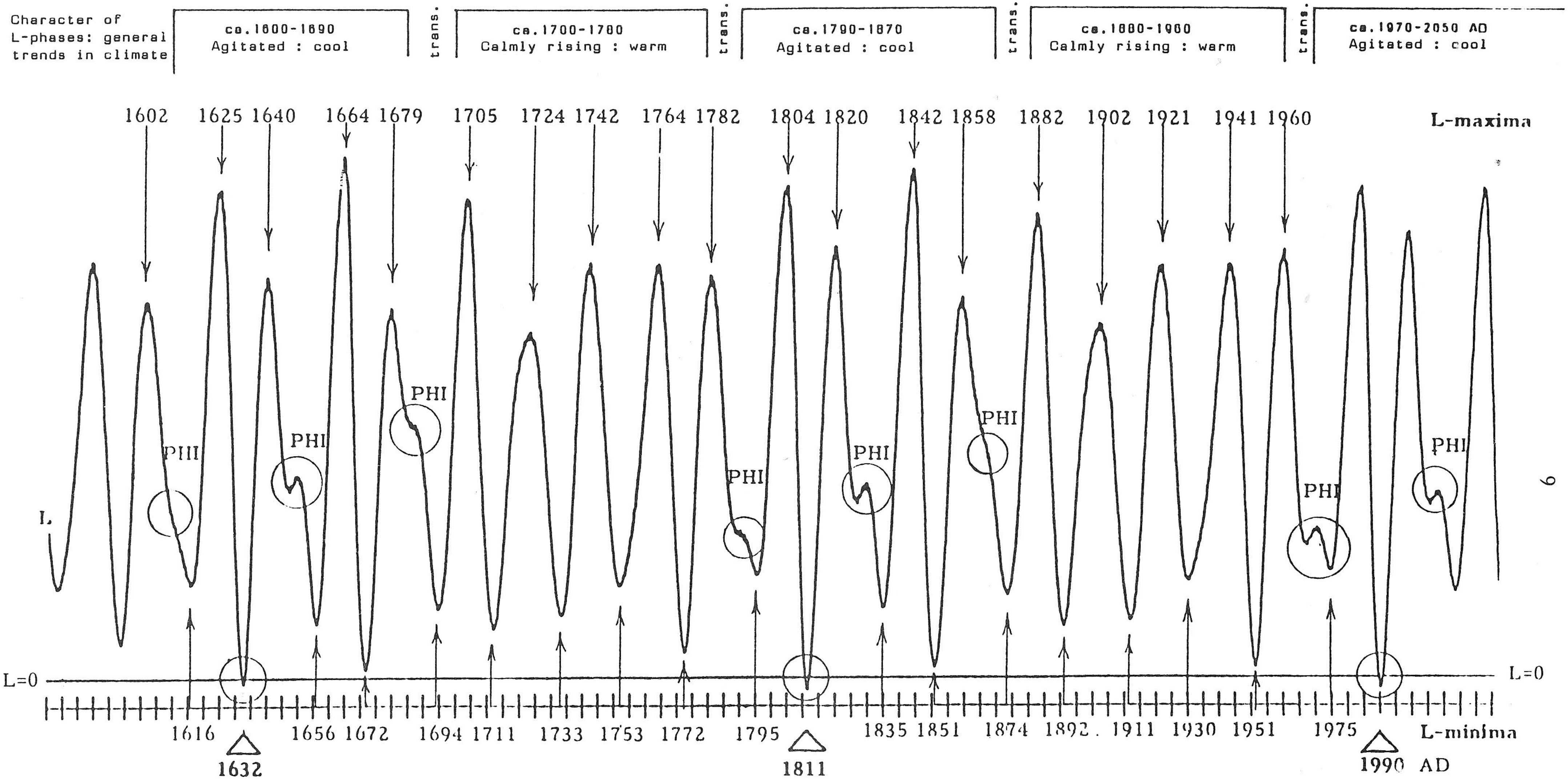


Fig. 7 DEVELOPMENT OF SOLAR ORBITAL ANGULAR MOMENTUM (L), 1600-1976

Plot from planetary program designed by N. Carlborg, Saltsjöbaden Observatory, Stockholm Univ.

L-minima: [dL/dt=0]
Occasions during the solar orbit when the solar centre lies nearest CM

L-maxima: [dL/dt=0]
Occasions when the solar orbit lies furthest from CM

Anomalous L-minima : △ 1811
Occasions when the Sun is forced to move in a retrograde fashion in relation to CM

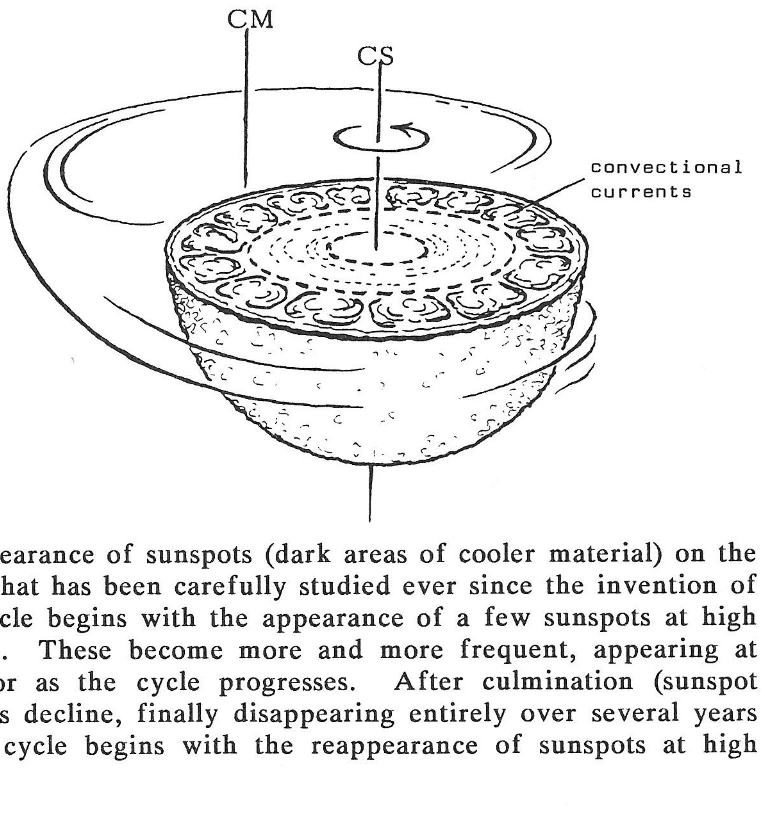
PHI : Phase Interference :
A break in the even rhythm of solar motion, sometimes involving only a minor shift in the rate of L-change, sometimes developing into a more disturbing event, consisting of two sub-minima and one sub-maximum [alternatively, two sub-maxima and one sub-minimum]. On these occasions, the solar torque [dL/dt] follows an indecisive development.

The solar oscillation and the sunspot cycle

How can the solar oscillation around CM (with its proportionally tiny share in the available total angular momentum) have any marked effect on the state of the Sun, let alone impinge upon the stability of the system as a whole?

T. Landscheidt has made the valuable observation that a fluid body set in oscillative motion develops convectional currents (Jour. of Interdiscipl. Cycle Res. 1981), pointing out that this is an experimentally confirmed, physical fact that should be generally valid, even for a fluid body such as the Sun (see fig. 8). It would therefore be logical to expect the strength and pattern of convectional flow beneath the solar surface to vary in response to variations in the rate of change of the angular momentum of the solar oscillation (dL/dt). Furthermore, disturbance of the convectional flow could be expected to cause changes in the long-term magnetic processes that this flow is currently considered to govern (dynamo theory). These changes in such a vital component of the solar mechanism would, in their turn, be likely to be reflected in the sunspot cycle.

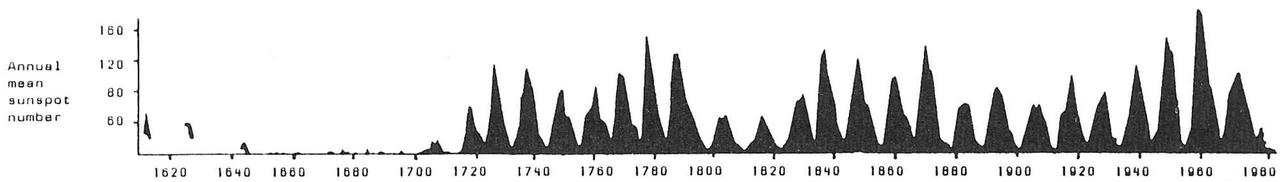
Fig. 8
The fluid, rotating and oscillating Sun



The periodic appearance and disappearance of sunspots (dark areas of cooler material) on the surface of the Sun is a phenomena that has been carefully studied ever since the invention of the telescope. A typical sunspot cycle begins with the appearance of a few sunspots at high latitudes on both solar hemispheres. These become more and more frequent, appearing at latitudes closer to the solar equator as the cycle progresses. After culmination (sunspot maximum), the numbers of sunspots decline, finally disappearing entirely over several years (sunspot minimum), before a new cycle begins with the reappearance of sunspots at high latitudes on the solar sphere.

The numbers of sunspots observed during these cycles (mean annual sunspot numbers) vary considerably (see fig. 9) and are considered to provide a rough, but reliable indication of the state of solar electromagnetic and radiational activity. Solar activity rises when approaching sunspot maximum and declines when approaching minimum.

Fig. 9 The sunspot cycle



In addition to their general use as an indicator of the level of solar activity, sunspots are important in that they give rise to those sudden and explosive eruptions of solar material (solar "flares") that in certain cases can batter the Earth with waves of particles and electromagnetic radiation, causing disruption to the geomagnetic field and disturbance in weather-patterns over large areas of the globe, especially at higher latitudes.

The sunspot cycle is ultimately sustained by the fusional process at the heart of the Sun. Nevertheless, there is strong evidence suggesting a correlation between variations in the rhythms of the sunspot cycle and variations in the phases of solar oscillation. Correlations of this nature have been observed by a number of researchers ever since José first remarked on the phenomenon during the 60's. Since the sunspot cycle cannot be held responsible for the solar oscillation (the movement of the planets being the decisive factor in this case), the observed correlations between the two indicate that the solar oscillation must exert a certain modifying effect on the pattern of sunspot behaviour.

Indulging in a further analogy, the solar oscillation can be said to function as a kind of variable "bellows", alternately stimulating and dampening the nuclear fires at the heart of the Sun. The action of this "bellows" is primarily steered by movements of the two most massive planets, Jupiter and Saturn (see Introduction).

This is why such a close correlation exists between the half-beat period of these two dominant planets (ie. the period between their conjunction and opposition = 9.93 years) and the <u>most frequently occuring</u> (median) length of the sunspot cycle - since the 17th. century, observed to be ca. 10 years. That the period of the sunspot cycle has varied considerably during the last 300 years, with an <u>average</u> duration of ca. 11 years, is connected with the sometimes reinforcing, sometimes weakening influence that can be brought to bear on the Jupiter/Saturn effect by the two other massive planets, Uranus and Neptune.

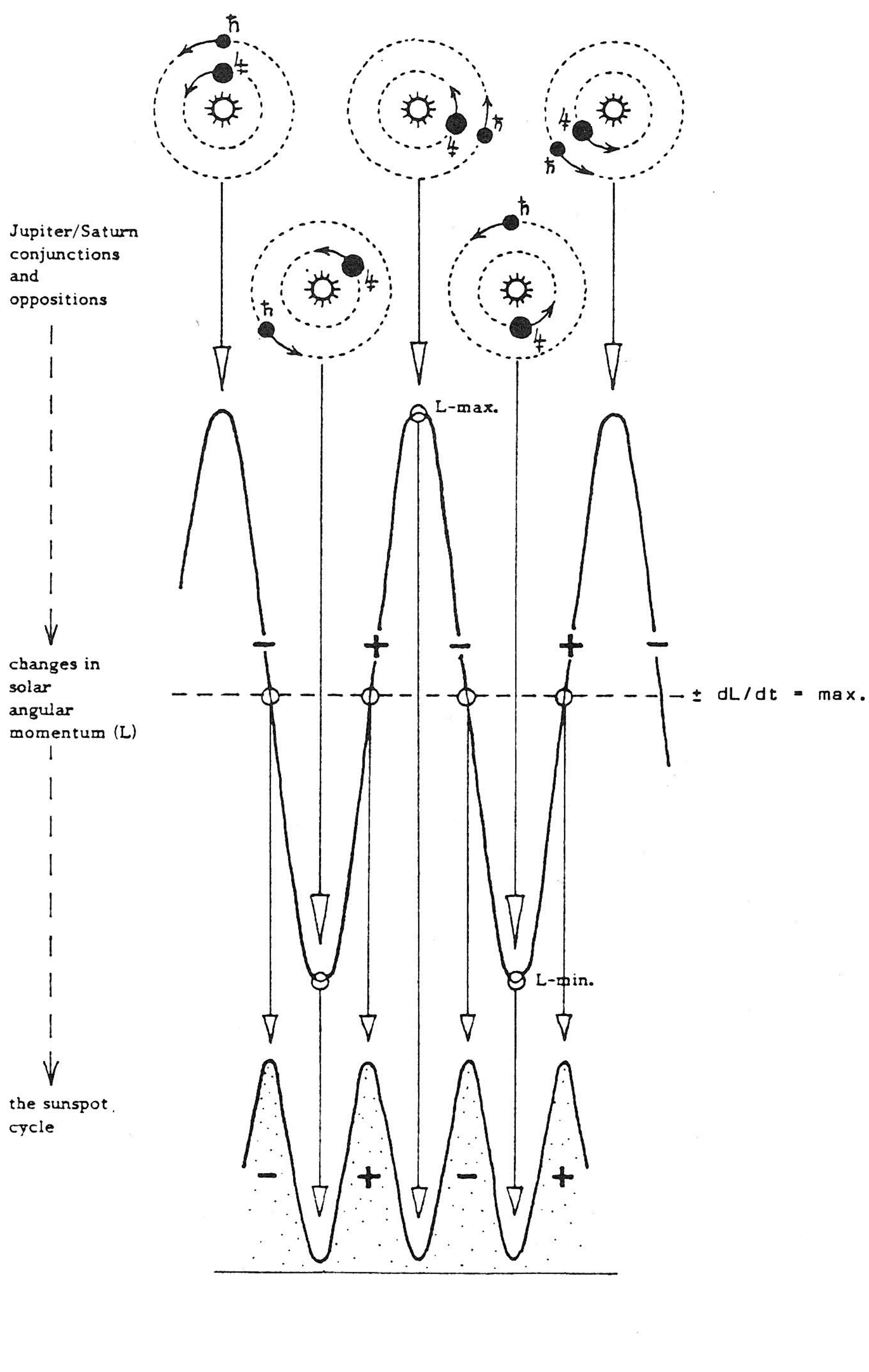
Stable and unstable phase-sequences in the development of solar momentum

An important observation to be made is that the change in the magnetic polarisation of sunspots that always occurs during the transition between two sunspot cycles (sunspots appearing on the northern solar hemisphere during a typical cycle have an opposite polarity pattern to those appearing on the southern hemisphere, a relationship which is reversed during the subsequent cycle) can be attributed to the two distinguishable phases of the solar oscillation, ie. a phase of increasing momentum (when the Sun passes from L-min. to L-max.), immediately followed by a phase of decreasing momentum (when passing from L-max. to L-min.).

During periods when the solar oscillation develops in a calm and even fashion, the sunspot cycle tends to culminate (sunspot maximum) at times when the respective positive and negative values of dL/dt are greatest, while degenerating (sunspot minimum) when these values approach zero. As a result, the shift in sunspot polarity pattern tends to occur adjacent to L-maxima and L-minima. Such periods extend over ca. 70-80 years and generate a somewhat warmer Sun and milder climate on Earth (see fig. 10).

Fig. 5

Principle mechanism governing phase-pattern and dominant electro-magnetic polarisation of the sunspot cycle during stable sequences in the solar oscillation



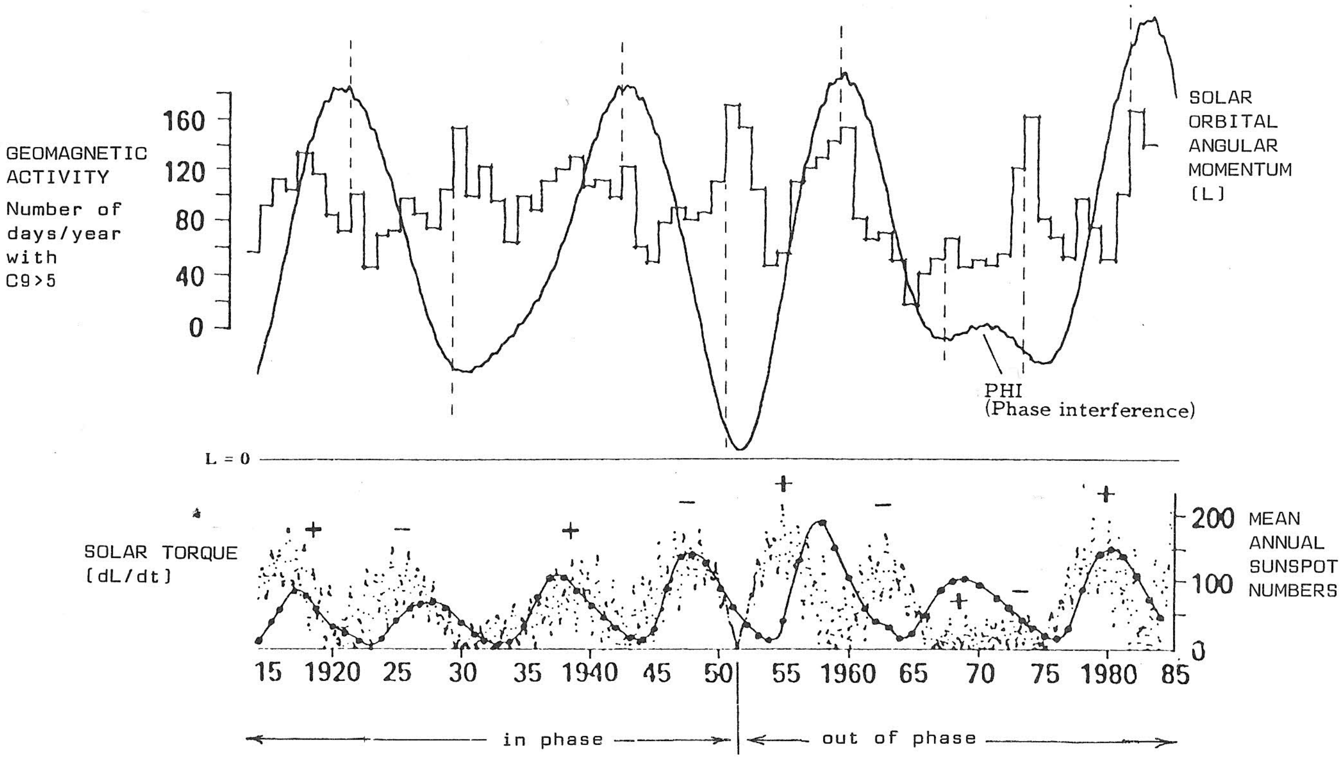
Subsequently, however, these periods of stability pass over into an indecisive, transitional period of ca, 10-20 years, followed by another 70-80 year period during which the solar oscillation becomes uneven and agitated. During these latter sequences, the solar oscillation and the sunspot cycle fall out of phase, the coupling between the two becomes less distinct, while the pattern of sunspot activity becomes more disordered.

The reason for this behaviour can be traced to the so-called "phase interferences" in the solar oscillation that appear at such times.

A **phase interference (PHI)** is a break in the even rhythm of solar motion (due to a particular pattern of planetary movement - see Appendix 2), sometimes involving only a minor shift in the rate of L-change, sometimes developing into a more disturbing event consisting of two sub-minima and one sub-maximum (alternatively, two sub-maxima and one sub-minimum). On these occasions, the solar torque (dL/dt) follows an indicisive development. PHI are invariably accompanied by particularly extreme L-maxima and L-minima (see fig. 7).

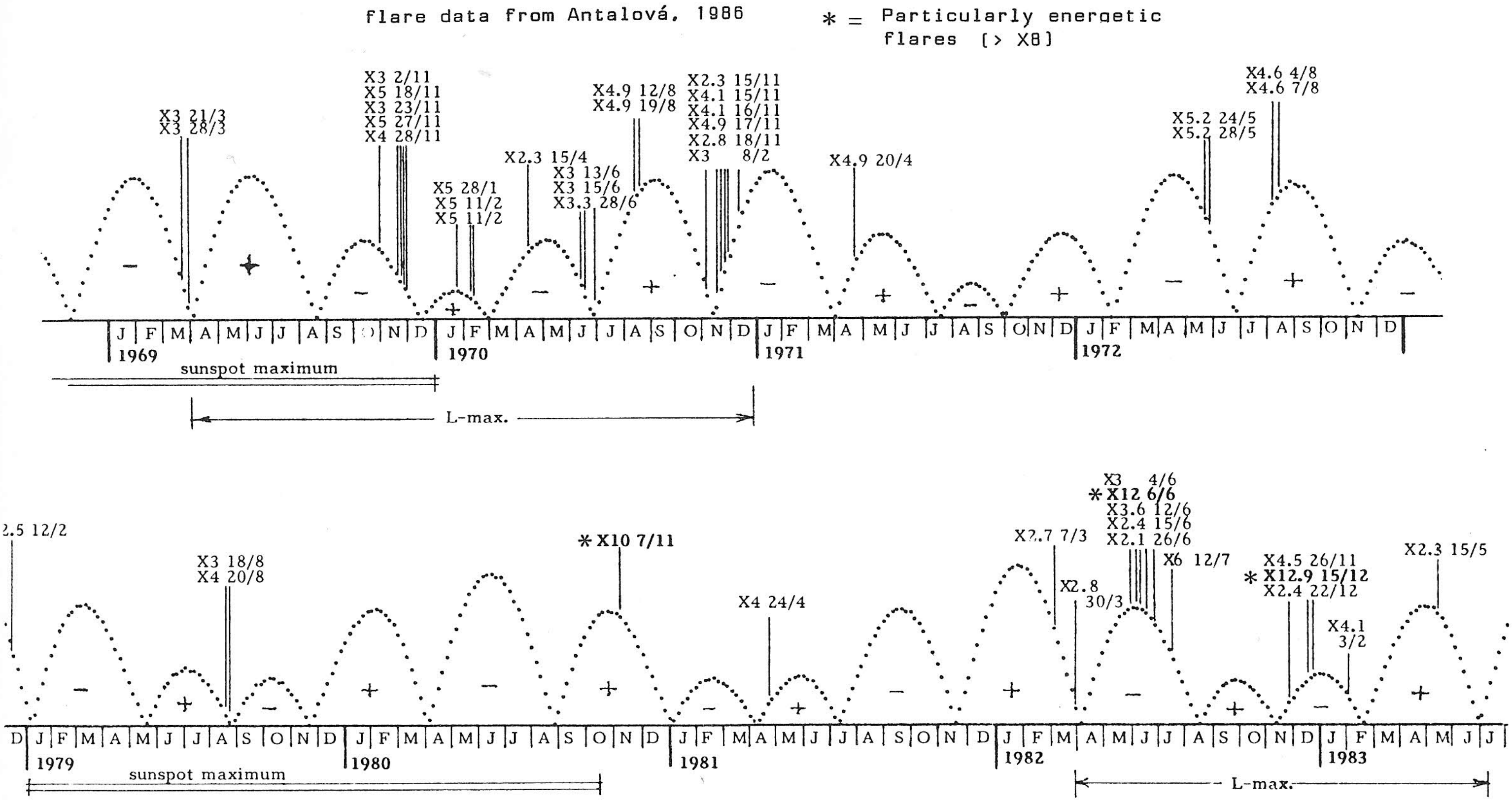
As fig. 11 shows, close phase-agreement was maintained between the sunspot cycle and the development of solar torque until 1950 (sunspot maxima and minima coinciding with torque maxima and minima). After the rather accentuated L-minimum in 1951, however, these two curves fall out of phase, a lack of coordination that is reinforced by the subsequent PHI sequence between 1965 and 1975.

Fig. 11 Changes in the solar orbital angular momentum (L), 1915-'85, compared with the development of solar torque (dL/dt), the sunspot cycle and variations in the level of geomagnetic activity



It is interesting to note that a closer correspondence exists between the fluctuations of the L-curve and the changing levels of activity in the Earth's magnetic field (both L-maxima and L-minima can be associated with surges in geomagnetic activity) than between the latter and the sunspot cycle. This comes as no surprise, since L-maxima and L-minima can invariably be shown to coincide with bursts of intensive flare-activity - provided, of course, that the state of the current sunspot cycle is such that there are sunspots available on the solar surface (see fig. 12). It should be emphasised in this context that a sunspot maximum is, in itself, no guarantee that any associated flare activity will be particularly intense. For the release of massive flares, there is usually needed the further irritating factor of either an accentuated L-maximum or L-minimum, or a PHI sequence.

Fig. 12 All LDE (Long Duration Event) X-class flares above X2, 1969-'72 and 1979-'83, compared with the development of inner planetary torque during these same periods



These sequences cover the last two sunspot maxima. Most flares (including two above X12, the largest in this series) cluster adjacent to the two L-maxima in the diagram, rather than near their respective sunspot maxima, as one might have expected. In the latter case, major flares do not appear (apart from an isolated X10 in 1980) until 1-2 years after the actual sunspot maximum in 1979-'80. This evidence indicates an important role for the solar oscillation in the mechanism of flare release.

Nb: Use of the torque curve of the 4 inner planets (negative sequences reversed to lie above the zero-line), highlights another interesting aspect: ie. the relationship apparently existing between the movements of these bodies and the distribution in time of solar flares.

There is some evidence to suggest that normal variations in the spin-rate of the Sun become more extreme during these unstable periods in the solar oscillation (especially in conjunction with L-minima, or sub-minima during PHI sequences). Lack of reliable data on solar rotation before 1967 makes impossible any categorical statements regarding this question. Nevertheless, irregularities in solar spin-rate are suspected to have occurred during the 17th. century (Eddy, 1977). Definite irregularities were observed in 1912 and 1930 (according to Landscheidt, 1988), and also in 1976 (see curve shown in fig. 13, based on precise measurements made at Mt. Wilson Observatory, USA - Howard 1983). The last three of these occasions were closely associated with L-minima or sub-minima events.

There are, therefore, good grounds for supposing that the uneven behaviour of the solar oscillation during these unstable periods gives rise to, (1) marked changes in the spin-rate of the Sun, (2) turbulence in the convection zone, where the two types of sunspot polarisation have their origin, and (3) sporadic interference between these two patterns of polarisation - all these phenomena resulting in (4) more aggressive flare activity. The most likely consequence of these different effects would be a somewhat cooler Sun and a more severe climate on Earth.

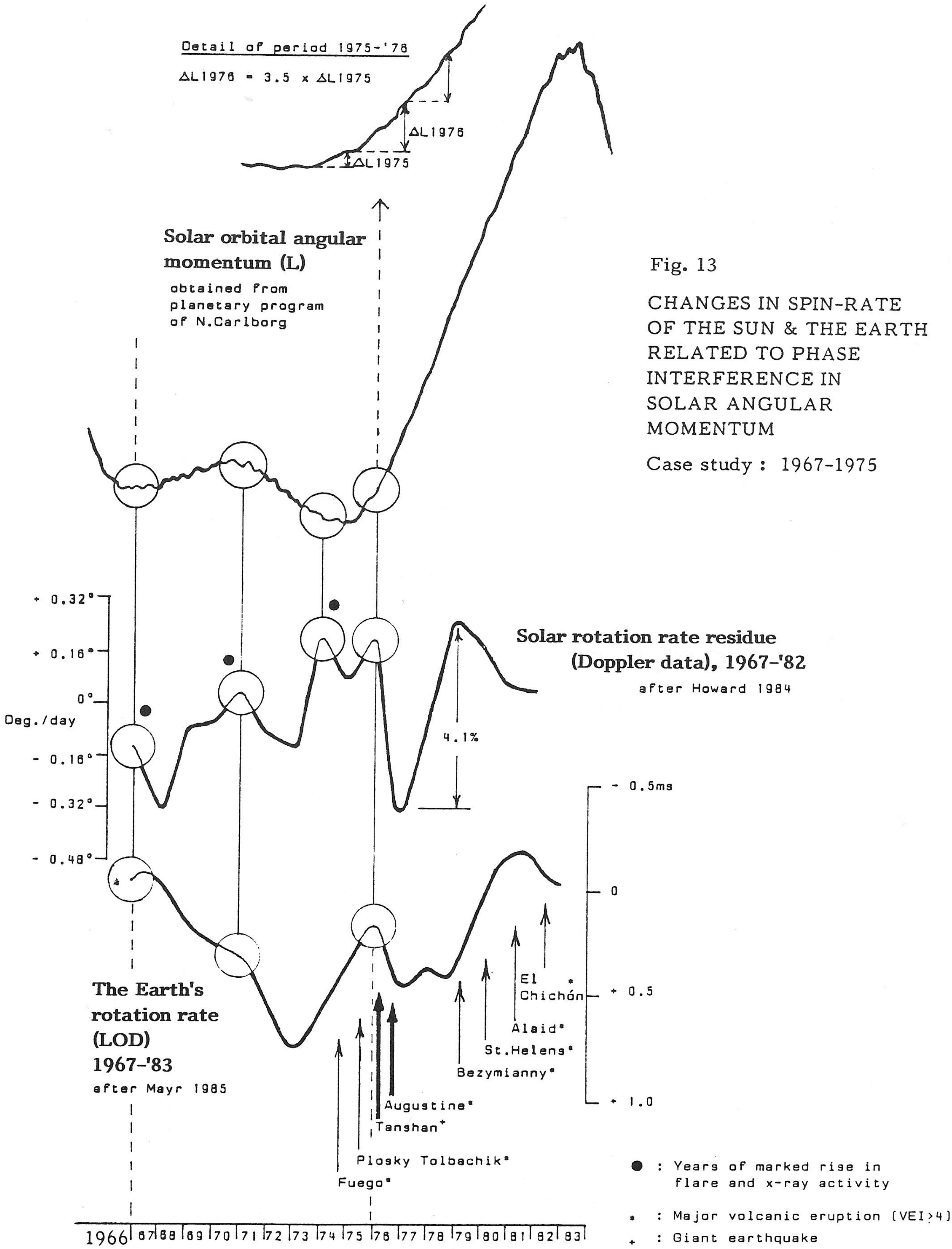


Fig. 13

CHANGES IN SPIN-RATE OF THE SUN & THE EARTH RELATED TO PHASE INTERFERENCE IN SOLAR ANGULAR MOMENTUM

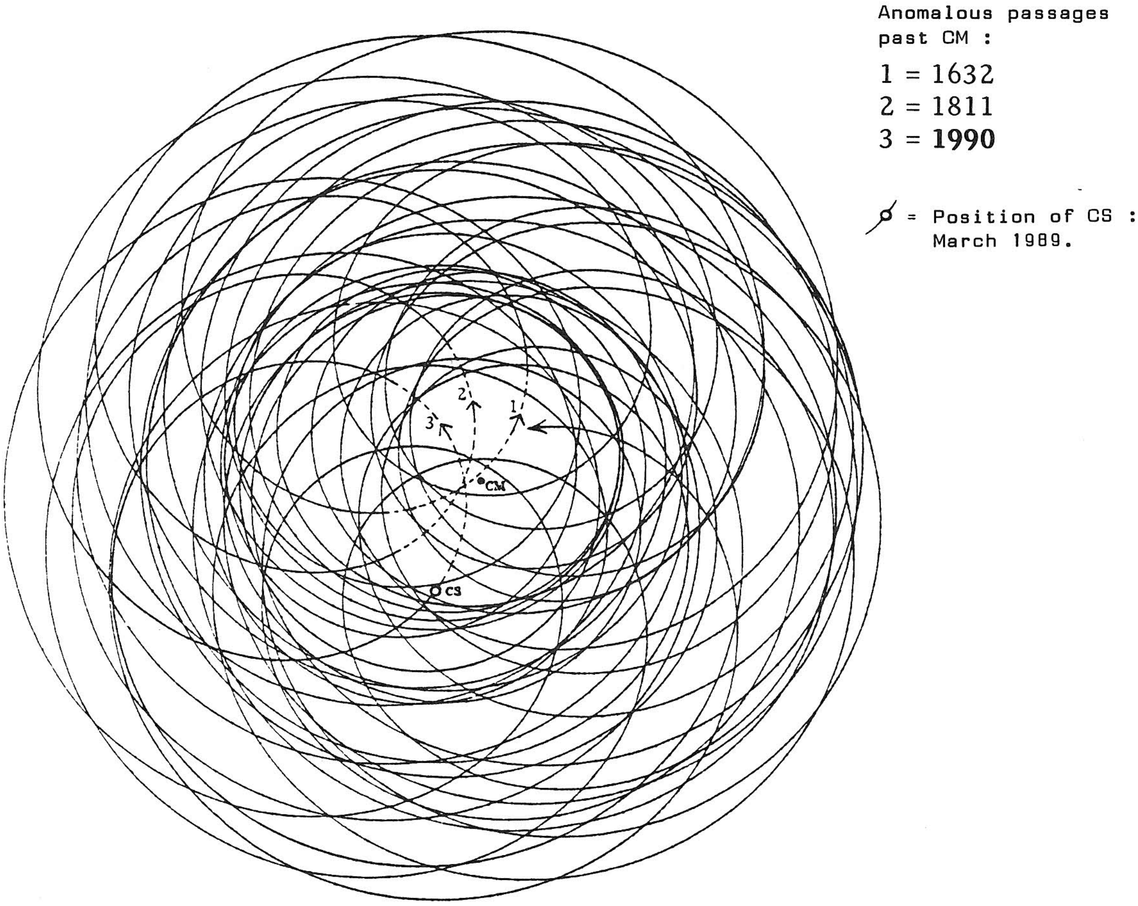
Case study : 1967-1975

Anomalous L-minima and sunspot maxima

The most disturbing type of this agitated, or "infected" behaviour on the part of the Sun is a very rare event in which a so-called anomalous L-minimum coincides precisely with an extreme sunspot maximum. Such a coincidence can be expected to occur no more than once, or at the most twice every 26 000 years (see calculations of mathematical probability in Appendix 3).

An anomalous L-minimum is in itself a rare event. It is characterised by the solar centre passing on the "wrong" side of the CM during its closest approach, - ie. with CM as reference point, the Sun follows a "retrograde" movement during the months of the actual passage (see fig. 14).

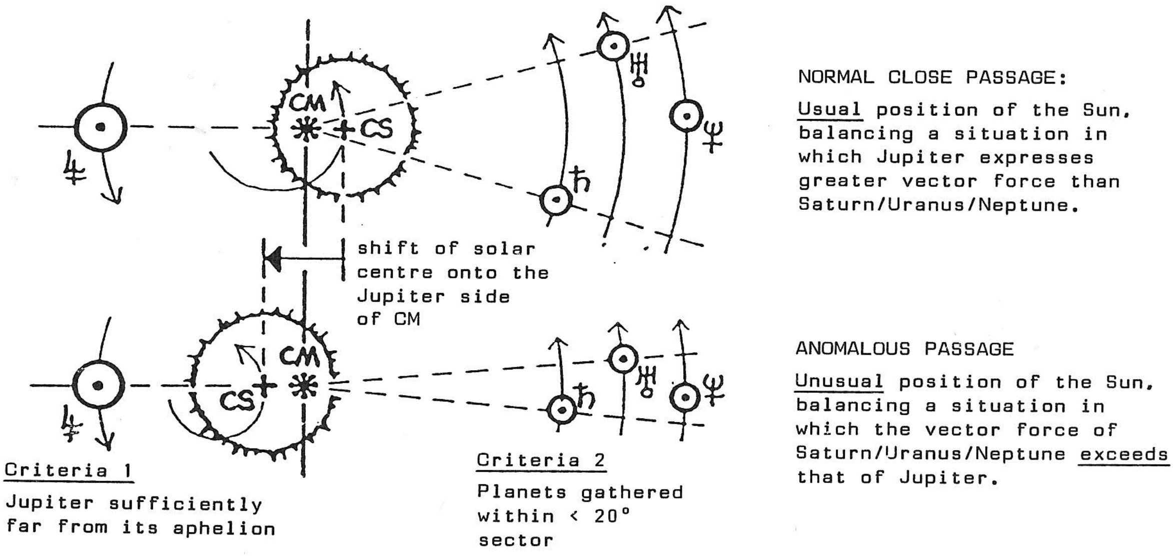
Fig. 14 Three anomalous L-minima



Two criteria must be fulfilled for an anomalous solar passage to occur (see fig. 15). Firstly, Saturn, Uranus and Neptune must be gathered into an unusually tight "synod" (< 20°) on one side of the Sun, with Jupiter in opposition on the other. Secondly, the synod must be so aligned that when passing the point of max. opposition, Jupiter lies in the sector between Aries and Cancer. In this sector, Jupiter's vector is weaker than usual, whereas Saturn in the opposing sector (Libra-Capricorn) exerts a stronger vector than usual. This balance of forces allows the synod to force the Sun over onto the Jupiter side of CM.

These two sets of conditions very seldom coincide, occurring only in sequences of 4-6 events, each event separated by 179 years, while the sequences themselves appear at varying intervals of between 1100 and 1900 years (see fig. 20).

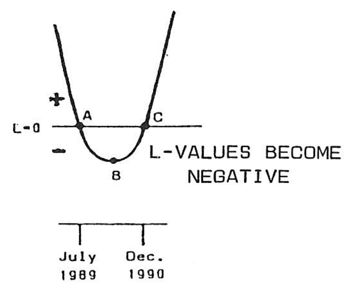
Fig. 15 Two criteria for an anomalous solar passage

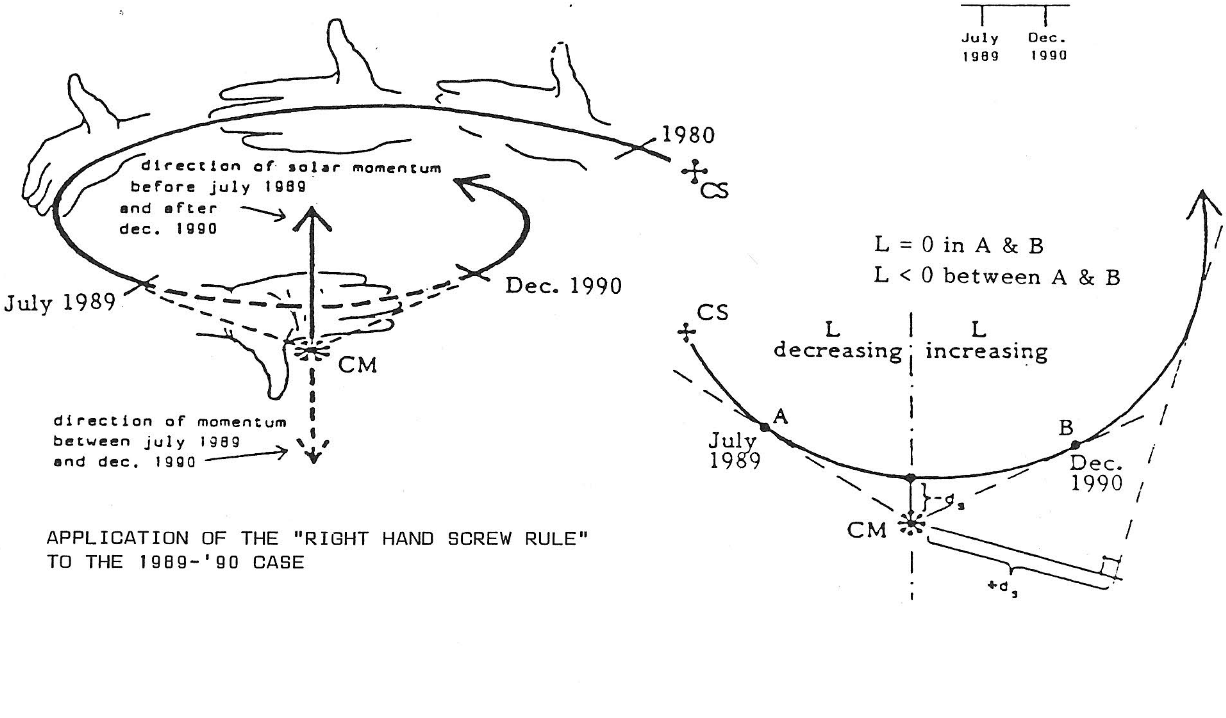


The retrograde movement of the Sun during an anomalous passage creates a situation in which L-values fall below zero, becoming "negative". Another, more precise way of saying the same thing is that the solar orbital angular momentum reverses direction (see fig. 16). The implications of such a reversal are hard to imagine, and harder to predict - that is, unless the phenomenon as such (a fluid, rotating and electrically charged body - the Sun - moving in a retrograde direction through a magnetic field - the galaxy) has been experimentally investigated by some kind of simulation in a laboratory. To our knowledge, no simulation of this nature has yet been undertaken.

Fig. 16

Reversal in direction of solar momentum





APPLICATION OF THE "RIGHT HAND SCREW RULE" TO THE 1989-'90 CASE

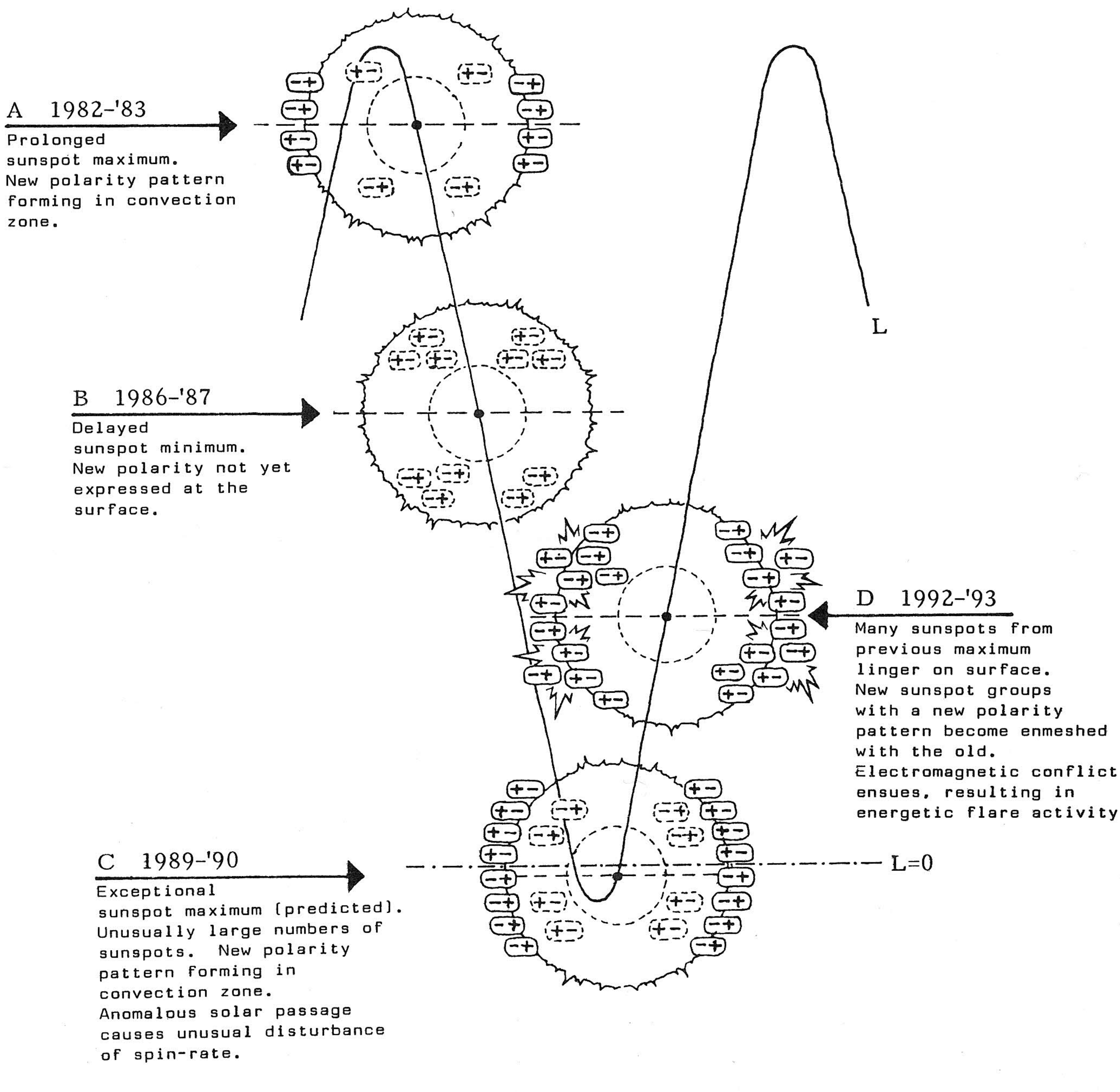
There are good physical reasons for believing that anomalous L-minima subject the Sun to more than usual stress (eg. the extreme tightness of curvature of the solar path during such passages), with accentuated changes in spin-rate and disturbance to the electromagnetic stability of the solar body as a consequence. In addition, there is convincing empirical evidence suggesting that this type of minima is capable of producing extreme fluctuations in climate, as well as sudden surges in seismic/volcanic activity on Earth (see p. 22 and Appendix 4).

What happens when an anomalous minimum clashes with an extreme sunspot maximum?

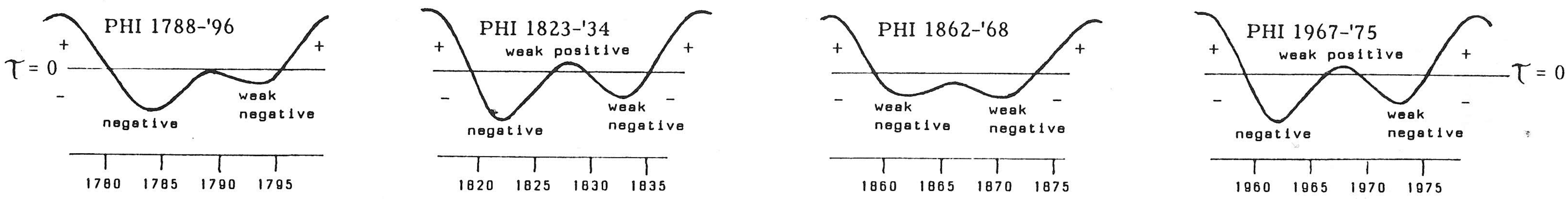
Firstly, the Sun is subjected to the marked disturbance of its spin-rate noted above, while at the same time expressing large numbers of sunspots. However, as the maximum peaks, a new strong cycle is already being generated within the solar body, resulting in new sunspots with a new polarity rapidly rising towards the solar surface - since positive dL/dt values (ie. the L-gradient) will at the time be rising unusually fast.

Fig. 17 Relationship between curve of solar angular momentum (L) and patterns of sunspot polarity between 1982 and 1993

(anomalous development - sunspot cycle out of phase with L-curve)



Development of Solar Torque (Ƭ) during four phase interferences (PHI) in the L-curve. program: adapted JPL (Shirley/Wilson)



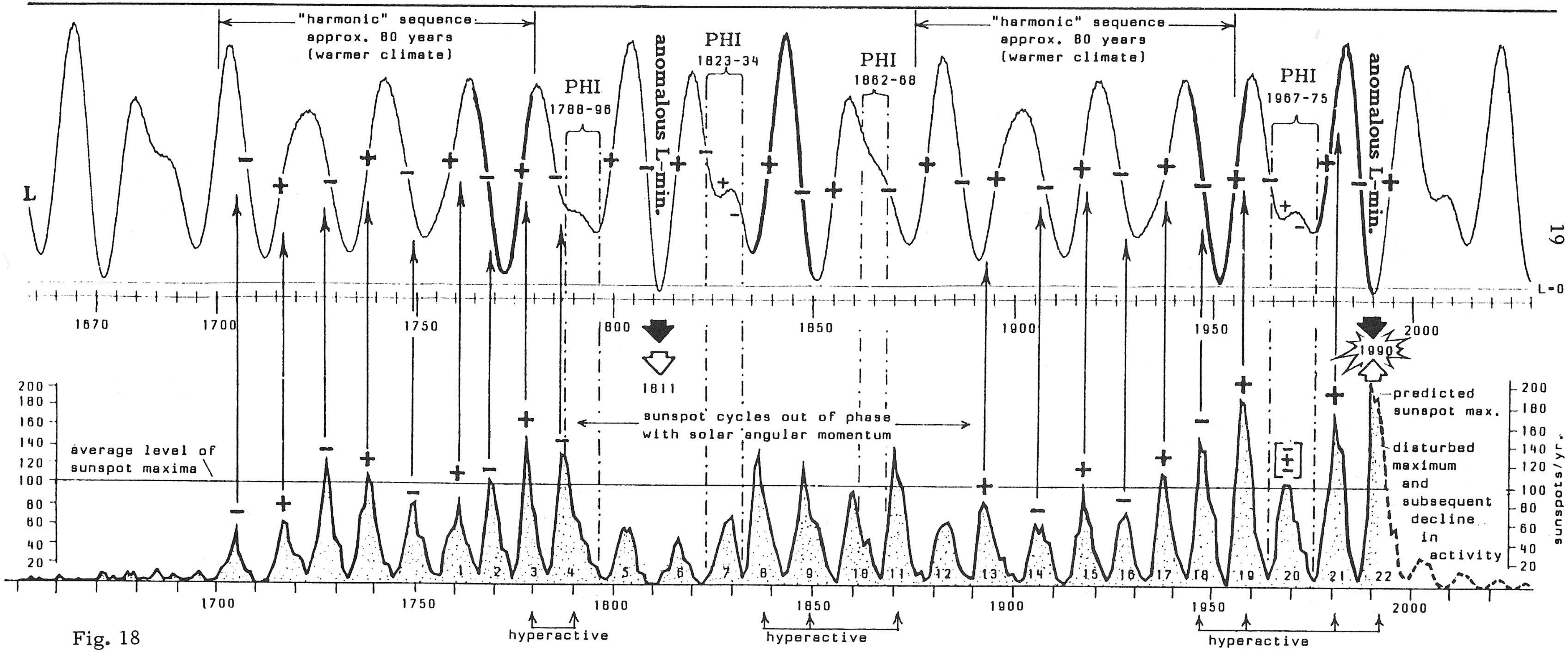


Fig. 18

PHASE INTERFERENCES AND MINIMA IN SOLAR ANGULAR MOMENTUM RELATED TO DISTURBANCES IN SUNSPOT ACTIVITY

Curve of solar angular momentum -- program: N.Carlborg 1988
Annual mean sunspot numbers -- Eddy/Waldmeier 1976

Thus when the new cycle approaches culmination there will be numerous sunspots left over from the previous cycle still lingering on the surface. This will lead to a conflict between opposing patterns of polarity, probably resulting in extraordinary flare outbreaks in the heavy X-ray class (X-flares), including unusually powerful streams of protons and electrons, This situation can only be aggravated by the disturbances in the solar spin-rate mentioned earlier, these probably being most marked during the couple of years immediately after the minimum. Such rotational disturbances could be expected to disrupt the relationship within and between sunspot groups, confusing polarities and causing further electromagnetic disorder, with even more exaggerated flare activity as a consequence.

The final result of such unusually hyperactive behaviour on the part of the Sun would probably be successive exhaustion of the solar magnetic process during the decades following the event. This would certainly have a dampening effect on several subsequent sunspot cycles, and thus also on the level of solar activity in general.

It is therefore of some concern to note that just such a situation as described above will arise during the period 1990-'93 (see fig. 17).

A decisive factor in this context, as far as can be judged from the record of the last 200 years (fig. 18), is that when a number of agitated (hyperactive) sunspot cycles succeed one another - they will relatively soon be compensated by a similar number of dampened cycles. Note in the figure, for example that the powerful cycles 3 and 4 were immediately followed by the weaker cycles 5, 6 and 7, in conjunction with the anomalous L-minimum in 1811. Note also that cycles 8, 9 and 11 were followed by the somewhat subdued cycles 12, 13 and 14.

Of particular interest, however, is the almost total disappearance of sunspots throughout the period 1640-1700 (the so-called "Maunder minimum" see below), following what may be supposed were powerful cycles during the preceding period 1600-1640. This latter sequence seems to have been abruptly broken about 6-7 years after the anomalous L-minimum of 1632 (not shown in the figure).

In this context it would be appropriate to point out that at the time of the last anomalous L-min. in 1811 there were no (zero) sunspots on the Sun, whereas in 1632 sunspot numbers are estimated to have reached 20 (Eddy/Waldmeier, 1976).

In 1811, the reaction of the climate system was constrained. Temperatures certainly fell (only partly due to the accompanying volcanic effect - see Appendix 4), but nothing like as low or as prolonged as after the 1632 passage. This may have to do with the total dearth of sunspots in 1811, implying a muted Sun, its processes running in very low gear. Under such conditions, the shock of an anomalous passage would have little effect on the solar mechanism.

In 1632, on the other hand, the climatic response was very marked (the volcanic, rather less so). Although only 20 spots are estimated for the actual year of the passage, only two or three years afterwards (1634-'35), the solar surface was alive with sunspots, protuberances and massive flares - as the illustration by Kirchner/Sheiner on the back cover of this report indicates. Five years after this, the rhythm of sunspot activity suffered total collapse, several subsequent cycles completely failing to materialise. This has been connected with the last, so-called "little ice-age", when Europe was gripped by a series of bitter winters and cool, wet summers between ca.1640 and 1700 (Eddy, 1976).

These observed and inferred reactions can be expected, since they are a natural consequence of the inner mechanics of the solar oscillation. The pattern of sunspot cycles cannot maintain a rising trend forever. In the long run, this pattern must faithfully reflect the fundamental, dynamic equlibrium ensured by the 180-year periodicity in solar motion which has already been discussed in terms of its 80-10-80-10-year substructure.

Here it is worth remembering that the 1990 anomalous minimum occurs after a series of no less than 4 unusually powerful cycles (18, 19, 21 and 22), of which the current cycle is without doubt the most extreme since measurements were first undertaken (see fig. 19).

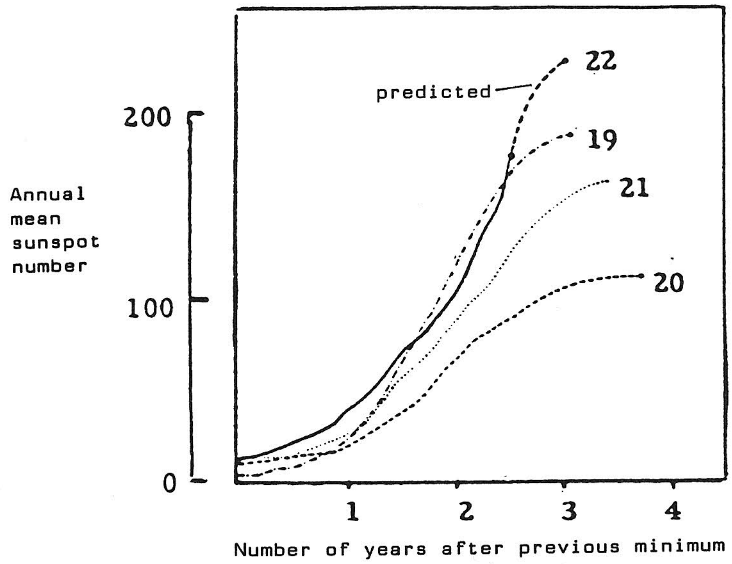


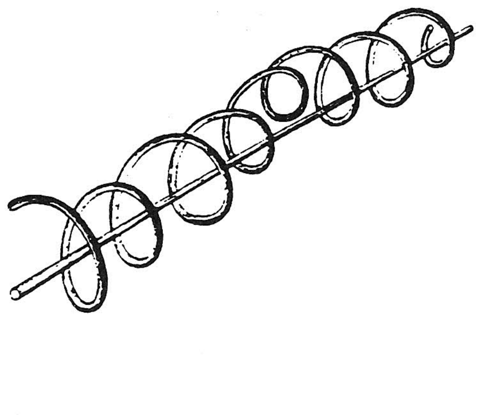
Fig. 19

The rise of sunspot cycle 22 compared with the rise of previous cycles

from IPS Radio and Space Services

There is thus every likelihood that the 1990 L-minimum will be followed by a period of 40-50 years when sunspot activity will be almost non-existent - as was the case during the period after the 1631-'40 sunspot cycle, presumably as a result of disturbance to that cycle by the 1632 anomalous minimum.

The record of the past, however incomplete, clearly indicates a close link between sunspot numbers and levels of global temperature. Whether this means that we may expect a "little ice-age" after 1990 - such as that during the 17th. century - or something worse, is anyone's guess at the moment. What we can be sure about, however, is that the supposed intensification of the greenhouse effect (due to increased levels of carbon dioxide and other trace gases in the atmosphere) is not going to have everything its own way. Any warming effect on the atmosphere that this latter phenomenon may cause will have to struggle for dominance against what may well be a considerably more powerful cooling effect caused by a sharp and prolonged reduction in the level of solar radiation.



The solar oscillation and the climate

The importance of the solar oscillation for the terrestial climate can be gauged by studying the following simple calculations:

According to currently accepted estimates, the fusional process at the heart of the Sun expresses a total, average radiational effect at the solar surface of 3.9 x 10^{26} W (J/s). That figure can be compared with those changes in kinetic energy that accompany the oscillatory motion of the Sun. The respective increase and decrease in kinetic energy that takes place between the two extreme positions on the solar path around CM (L-max. and L-min.) ranges between approx. **1 and 2.3 x 10^{32} J.**

In extreme cases, the orbital velocity of the Sun changes from a minimum of below 1 m/s - when very close to CM - to well above 15 m/s when furthest from CM, and vice versa, rendering a change in kinetic energy of approximately 1.989 x 10^{30} (15^2 -1) /2 = 2.3 x 10^{32} J.

These changes develop over a period that varies between 7 and 16 years. Accordingly, when the variations in kinetic energy are translated into terms of effect, they imply change in the range of 0.2 - 1 x 10^{24} J/s, which represents **0.05 - 0.25%** of the total radiational effect of the Sun.

These figures agree remarkably well with the small variations in solar radiation that have been observed during recent years with the help of measurement from satellites (Solar Maximum Mission). These measurements show a 0.1-0.2% fall in radiational effect between the 1980 sunspot maximum and the 1986 sunspot minimum. This is equivalent to a difference in the amount of solar radiation reaching the Earth of 4-6 W per square meter. This may not sound much, but when spread out over the entire surface of the planet nevertheless has considerable effect. It represents a theoretical drop in average global temperature of about **0.5°K.** (Willson et al, 1988).

Good agreement can also be noted with the magnitude of those cumulative, century-long variations in temperature that can be shown (by analysis of bore samples from the ocean bed, the polar ice-sheets and peat bogs) to have occurred during the last 11-12 000 years - the duration of the present interglacial period. At times, these temperature fluctuations have amounted to as much as **1-2° K**, a figure that in practical terms describes quite extreme change in climatic conditions - including a number of little ice-ages during the period in question. See fig. 20, showing reconstructed temperature variations over the Greenland ice-cap 0-12 000 BP (nb: a change in temperature of 8°K over Greenland can be judged to be equivalent to a change of ca. 2° K in the average global temperature of the planet).

The arrows in the diagram indicate those occasions in the past when the L-curve has passed through particularly extreme phases in its development, sequences which include anomalous L-minima (dates given). After a pause of ca. 1200 years since the end of the last series of anomalous minima, a new series is now under way - commencing with the 1632 and 1811 solar passages and continuing with the somewhat more marked passage of 1989-'90. The present series will end with the anomalous passage in 2169 AD.

Thus, both the empirical evidence and theoretical considerations suggest that the solar oscillation plays a decisive role in the development of the terrestrial climate. The solar radiational effect maintains, for example, an average temperature at the surface of the planet that, according to current measurements, lies at ca. **285°K.** A particularly marked disturbance of the solar oscillatory rhythm (such as could be expected in conjunction with anomalous L-minima) would probably be capable of achieving a dampening effect of at least 0.3%. Such a reduction in the solar radiational effect would theoretically lower the average temperature of the Earth by 0.3% x 285 K = ca. **0.8°K** over a decade - or even more, if possible non-linear effects are taken into consideration.

It can thus be concluded that the solar oscillation (expressed as changes in the solar, orbital, angular momentum), in terms of energy, almost exactly fulfills the demands that must be met if this phenomenon is to qualify as a primary factor of climate change on Earth.

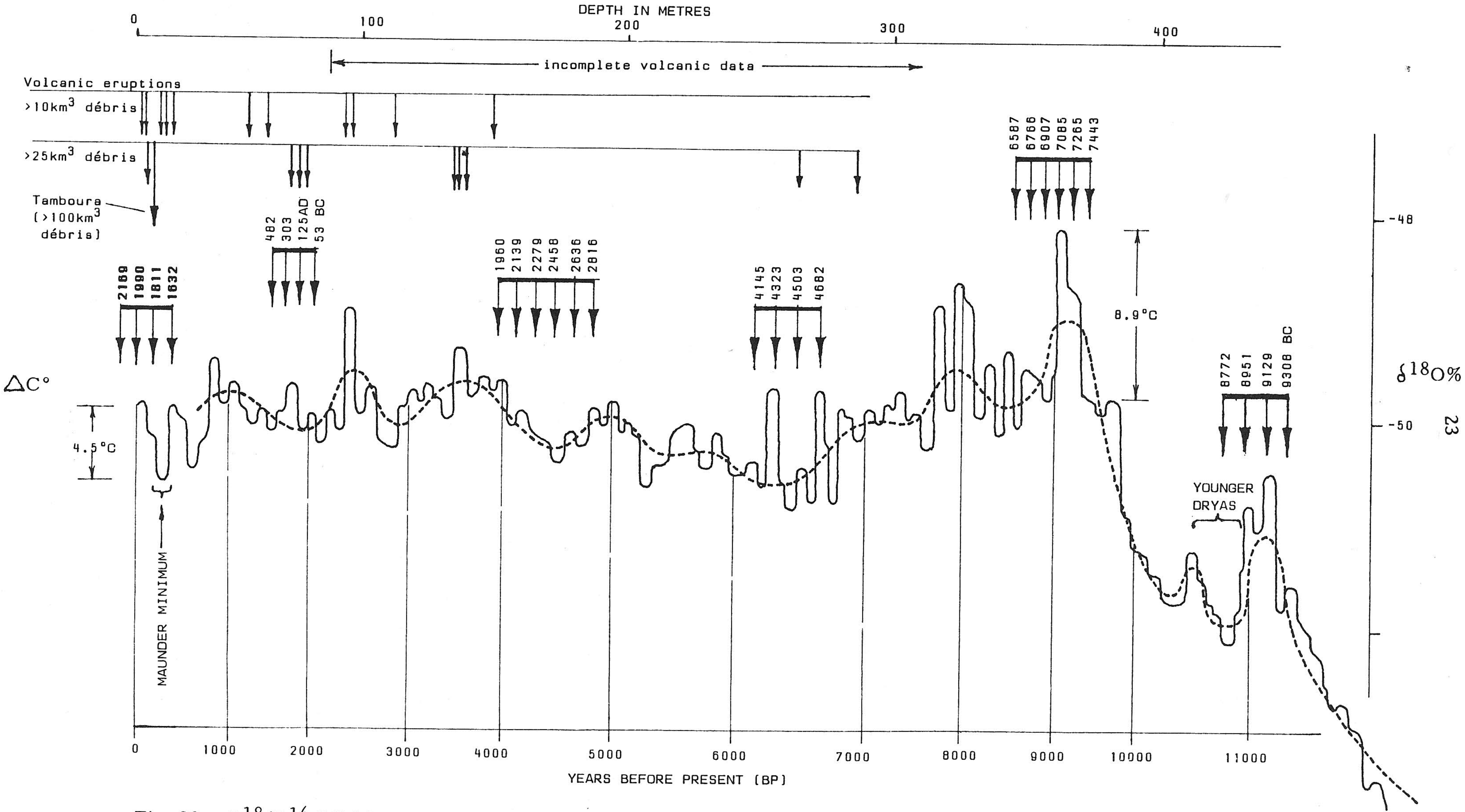


Fig. 20 O^{18}/O^{16} RECORD FROM GREENLAND ICE-CORE (Dome C) after Dansgaard
COMPARED WITH EPISODES OF ANOMALOUS SOLAR EVENTS
AND ALL KNOWN LARGE-SCALE VOLCANIC ERUPTIONS (> 10 km³ débris), 0-11 000 BP

Infrastructure for an integrated climate model

The actual process whereby these energy transactions take place is more difficult to describe; there are still many tantalisingly blank areas on our map of the workings of the solar system. Nevertheless, evidence suggests that the solar oscillation is capable of generating sufficiently strong impulses to steer or modulate a number of vital subordinate processes in the Sun and on the Earth. All these are either known or suspected to be directly or indirectly responsible for observed fluctuations in the Earth's climate. The most important of these subordinate processes are listed below:

Changes in:

the spin-rate of the Sun;
the flow of convectional currents within the Sun;
the number and size of sunspots;
the Sun's flare activity;
the intensity of radiation at the solar surface.

Non-seasonal changes in:

the spin-rate of the Earth;
the terrestrial magnetic field;
seismic and volcanic activity;
the ocean currents;
the atmosphere.

If these general insights are adopted as a guiding light when attempting to organise the many different factors that condition the Earth's climate, it becomes possible to construct a simple principle outline of how these are related. Such an outline, revealing a complex hierarchy of cause and effect, can be found in the form of an block-diagram in fig. 21 and in the more graphic illustration in fig. 22.

It would probably be saying too much to call this outline sketch a model for how the climate system works. The sketch represents rather an infrastructure upon which an integrated model of the climate can be built - one that can be claimed to agree with known facts and scientifically accepted notions of how the laws governing the Earth and the solar system actually work.

The square in the block-diagram dealing with the interaction between the Sun and the planets should be explained in more detail. What we wish to say here is merely that variations in the solar orbital, angular momentum (L_O) affect both the spin rate of the Sun and the angular momentum of the planets (respectively L_S and L_P). It is this interaction that releases the energies which transform terrestrial parameters to the extent that short and medium-length change in the Earth's climate (< 1000 years) can occur.

As should be apparent from these diagrams, the influence of the solar oscillation on the climate is exerted along several different paths. On the one hand, via changes in the spin-rate of the Earth, changes in the terrestrial magnetic field and, especially important, changes in the level of seismic/volcanic activity - all intimately connected factors. On the other, via medium-term changes in solar activity (ie. changes in the magnetic field and radiational flux of the Sun).

In addition, account must be taken of the extremely slow, long-term changes in the orbital elements of the Earth, and in the tilt and orientation of its axis (Milankovic variables), which over periods of 10 000 - 100 000 years either promote or disfavour a transformation to glacial conditions. **For such a transformation to take place, however, there must occur an interaction between these long-term factors and those governed by the solar/planetary agent.**

Fig. 21 CHANGE IN THE TERRESTIAL CLIMATE — CONTRIBUTING FACTORS

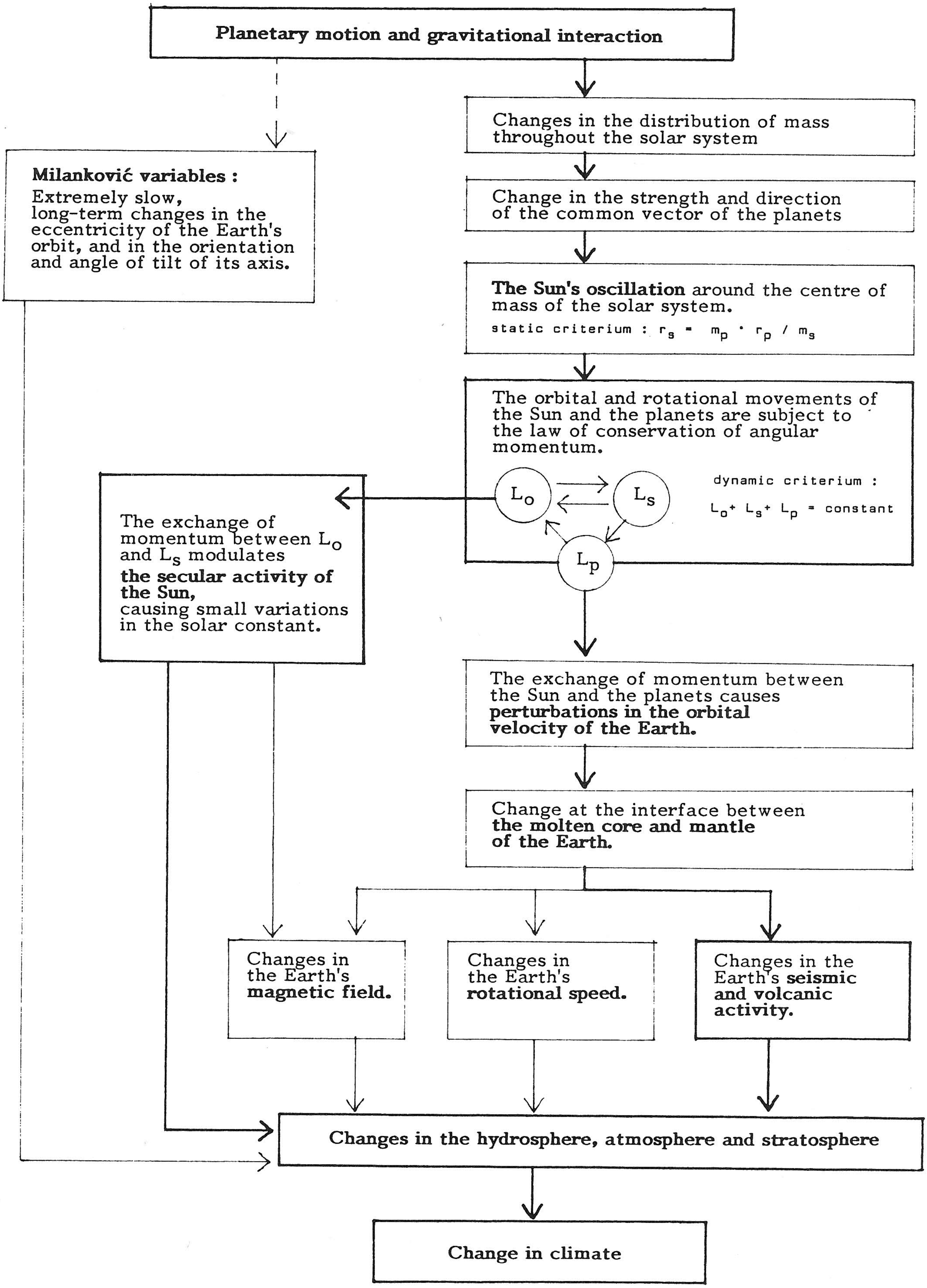
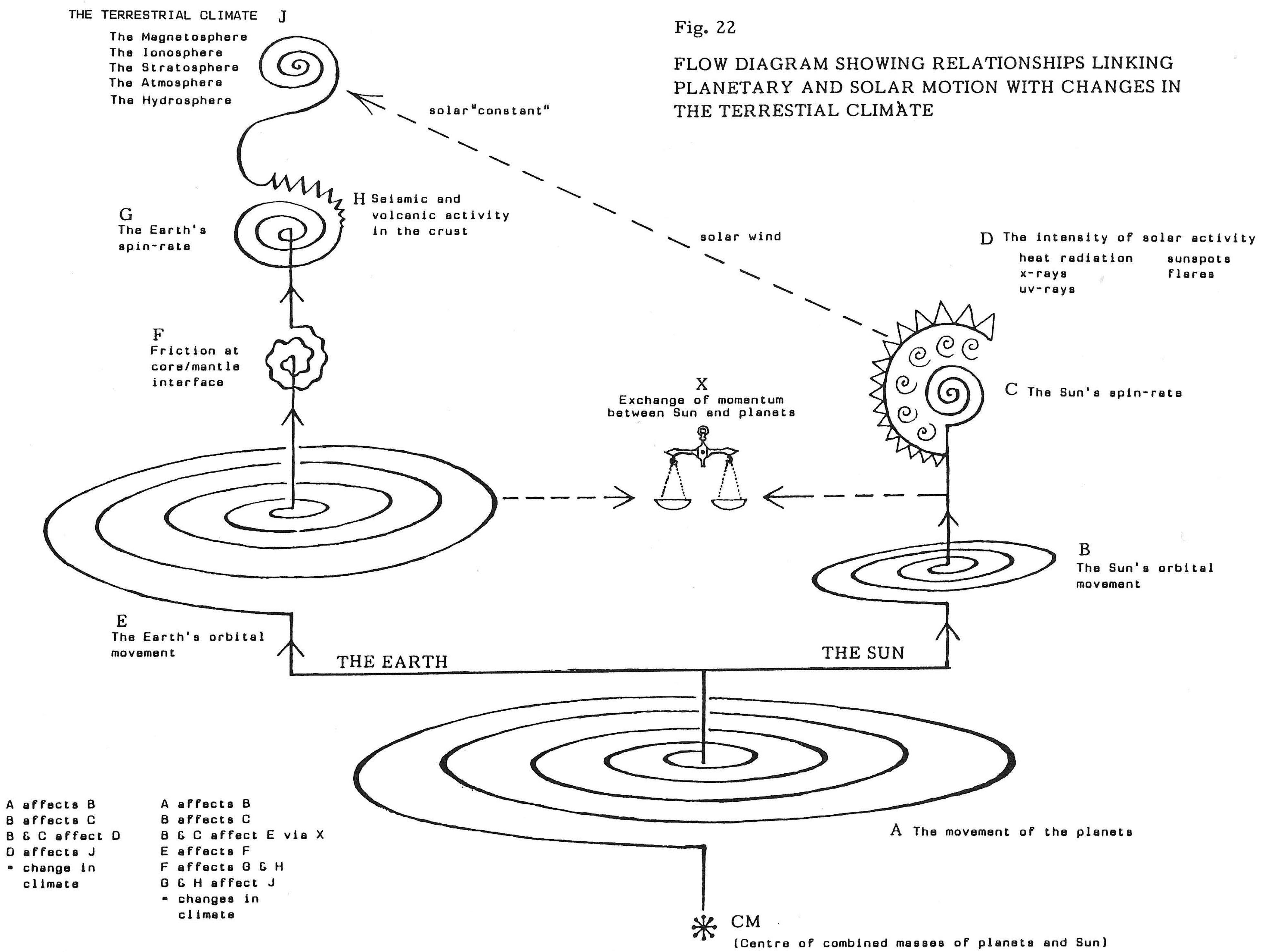


Fig. 22

FLOW DIAGRAM SHOWING RELATIONSHIPS LINKING PLANETARY AND SOLAR MOTION WITH CHANGES IN THE TERRESTIAL CLIMATE



This latter statement represents a completely new contribution to the debate on ice-age mechanisms. It rests on the assumption that the solar oscillation does indeed modulate the frequency and amplitude of the sunspot cycle (and therefore the level of solar activity in general), and that this is the primary factor governing short and medium-term fluctuations in the Earth's climate. Having once accepted the importance of this factor, it would be reasonable to suppose that it also plays a role in long-term climate change.

This, at any rate, is surely a more plausible hypothesis than that proposing the "greenhouse effect" to be the primary modulating factor of the Milankovic effect (an idea most recently propagated by John Gribbin in New Scientist, 17 June 1989, where he quotes Shackleton's work with sediment cores).

It is true that without some form of help, the Milankovic variables would never of themselves have been able to impose on the planet precisely those fluctuations in global temperature that we find in the reconstructions of the paleo-climatologists. However, whether varying levels of carbon dioxide in the Earth's atmosphere really do act as a climate-forcing factor, either today or in the distant past, is still a matter of contention among climatologists. It will take quite a few years before we know the answer to that question.

In the meantime, we should consider at least two further modulating factors: (1) a periodic sequence of cooling impulses, imposed by a combination of increased vulcanism and changes in the Sun's energy output, both these effects being ultimately caused by the solar oscillation, and (2) a sequence of warming impulses, imposed by the same mechanism when operating in its more stable mode. The interaction between these two factors and the Milankovic effect would finally express itself in a variable temperature-budget determined, on the one hand, by changes in the degree of **insolation** (incoming solar radiation), and on the other, by changes in the **albedo** (reflectivity) of the planet.

These warming and cooling impulses may, under certain extreme circumstances, be marginally reinforced or dampened by the "greenhouse effect", depending on the current state of balance between fauna and flora on the surface of the planet. In the uniquely unbalanced conditions of today, no one can forecast for certain the outcome of any eventual struggle between an artificially intensified greenhouse effect and impulses coming from outside the earth-system. Nevertheless, it should be borne in mind that these latter represent energies far in excess of any attributable to the former, even though the extra-terrestrial impulses in question constitute only a minute proportion of the total amount of energy in circulation within the system as a whole at any one given time.

There are therefore no grounds for complacency when it concerns the likely state of the climate during the next 20 years or so. We could as easily be facing a catastrophic cooling as a catastrophic warming. What this means in practice is the need for a revaluation of current thinking - before too many irreversible decisions are made. Many of those decisions may prove to be correct in the long run - eg. certain currently planned readjustments in energy policy. If so, this will largely be a question of luck, since decision-makers today have hitherto been working on the basis of unduely selective assumptions. What we need is a more comprehensive strategy, geared to preparing an appropriate response to the full range of actual conditions we may be facing within a very few years.

An after-thought

Regarded from the view-point outlined in this text - a choice of perspective well motivated by the available facts relating to the processes under discussion - the L-curve can be seen to reflect a basic, system-supporting rhythm within the solar system, a pulsating beat to which all geophysical, and therefore also biospheric processes on the Earth must harmonise. The survival and well-being of all terrestrial organisms (including the human) is therefore ultimately dependent on the state of this basic rhythm (to understand that this must be so, it is sufficient to remember, for example, that microbes mutate faster and are many times more aggressive during sunspot maxima, or that termites eat 10 x more under such conditions than otherwise).

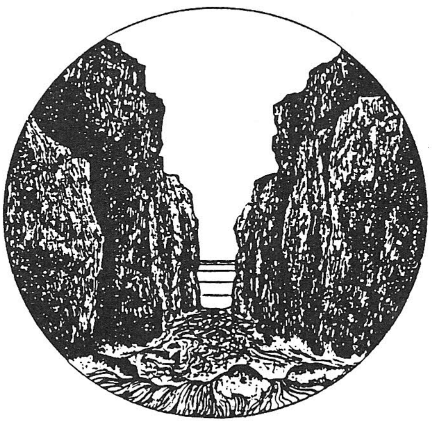
Human history - to the extent that such be written in a less anthropocentric and/or mythological fashion than is customary today - should therefore take the form of a story, telling how individuals, societies and entire cultures have reacted in the past to the variations in geophysical conditions that this continuous, cyclical process of gradual, and sometimes drastic change in solar activity seems capable of initiating.

The rise and fall of civilisations (even of our own) can therefore be seen to reflect the more or less successful attempts of human beings to adapt themselves, their institutions and various social and cultural systems to the imperative manifested in the insistent rhythm of the "base drum" of the solar system - the solar oscillation.

It is therefore a delusion to believe that human beings, whether seen as individuals or as a collective, are capable of "creating their own future" - other than in a very improvised manner. Human freedom of action to change the conditions of life is severely restricted by fundamental environmental limits, immutably imposed by powerful cyclic forces at work in the solar system as a whole (generally, these restrictions are intimately connected with economic factors, a relationship that is discussed in the brief analysis presented in Appendix 5, showing the utter dependence of business cycles in the modern world upon the solar-planetary process).

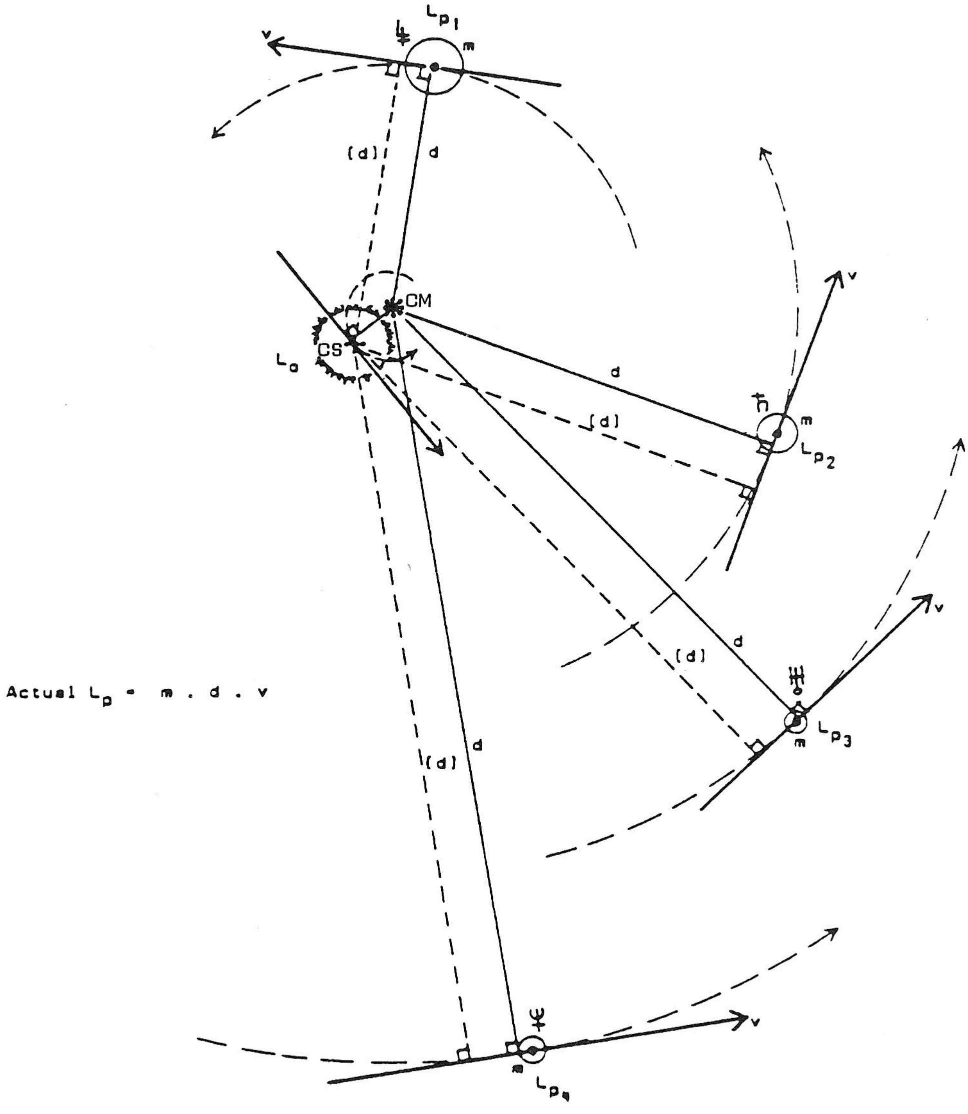
Scientifically speaking, this means that without knowledge of how the curve of solar orbital, angular momentum has developed in the past, and without having first deciphered the "code" it contains, no reliable predictions can be made, either of future trends in the natural world, or in human society itself.

Philosophically speaking, it is also easy to appreciate the vulnerability of societies constructed without inbuilt, psychological and practical preparedness to deal with the full consequences of short and medium-term variations in the Earth's climate. Such societies will never be able to guarantee their members any permanent material or spiritual prosperity.



APPENDICES

Fig. 23 CM & CS - two alternative central reference points for calculating values of planetary momentum



APPENDIX 1

THE ROLE OF CM IN THE SOLAR SYSTEM

The solar system is a vortex of rotating masses revolving around a common centre. Adhering strictly to Newtonian principles, CM must be regarded as the true centre of this vortex, not only because this point is the only part of the system that travels in a straight line through the galaxy (seen in a < 1000 year perspective), but also because CM is the point around which the oscillating Sun rotates.

Numerous investigations testify to the fact that the solar orbital motion around CM is not just a relativistic abstraction adopted in celestial mechanics to facilitate calculation. On the contrary, this relationship reflects an authentic balance of forces that is of fundamental importance for both the Sun and the planets.

If this statement is correct, it also becomes neccessary to recognise that the law of conservation of angular momentum - if this law is to have any meaning at all - must refer to a system in which CM is the sole, natural point of reference. Accordingly, the true value of angular momentum for a planet at any given time must be slightly different from the value that can be extracted from the standard ephemeris (**d** differs from (**d**) - see fig. 23).

Neither can the constant corrections in orbital speed of this planet - made in response to changes in the orbital movement of the Sun - be calculated exactly, unless the standard ephemeris includes the explicit criterion that the combined solar and planetary momentum (calculated with CM as reference point) shall remain constant.

In other words, merely knowing the approximate eccentricity of the planetary orbits and applying the law of mutual gravitational attraction (ie. solving the 3-body problem) is not enough to ensure a correct result regarding actual changes in the orbital velocity of the planets.

In general, of course, these differences are so small that a system which assumes the Sun to be the true centre will provide quite acceptable results for all practical intents and purposes. Deviations from calculated positions have, however, been observed (eg. Jupiter and Neptune during the 70's) which suggests the validity of the above line of argument - that is, provided one dismisses from consideration the rather unlikely possibility that a tenth planet of sufficient mass exists somewhere out there beyond the orbit of Neptune.

For our purposes here, it is sufficient to emphasise that during certain anomalous passages of the Sun past CM, estimates of planetary velocities and positions based on the ephemeris will differ significantly from estimates based on a system where CM is the reference point. In these cases, reliance on the ephemeris will only succeed in obscuring the real effect of such a passage on the planets.

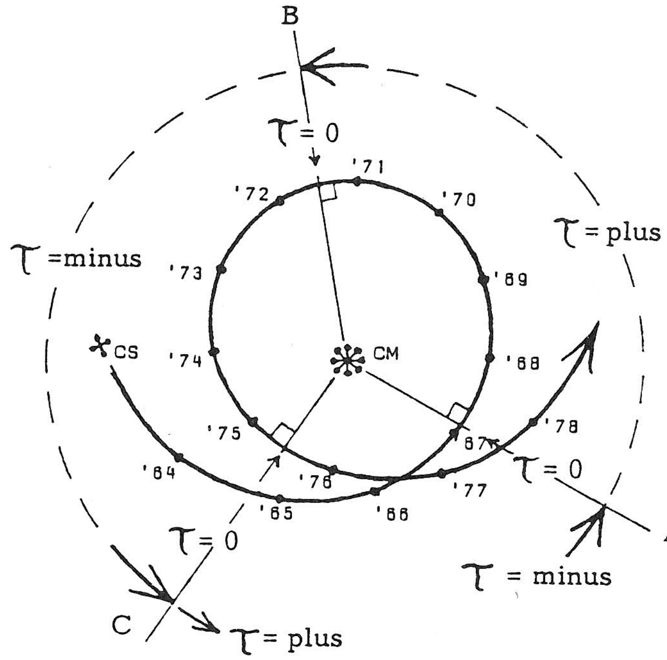
APPENDIX 2

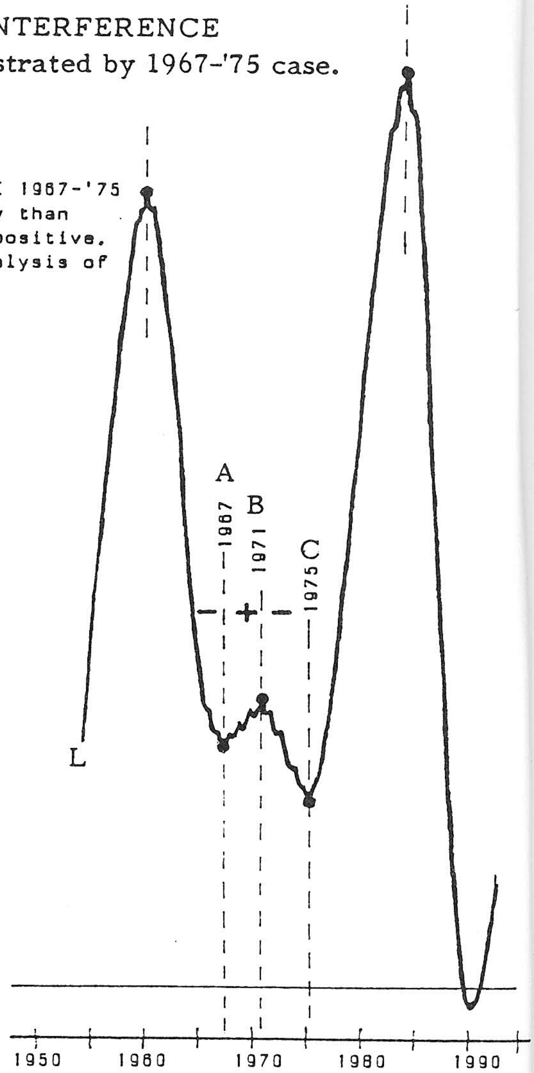
THE MECHANICS OF PHASE INTERFERENCE (PHI) IN THE L-CURVE

TYPE OF SOLAR LOOP ASSOCIATED WITH PHASE INTERFERENCE IN CURVE OF SOLAR ANGULAR MOMENTUM — illustrated by 1967–'75 case.

Weak and vaccilating torque impulses create disturbance and hesitancy in sunspot cycle.

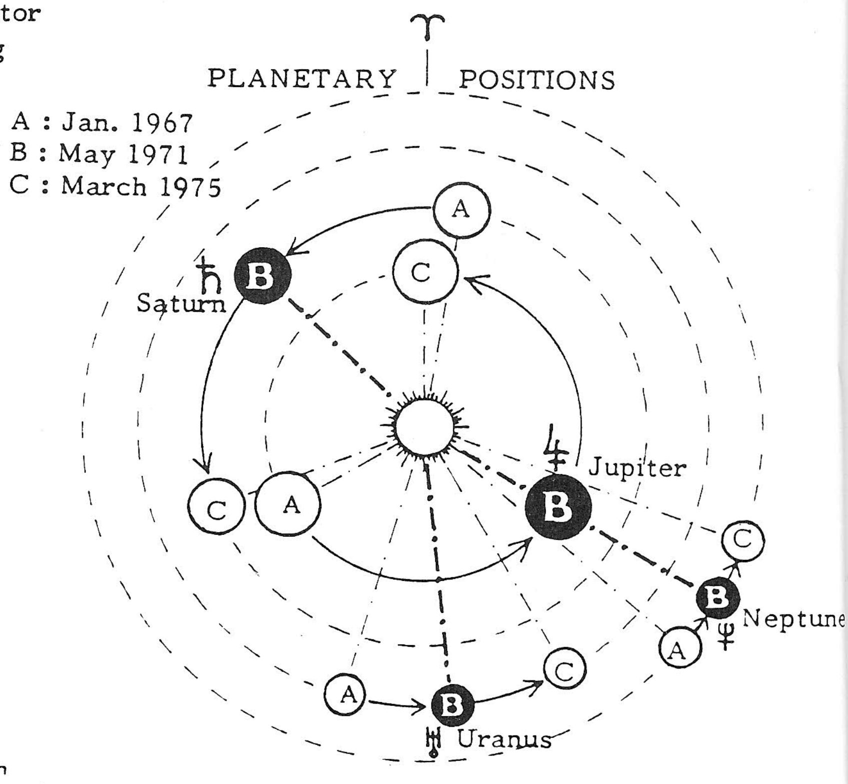
nb: For the sake of distinction, it should be noted that PHI 1967-'75 has a fundamentally different effect on sunspot activity than PHI 1788-'96, due to the short-lived intermission of a positive, albeit weak torque impulse (1967-'71) -- see further analysis of sunspot cycle.





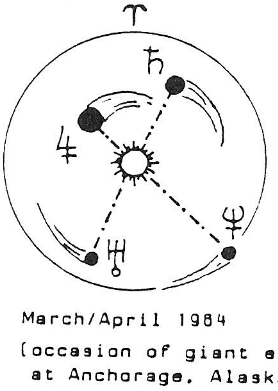
Cause of phase interference :

Positions of Uranus and Neptune are such that their combined vector reinforces Jupiter's vector during a Saturn/Jupiter opposition.



TWIN-OPPOSITIONAL CONSTELLATION

(Jupiter/Neptune-Saturn/Uranus)



March/April 1964

(occasion of giant earthquake at Anchorage, Alaska)

signalling approaching Jupiter/Saturn opposition and accompanying phase interference.

APPENDIX 3

INCIDENCE OF ANOMALOUS L-MIN./EXCEPTIONAL SUNSPOT MAX. COINCIDENCES

Observations of sunspot activity during the last 200 years show that a sunspot maximum reaching a sunspot number above a yearly mean of 180 is rather unusual. Only 5 such cycles (cycles 3, 18, 19, 21 and 22 - see fig. 18) out of a total of 27 have appeared during the period in question. Of these cycles, the present (cycle 22) is incomparably the most powerful, rapidly approaching a sunspot number well above 200 (see fig. 19) - more than double the average level of all known sunspot maxima.

As explained in the main text, this exceptional maximum will coincide, to the year, with the anomalous L-min. 1990, a rare coincidence which threatens to produce exceptional electro-magnetic interactions on the Sun with potentially quite serious consequences for many natural processes on Earth.

It would therefore be useful to ask whether any comparable event has occurred in the more distant past - this might give valuable hints as to what we may expect during the next few years.

Unfortunately, this important question cannot be answered with full certainty. It is not known how sunspot cycles developed before the beginning of the 17th century - before the invention of the telescope. A coincidence of the kind envisioned here cannot therefore be identified earlier than ca. 1600. What is known for sure is merely that such a coincidence did not occur at the time of the last two in the present series of anomalous L-minima, ie. in the years 1632 and 1811. On both these occasions sunspot numbers were at a low ebb (< 20 in 1632 and none - zero - in 1811).

However, provided one uses the frequency of extreme sunspot maxima (> 180) during the last 300 year period as a sample, assuming this sample to be representative for the whole period during which anomalous L-minima can be identified (11 308 years - see table 1) - a legitimate assumption - it is possible to calculate exactly the probability of a concidence of these two kinds of events occurring during a particular year.

Such a calculation is presented in table 2. It shows that **only 0.434** such coincidences can be expected to have occurred during 11308 years - a result which is equivalent to **once in 26055 years.** A similar calculation was also carried out (not shown here) to establish the probability of a coincidence of an anomalous L-minimum with a sunspot maximum at any level of sunspot numbers. It showed that **only 4** such coincidences can be expected to have occurred during any given 11308 year period.

No definite conclusions can, of course, be drawn on the basis of these calculations. Nevertheless, it can be maintained that it is rather unlikely that another event identical to the 1990 event occurred at any time during the last 11 000 years. Or one could take a more generous standpoint and say that possibly one, or at the most two such events occurred. If the latter were the case, one might reasonably suspect that the event/s in question occurred during periods when the Earth's climate experienced a particularly severe cooling.

The period of the Younger Dryas (see fig. 20) would, in that case, be an obvious candidate. This 500-year long temperature recession at the beginning of the present interglacial - during which the ice-sheet once more began to advance and large parts of Europe returned to tundra-like conditions - is one of the most intriguing puzzles of contemporary climatology. No adequate explanation has yet been proposed for this unexpected break in the powerful warming trend that terminated the last glacial period. It is therefore tempting to see the series of anomalous passages 8772-9308 BC - located precisely over the point where the temperature curve begins to plunge - as a possible causative factor in this temporary return to ice-age conditions.

Within the near future (1990-'95) the behaviour of the Sun and the reactions of the Earth are likely to provide more definite answers to these questions.

Table 1: Number of expected sunspot maxima > 180 spots (annual mean)) and number of anomalous L-minima ocurring 0 - 11 308 BP

Period no	Period	Length of period (years)	Expected no of sunspot maxima > 180	No of anomalous L-minima
1	1632 - 2000 AD	368	6	3
2	53 BC - 482 AD	535	9	4
3	2816 - 1960 BC	856	14	6
4	4682 - 4145 BC	537	9	4
5	7443 - 6587 BC	856	14	6
6	9308 - 8772 BC	536	9	4
				27

Table 2: Mathematical probabilities of a sunspot maximum of > 180 coinciding with an anomalous L-minimum

Period no	Probability	
1	1 - (362 x 361 x 360) / (368 x 367 x 366) =	0.048
2	1 - (526 x 525 x 524 x 523) / (535 x 534 x 533 x 532) =	0.066
3	1 - (842 x 841 x 840 x 839 x 838 x 837) / (856 x 855 x 854 x 853 x 852 x 851) =	0.094
4	1 - (528 x 527 x 526 x 525) / (537 x 536 x 535 x 534) =	0.066
5	1 - (842 x 841 x ....) =	0.094
6	1 - (527 x 526 x 525 x 524) / (536 x 535 x 534 x 533) =	0.066
		0.434
	11 308 years : 0.434 = 26 055 years	

APPENDIX 4

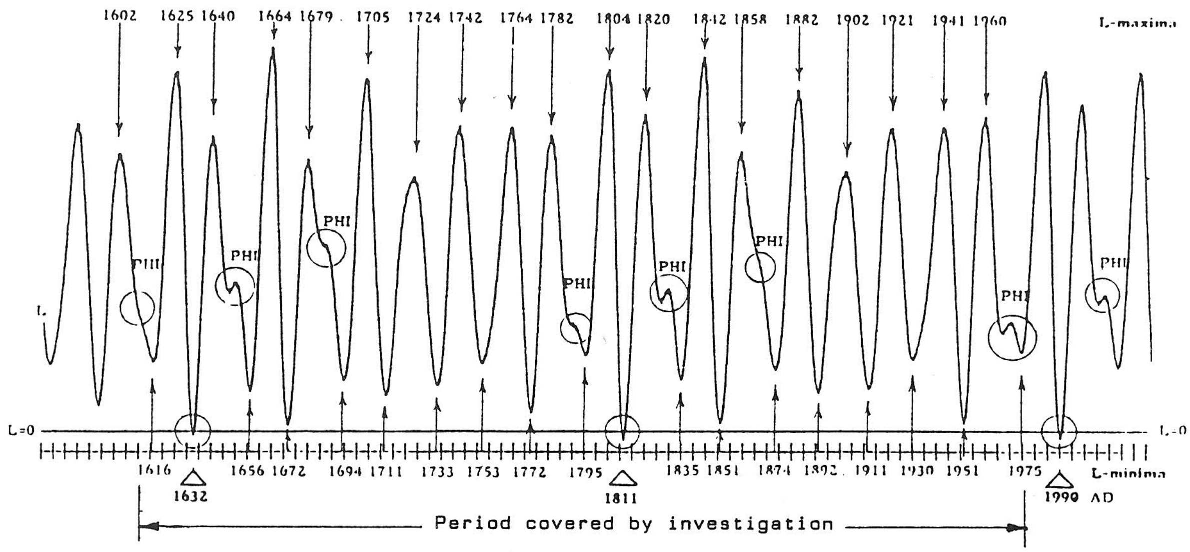
L-MINIMA AND THE VOLCANIC FACTOR

It has been pointed out in the main text that vulcanism is a vital factor in climate change. Furthermore, we have stated that the solar oscillation is the prime mechanism governing this factor.

The evidence supporting this latter statement is more fully presented in "The 1990 Solar Event - signal of terrestrial upheaval?" (Solaris Research Report, 89/2). This appendix summarises some results from the investigation described in that report.

Available data concerning large-scale vulcanism during the period 1600-1976 AD (see list of all known large-scale eruptions in table 3) were compared with the development of solar orbital angular momentum during the same period (see figure 25).

Fig. 25 Development of solar orbital angular momentum



It was found that a large number of these eruptions occurred in close temporal proximity (< 2 years) to those years when L-minima occurred. A statistical test gave the following result:

Period:	**376 years**
No of L-min. events:	**19**
No of large volcanic eruptions	**122**
Estimated average time interval between L-minima and eruptions fulfilling criteria:	**2 years**
No of eruptions fulfilling criteria:	**34 (x)**
No of eruptions not fulfilling criteria:	**88 (y)**
Total period encompassing x-events:	**38 years (t_1)**
Total period encompassing y-events:	**338 years (t_2)**

X- and y-events follow a Poisson distribution. By approximating the Poisson distribution with a normal distribution one obtains a good estimate of the value of z = the number of standard deviations from the mean under a zero-hypothesis:

$$z = (x / t_1 - y / t_2) \; / \sqrt{x / t_1^2 + y / t_2^2} = 4.08$$

P = <u>0.0000456</u> (< 1 : 21 000)

Table 3: Large volcanic eruptions 1600-1976

Sources :

M = 'Vulkanausbruch, Ursachen und Risiken' (1983), Münchener Rücksversicherungs Gt. München.

L = Lamb,H.H. (1970): 'Volcanic dust in the atmosphere; with chronology and assessment of its meterological significance'; Philosophical Transactions of the Royal Society, vol.A266.

S = Simkin,T. et al (1981): 'Volcanoes of the World', Huchinson, Stroudsberg, Penn.

E = Variousencyclopedias -- Encyclopedia Brittanica; Planet Earth series, Time/Life. etc.

DVI = Dust Veil Index (Lamb).
VEI = Volcanic Explosivity Index (Newhall & Self-1982)

● = Within one year before or after an L-min. passage
○ = Within two years before or after an L-min. passage

Total number of large eruptions 1600-1976 —— = 122
Number of eruptions within one year before or after an L-min passage —— = 34
Number of L-min. passages —— = 19
Total number of years 1600-1976 —— = 376
Total number of years between L-minima and eruptions fulfilling criteria (estimate) —— = 38
Number of years during which eruptions were not fulfilling criteria (estimate) —— = 338

L-minima	Date	Location	Débris km^3	DVI	VEI	Death-toll	Source
	1601	Unknown		1000+			L
1616 ○	1614	Little Sunda Is. Malaysia		1000			L
○	1630-'40	Etna, Italy - 5 eruptions					E
1632 ●	1631	Vesuvius, Italy				3000	M
●	1632	Öraefajökull, Iceland	>10				M
	1637	Gamma Kunnora, Moluccas					E
	1638	Raung, Indonesia		500		3000	M/L
	1640	Kamagatake, Japan	1	500		700	M/L
	1660	Omata, Peru	1			1000	M/L
	1660	Katla, Iceland		800			L
	1660	Pichincha		300			L
	1660	Teon, Banda Sea		300			L
	1669	Etna, Italy	0.75 (lava)			20000	M
●	1672	Merapi, Indonesia				3000	M
1672 ●	1673	Gamma Kunnora, Moluccas		1000			L
	1680	Tongoko, Celebes		1000			L
	1680	Krakatoa, Sunda St.		400			L
●	1693	Hekla, Iceland		300			L
●	1693	Serua, Moluccas		500			L
1694 ●	1694	Amboina, Moluccas		250+			L
●	1694	Celebes		250+			L
●	1694	Vesuvius, Italy					E
	1700	Long Is. Indonesia	>10			3177	M
	1704	Pico de Teide, Canary Is.					M
	1707	Mt. St. Helens, USA	1				M
	1707	Fujiyama, Japan					M
●	1710	Santorini/Nea Kamene, Greece	large sub-marine				E
1711 ●	1711	Awu, Indonesia					M
	1730	Raung, Indonesia				3000	M
1733 ●	1733	Lanzarote, Canary Is.	5-10 (lava)				M
	1741	Oshima-o-sima, Japan				1467	M
●	1752	Little Sunda Is.		1000		1200	L
1753 ●	1754	Taal, Philippines		300			M/L
○	1755	Katla, Iceland		1200			L
	1760	Makjan, Indonesia				2000	M
	1768	Cotopaxi, Equador	1				M
1772 ●	1772	Papandajan, Indonesia	1			2597	M
	1779	Sakurajima, Japan	1			140	M
	1783	Eldeyjar & Jökull, Iceland		2300			L
	1783	Lakispalte, Iceland	12 (lava)			10000	M
	1783	Asamayama, Japan	1	600		1162	M/L
	1785	Vesuvius, Italy		2500			L
	1792	Unzendake, Japan	0.5			10452	M
1795 ●	1794	Vesuvius, Italy					E
1811 ●	1812	Awu, Indonesia				953	M
○	1814	Mayón, Philippines		300		300	M/L
	1815	Tamboura, Indonesia	100-150	3000		56000	M/L
	1817	Kawah Idjen				2000	M
	1821	Eyjafjallajökull, Iceland		300			L
	1822	Galunggung, Indonesia	>1	500		4011	M/L
	1822	Vesuvius, Italy		300			L
	1829	Kliuchevskaja Sopka, Kamchatka	3-4				M
●	1834	Vesuvius, Italy					E
1835 ●	1835	Coseguina, Nicaragua	25				M/L
	1837	Avachinskaya Sopka, Kamchatka					L
	1842	St. Helens, USA					E
●	1850	Vesuvius, Italy					E
1851 ●	1852	Etna, Italy					E
○	1853	Usu, Japan			4		S
○	1854	Shevaluch, Kamchatka			5		S
	1856	Awu, Indonesia				2806	M
	1856	Komagatake, Japan			4		S
	1859	Mauna Loa, Hawaii	2.7 (lava)				M
	1861	Dubbi, Ethiopia				106	M
	1869	Purace, Columbia			4		S
○	1872	Vesuvius, Italy					E
1874 ●	1875	Askja, Iceland	>1		5		M/S
○	1877	Cotopaxi, Equador			4		S
○	1877	Suwanosejima, Japan			4		S
	1881	Nasu, Japan			4		S
	1881-'2	Mauna Loa, Hawaii	2(lava)				M
	1883	Krakatoa, Indonesia	18			36417	M/L/S
	1886	Tarawera, New Zealand	1.5			153	M
	1886	Tungurahua, Equador			4		S
	1888	Bandai-san, Japan	1.2		4	461	M/S
	1888	Ritter Is. Indonesia	1-2			3000	M
	1889	Suwanosejima, Japan			4		S
1892 ●	1892	Awu, Indonesia				1532	M
	1897	Mayón, Indonesia				1335	M
	1899	Dona Juana, Columbia			4		S
	1902	Soufrière, St. Vincent	1		4	1500	M/L/S
	1902	Mont Pelée, Martinique	1	100	4	30000	M/L/S
	1902	St. Maria, Guatamala		600			L
	1903	Tordahyna, Iceland			4		S
	1906	Vesuvius, Italy				700	M
	1907	Ksudach, Kamchatka			5		S
○	1909	Tarumai, Japan			4		S
1911 ●	1911	Taal, Philippines			4	2000	M/S
●	1912	Katmai, Alaska	16	500+			M/L/S
○	1913	Colima, Mexico			4		S
○	1914	Sakurajima, Japan			4		S
	1917	Agrigan, Mariana Is.			4		S
	1918	Katla, Iceland			4		S
	1918	Tungurahua, Equador			4		S
	1919	Manan, New Guinea			4		S
	1919	Kelut, Indonesia				5110	M
	1924	Raikoke, Kurile Is.			4		S
●	1929	Komagate, Japan			4		S
1930 ●	1930	Merapi, Indonesia				1369	M
	1937	Rabaul, New Britian	>1				M
	1943-'52	Paracutín, Mexico	12			1000	S
	1945	Kiuchevskoi, Kamchatka			4		S
	1946	Sarychev, Kurile, Is.			4		S
	1947	Hekla, Iceland			4		S
●	1951	Mt. Lamington, Indonesia				2942	M
●	1951	Hibokhibok, Philippines			4	2000	M/S
1951 ●	1952	Bagana. Solomon Is.			4		S
●	1952	Paracutín, Mexico					M
○	1953	Spurr, Alaska			4		S
	1956	Bezymianny, Kamchatka	1.5		4		M/S
	1963	Surtsey, Iceland			4		M
	1963	Agung, Bali	800+			3870	M/L/S
	1963-'65	Irazu, Costa Rica					M
	1964	Shevaluch, Kamchatka	1.5		4		M/S
	1965	Taal, Philippines			4		S
	1966	Lengai, E.Africa			4		S
	1966	Kelut, Indonesia			4		S
	1966	Awu, Indonesia			4		S
○	1973	Eldafjell & Vestmannaeyiar					M
●	1974	Fuego, Guatamala			4		S
1975 ●	1976	Plosky Tolbachik, Kamchatka	>1		4		M/S
●	1976	Augustine, Alaska			4		S

These results show that more than **90%** of L-minima during the period 1600-1976 were connected with large volcanic reactions. On the other hand, a separate study of L-maxima did not show any obvious correlation. Only 12 large eruptions out of a total of 122 occurred close to L-max. events, while 15 of the 19 such events covered in the investigation could not in any way be connected with large eruptions. This latter result only serves to emphasise the high statistical significance of the former investigation.

Another important result obtained concerns the relationship between **anomalous L-minima** and vulcanism. It was found that considerably more powerful volcanic reactions tend to coincide with anomalous solar passages than with other L-min. occasions. These reactions also tend to be accompanied by exceptionally large earthquakes.

In a further study (not shown), we sought to confirm these observations.

The seismic record before about 1900 AD is rather incomplete, a fact that in this case limited the investigation to somewhat less rigorous tests than one might have wished. Nevertheless, by selecting (1) only the largest eruptions known to have occurred in the past, and (2), by carrying out a special study of Vesuvius and Etna (for which the historical record can be considered complete), it was possible to establish significant correlations between anomalous L-minima and powerful volcanic reactions at least as far back in time as 475 BC (see "The 1990 Solar Event").

It can thus be concluded that volcanic reactions on Earth are unmistakably linked to the solar oscillation, and that in this respect L-minima should be regarded as critical, while anomalous L-minima are highly critical.

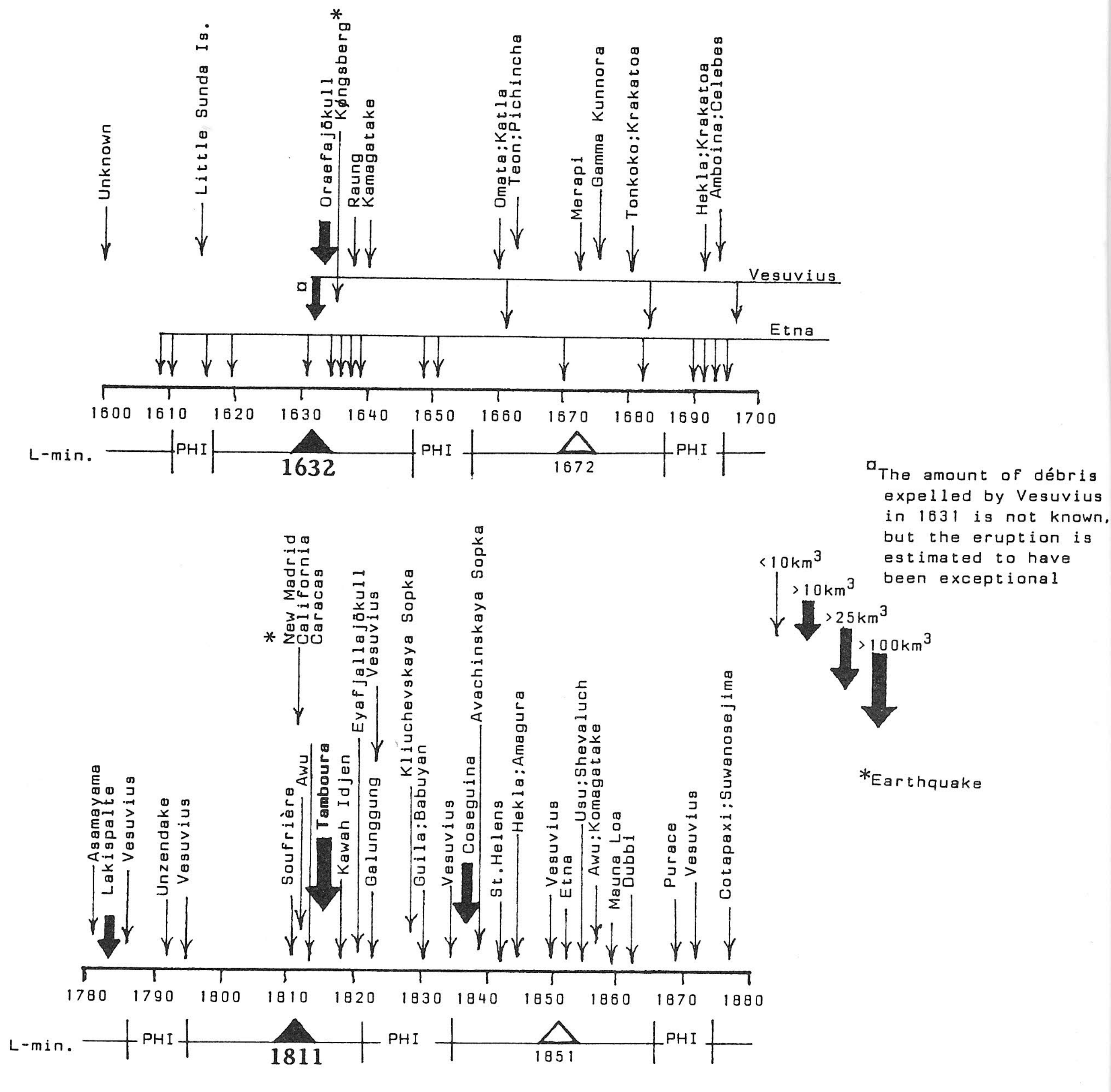
This result is of considerable value from the point of view of climatology. It makes it possible to predict those periods when the volcanic factor can be expected to play a greater role than usual in forming climatic conditions on Earth. As is well known, sulphur-rich dust-clouds from volcanic eruptions, when these penetrate the stratosphere, can spread a reflective veil around the globe, thus raising the planet's albedo and lowering temperatures at the surface. It has been estimated that one large eruption of this kind is capable of lowering global temperatures by as much as 0.5° C over a period of ca. 5 years.

The question remains as to <u>how</u> the solar oscillation governs the occurrence of earthquakes and volcanic eruptions in the Earth's crust.

In the light of the material presented in the main text, however, this is not hard to understand. Exchanges of momentum between the Sun and planets - maintained here to be associated with L-min. events - could well be the source of the cyclical surges of seismic and volcanic activity that are known to periodically beset the Earth. The redistribution of the planet's own angular momentum that invariably arises in conjunction with more extreme changes in its rotational speed, would probably be sufficient to eause extra stress along the borders of the tectonic plates, while also releasing any accumulated tension in the bed-rock and increasing the pressure within the already well-filled magma chambers of some volcanoes.

It should be remembered that many of the volcanic eruptions that have occurred in the past were considerably more powerful than any experienced during the last century. We are thus not well-equipped to imagine the likely effects of a major surge in global seismic and volcanic activity. To assist the imagination in this respect, it would be useful to take a closer look at events during the last two anomalous solar passages - those of 1632 and 1811 (see figure 26). These two passages were both accompanied by particularly violent volcanic and seismic reactions.

Fig. 26 Vulcanism 1600-1700 and 1780-1880



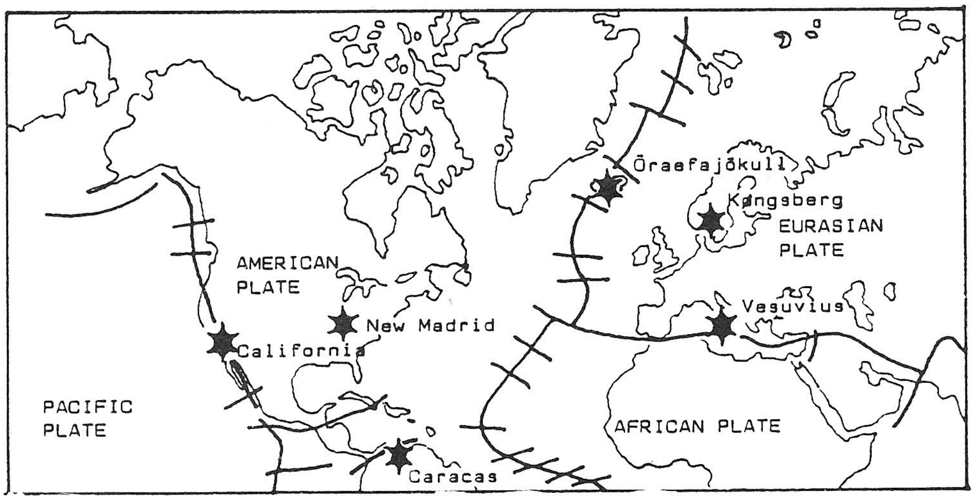
The most violent eruption of Vesuvius in modern time occurred in Dec. 1631. ie. immediately preceding the 1632 passage. Prior to this eruption, Vesuvius had been dormant for ca. 600 years. The following year, Køngsberg in Norway was struck by an unusually strong quake, which destroyed an entire system of mines constructed under that mountain by Christian IV of Denmark/Norway. Six months later, the volcano Öraefajökull on Iceland flung an estimated 10 cubic kilometers of débris into the atmosphere - one of the largest eruptions of the last few hundred years. Taken in isolation, these three events, although impressive, can hardly be termed exceptional. The fact that they occurred in immediate conjunction with the critical L-min. passage in question, however, leaves a strong impression that they constitute the end result of a process set in motion by the solar passage, whereby, via perturbations in the Earth's orbital speed and disturbances in the spin-rate of the planet, the entire Euro-Asiatic plate received a temporary, but keenly felt shock (see figure 27).

A similar chain of events can be reconstructed in conjunction with the 1811 passage. In this case, the more complete historical record provides further evidence indicating that anomalous solar passages can trigger extreme seismic and volcanic reactions.

During the months directly in conjunction with the 1811 passage, 3 gigantic earthquakes hit the New Madrid fault-zone in the US midwest in quick succession. These shocks occurred on Dec. 16, 1811, and Jan. 23 and Feb. 7 1812, and are estimated to have reached respectively 8.6, 8.4 and 8.7 on the Richter scale. According to the few eye-witness accounts that are available, the Great Plains rose and fell in waves like the rollers of the Pacific. A few months later, the city of Caracas in Venezuela was transformed to rubble by a quake that must have been similar in strength to those at New Madrid. At the same time (Dec. 1812), 3 very powerful quakes struck the San Diego/Santa Barbara area of the San Andreas fault-zone in California (according to a new method of dating earthquakes using tree-ring data - see Jacoby et al, 1988).

The reactions in California are particularly interesting in that they ended a 300 year period of relative quiescence in the San Andreas zone. Once again, it is possible to see the more or less simultaneous occurrence of these massive quakes in locations (California, New Madrid and Caracas) on opposite edges and in the middle of a tectonic plate - in this case, the North American plate - as a sign of reaction to sudden and extraordinary stress in the lithosphere on a global scale (see fig.27).

Fig. 27 Major seismic/volcanic events in the northern hemisphere, 1631-'32 and 1811-'12



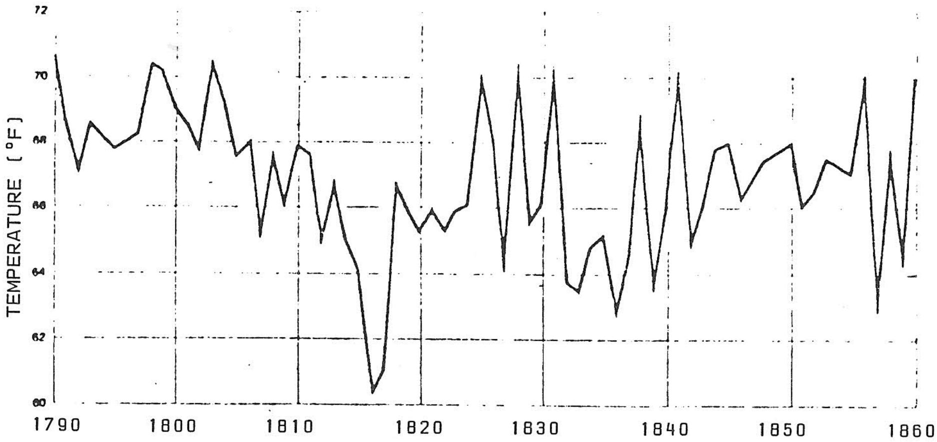
The 1811 passage, however, was even more eventful than is indicated by the seismic record. It was both preceded and succeeded by an unusual number of large volcanic outbreaks (12 between 1810 and 1822), among these the hitherto most violent in historical time, that of Tamboura in 1816.

According to the latest estimates, this latter eruption cast 100-150 cubic kilometers of débris up into the atmosphere. As figure 28 indicates, air temperatures sank drastically over large areas of the northern hemisphere during the years immediately following the explosion. In the USA, for example, the year 1811 came to be known in popular parlance as "the year without a summer", or "eighteenhundred-and-froze-to-death." Agriculture along the entire US eastern seaboard collapsed, forcing starving farmers to sell their holdings and swell the flood of settlers heading west. This volcanic-induced change in climatic conditions can, however, not only be held responsible for considerable demographic change; it also indirectly contributed towards the creation of the American character. The social conflict caused when this sudden invasion of land-hungry settlers met already established hunters and herders, to say nothing of the indian tribes living at that time in these regions, has provided the basic material for thousands of Hollywood films, thus helping to form the ideals upon which the "american myth" is based.

The most striking aspect of these events, however, is that the earth tremors did not only affect traditional high-risk seismic zones (such as western California), but also regions far from the borders of the tectonic plates, today regarded as relatively stable from a seismic point of view. Many of these regions were nothing more than wilderness at the time (eg. New Madrid). Today they accomodate a population of millions, with all that that implies in terms of dangerous and sensitive industrial processes, vulnerable communication systems, insufficient health services etc. etc. (see fig. 29).

Fig. 28 Temperature records for New Haven, Conn. USA, 1790-1860

from Stommel, 1987



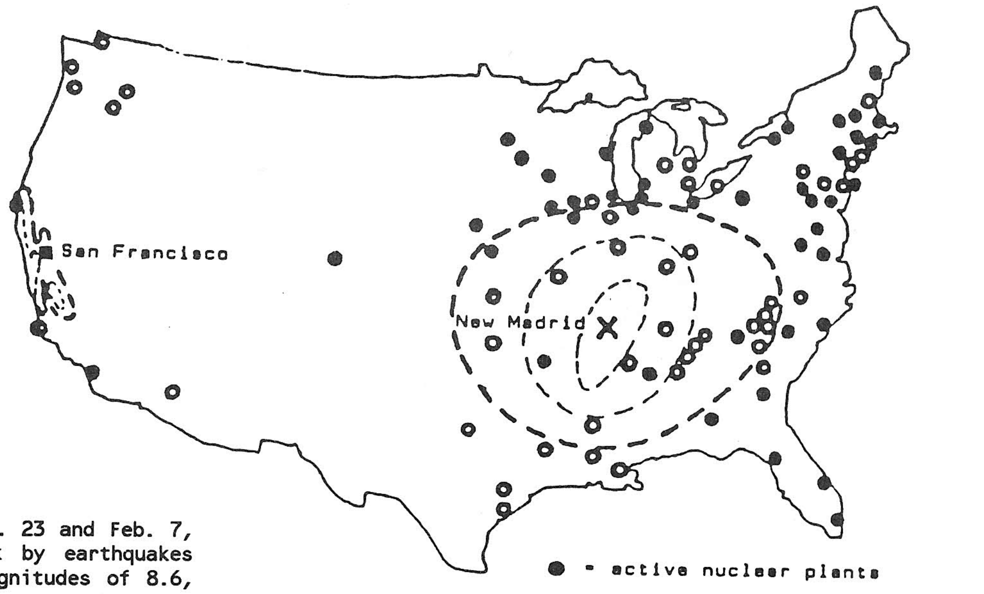
The curve describes mean temperatures in June over a period of 70 years, beginning in 1790. The low of slightly more than 60 F in 1816 was the result of temperatures that ranged from 35 F at sunrise on June 7, to 88 F on June 24, according to a journal kept for many years by the presidents of Yale College.

Fig. 29 Two seismic zones in the USA potentially capable of extreme reaction during periods of exceptional global seismic activity

from Johnston, 1982

Estimated areas of damage from the hypothetical recurrence of an earthquake at 8.6 Richter in the New Madrid seismic zone, compared with those of the San Francisco quake in 1906.

Both quakes are of roughly the same magnitude - the areas of damage differ greatly because the crustal rock in the west attenuates seismic shock over much shorter distances than does the crustal rock of the central USA.



On Dec. 16, 1811, and on Jan. 23 and Feb. 7, 1812, the region was struck by earthquakes with respective estimated magnitudes of 8.6, 8.4 and 8.7.

Since 1811/12, no major seismic event has occurred in this region. Nevertheless, New Madrid is still highly active, thousands of microquakes being registered in the area every year.

In this context, it should be pointed out that seismologists have warned that the New Madrid zone, although at present relatively quiescent, is still a potential source of major earth tremors (Johnston, 1982). As recently as Feb. 1988, geologist Leonardo Seeber emphasised at a meeting of the American Association for the Advancement of Science that the possibility of "super-quakes" in the eastern US constitutes a hazard every bit as great as that posed by the San Andreas fault in the west.

In conclusion it can be said that if the 1990 solar passage shows itself to be as disruptive as its predecessors in 1632, and especially 1811, there is every reason for concern. There is no way of predicting precisely where and when any associated earthquakes or volcanic eruptions may strike, but there are obviously certain particularly vulnerable zones that could reasonably be expected to react strongly should the planet be subjected to out of the ordinary rotational and other disturbances - eg. Vesuvius, which has been quiescent for some considerable time, but is now showing signs of restlessness, and, in regard to the seismic threat, the San Andreas Fault, and, of course, Japan. There are many other areas of the globe, however, where exceptional seismic/volcanic reactions are possible during the next few years. In view of the evidence, it would be foolish to assume any major or even marginal seismic zone to be exempt from this threat.

At the time of writing (July 1989), the Sun is just beginning the anomalous phase in its passage, and will remain on the "wrong" side of CM until the end of December 1990. The evidence presented here suggests that reactions may begin to occur at any time during the next 12 months. The evidence also suggests that these reactions can be expected to commence with extensive earthquake activity in different parts of the world, followed by a series of more or less violent volcanic eruptions during the coming decade.

It can be argued that this information changes nothing - that the threat of seismic attack is something human-beings have always lived with ("sufficient unto the day is the evil thereof"), and anyway, what meaningful measures can be taken in the short time available before this cataclysm strikes - if indeed it does strike, which is not 100% certain? It is tempting also for those living in relatively stable regions to dismiss the threat as something that only concerns others: "I'm alright Jack - to hell with you".

These arguments ignore the scale of the threat posed - sudden and massive earthquake activity in a region like Japan (or the US Midwest) would rock the entire global economy, while the implications of such a development for the environment exceed our capacity to imagine. The climatic implications, at least, should be seriously considered by all those with any responsibility for deciding the direction of society during the next ten years or so. The global warming scenario, at present dominating the thinking of politicians and planners - when these deign to consider climate questions at all - perhaps needs some revision in the light of these research results.

Regarding the more immediate issue, the recent experience of Armenia encourages the optimistic view that a global seismic threat of the kind envisaged here could well lead to an unparallelled degree of international cooperation. On the other hand, that experience also suggests that there is much that needs to be done to strengthen and make more effective the work of national and international disaster agencies. Entire populations cannot be moved, of course; neither can inadequate building techniques be corrected overnight. Nevertheless, there is a great deal of preparatory work that might be undertaken now, that would mitigate the worst effects of the approaching seismic "tsunami", should it transpire. The question is one of political will.

Finally, it can be pointed out that the decade of the 1990's has been designated by the UN as "Hazard Mitigation Decade" - under the circumstances, an inspired choice of theme for the global community as it faces the last years of the 20th. century. Determining the exact implications of the word "hazard" in this case, has therefore become one of the primary tasks of contemporary science, a project that must precede in priority any attempt to define suitable measures of "mitigation". It is hoped this text may contribute something towards the first, thereby speeding up the process that leads to the second.

APPENDIX 5

BUSINESS CYCLES AND THE SOLAR-PLANETARY PROCESS

No real understanding of human history is possible without due account being taken of economic factors and their role in the formation of human society. Neither can the variable conditions underlying economic development be ignored. No longer exclusively a marxist view-point, this attitude is probably shared by most historians today.

The changing nature of geophysical conditions is by far the most important factor governing the economic affairs of all societies, whatever their political persuasion. The state of these conditions determines, for example, the type of raw materials dominating market interests at any given time. If geophysical conditions change, human economic affairs will also change.

In general, geophysical changes take place over long periods of time, allowing gradual adaptation of human activity to their demands. Fluctuations in climate can be included in this category. However, at times when the planet is forced to adjust itself to certain cyclically recurring changes in the solar system as a whole, sudden and relatively drastic change in the Earth's climate can throw human societies into a state of crisis. When harvests wither in drought or frost, or drown in floods, this can undermine the economic achievements of a nation, or even of an entire geophysical region. Thus, all major shifts in demographic balance in the past - those great migrations of peoples that periodically change the course of history - have their ultimate source in changing conditions of climate and in the food-supply problems that inevitably accompany such shifts in the state of the natural environment.

It should therefore be apparent that any change in the state of the Sun - the "nucleus" of the solar "cell" and the ultimate sustainer of all life on Earth - can be expected to have considerable effect on Earth, even in the economic sphere (something well understood by many ancient peoples - eg. the Egyptians and the Aztecs).

This pronounced dependence on the Sun can be studied in more detail from the perspective of natural science.

Regarded as a physical abstraction, nature consists of a multitude of different forms of energy. These energies are in a constant state of flux, following patterns of movement that conform to well-established laws of motion. Wherever they reveal themselves - on Earth or elsewhere in the Universe - the spontaneous movements of nature invariably take the sometimes contracting, sometimes expanding form of a **spiral**. This can be seen in the eddies of flowing water, in the cyclones of the weather system, in the magnetic vortices on the surface of the Sun called "sunspots", and even in the shape of our own galaxy. Every shell on the beach enshrines the same principle.

When the Sun oscillates around the centre of mass of the solar system, in response to demands imposed by the orbiting planets, then this, once again, is an expression of the universal, spiral principle. This oscillating movement evolves so slowly that we cannot observe it - as little as we can observe the growth of a shell. The only way of following the oscillations of growth in these two cases, as they develop in time, is by studying their computer-constructed representations in graphic form.

How is this spiral movement of the Sun organised?

If we choose as a line of reference that line taken by the centre of mass of the system (CM) as it travels through the galaxy (see p. 4 in main text), it will be seen that solar motion consists of two **contrary** types of movement: the one curving away (expanding) from the line of reference, until, when reaching the point of maximum distance from CM, it turns into its oppposite, a movement curving in (contracting) towards the same line of reference. Together, these two opposing types of motion make up one completed cycle (cf. gr. "kyklos" = circulation, cycle). This process repeats itself ad infinitum - with unending variation, although always within bounds imposed by certain characteristic forms, both in regard to the shape, size and alignment of individal cycles, and to their order in time.

The synthesis in dynamic balance of these two opposing types of movement is summarised in the concept of **polarity**. Polarity refers to a principle which no movement in nature can ignore without disintegrating into disorder. Electromagnetic vibrations, for example, are characterised by "positive" and "negative" polarity. The Earth itself maintains two magnetic poles - a magnetic "north pole" and a magnetic "south pole".

Since all living creatures, including the human, are an indissoluble part of nature, it follows that the activities carried out by these creatures will also be subject to the above principle (precisely because all activity basically consists of more or less complex, inner and outer motion).

Consistently enough, human economic activity demonstrates a number of clearly defined polarities: production-consumption, income-costs, the in and outflow of currency etc. In addition, the common economic life of the community manifests itself in a series of contractive and expansive movements that have been termed **business cycles**.

If the previous argument holds true, then these business cycles should be as bound by the laws of motion as any other movement in nature - thereby constituting a natural process that can neither be anulled nor manipulated, comprising something that humans should leave well alone, rather than attempting to exploit through artificial means. Any attempt at exploitation will only lead to distortion of natural fluctuations in economic activity, this inevitably having detrimental effects on the state of the future economy (as has occurred many times in the past).

What is it that makes business cycles so different from one another? Why do they sometimes degenerate into catastrophic depressions?

The answer to these questions can most logically be saught in a wider context - in that area where the central processes of the solar system (the interaction between the Sun and the 4 most massive planets) determine the general course of development in all natural processes on Earth.

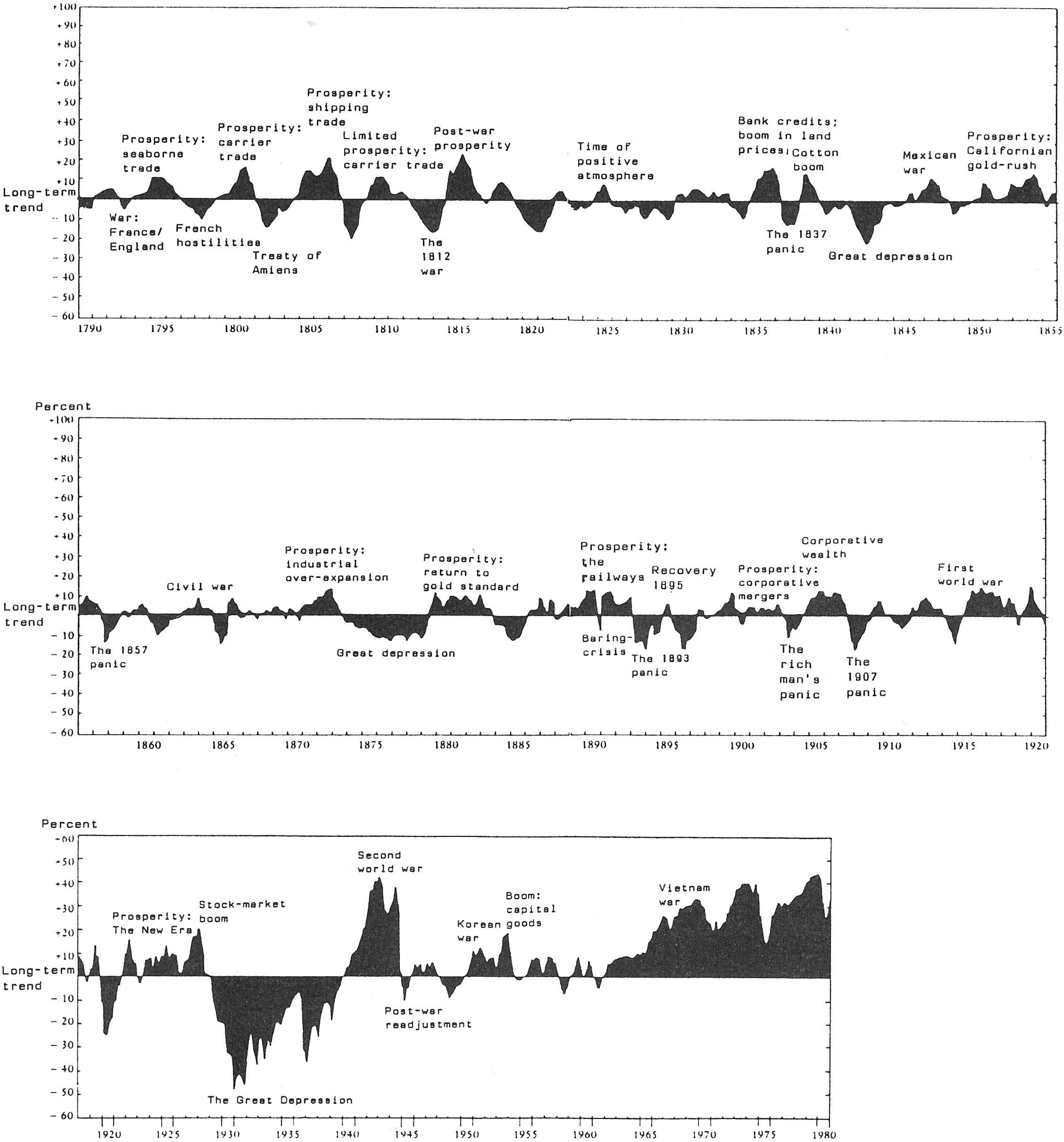
According to the basic thesis outlined in the main text, oscillations of higher amplitude (greater energy) steer those of lower amplitude. The oscillation of the Sun develops incomparably the highest amplitude in the system. The pattern of business cycles should therefore demonstrate signs of reaction to the rhythms of solar oscillation. The beating of the "base drum" resonates throughout the solar system on many different levels, and could thus reasonably be expected to leave some imprint on the curves that describe the ups and downs of human economic activity.

Such an idea may appear strange to those who have become accustomed to seeing economic processes as exclusively a product of human endeavour. At first glance, the insight that solar motion affects the economy would even appear to seriously undermine the human collective ego - are we merely pawns in the game of the gods after all? And it is certainly hard to imagine how human activity on this tiny planet so far from the Sun could in any way be affected by broader processes in the solar system as a whole, processes which move so slowly compared with the human mode of awareness that they totally escape our attention.

During the last few decades, however, research has revealed this idea to be more than merely conceivable. Indeed, it probably provides a principally correct explanation of the known facts. Despite the obscurity of some details, the main links in the chain of cause and effect that ties the convolutions of solar motion with fluctuations in the economy are clearly discernable. These can be summarised as follows:

The oscillating motion of the Sun causes variation in the electromagnetic activity of the solar body (affecting both the intensity of the "solar wind" and the level of flare activity). In its turn, the combined effect of the oscillation itself and its electromagnetic consequences results in variations in (1) the spin-rate of the Earth, (2) the intensity of seismic and volcanic activity in the lithosphere, (3) the state of the geomagnetic field, and (4) the weather and climate of the planet.

Fig. 30 BUSINESS CYCLES IN U.S.A. 1790 - 1980
Adapted from the annual report of
Ameri Trust Company (Batra 1986)



All these factors to a greater or lesser extent affect basic conditions essential for maintaining the strength of the economy, as well as having some influence on the stability of the human psyche (unpredictably in individual cases, but probably possible to forecast when it comes to wider, collective tendencies). The essential import of the above-mentioned research is, therefore, that human economic activity - both individual and collective - can be affected by processes that have their origin outside the earth system (support for the validity of this train of thought can be found in fig. 32, which shows how business cycles in the USA have reacted to the development of solar momentum during the period 1940-1975 - see further commentary below).

In 1986, Ravi Batra - at that time both controversial and misunderstood, but today an economist with a growing reputation - published his book "The Great Depression of 1990". Based on careful study of business cycles in the American economy between 1780 and 1980 (see fig. 30), Batra formulates an intriguing theory regarding the apparent conformity of these cycles to certain laws. He finds distinctive periodicities of both 30 and 60 years in his material, which he describes in the following manner:

> *"In the American economy at least one recession has appeared every decade and a deep depression every third or sixth decade, in such a manner that if the third decade succeeded in avoiding a depression, the sixth experienced a cumulative effect - a total catastrophe. Thus, the 1780's had a depression, whereas the 1810's did not. Three decades later, the 1840's went through a crisis of unparalleled proportions. There was also a deep depression during the 1870's, but not between 1900-'10. And then, thirty years later, occurred the greatest depression in history."*
>
> *(translated from the Swedish edition of "The Great Depression of 1990" by Ravi Batra.)*

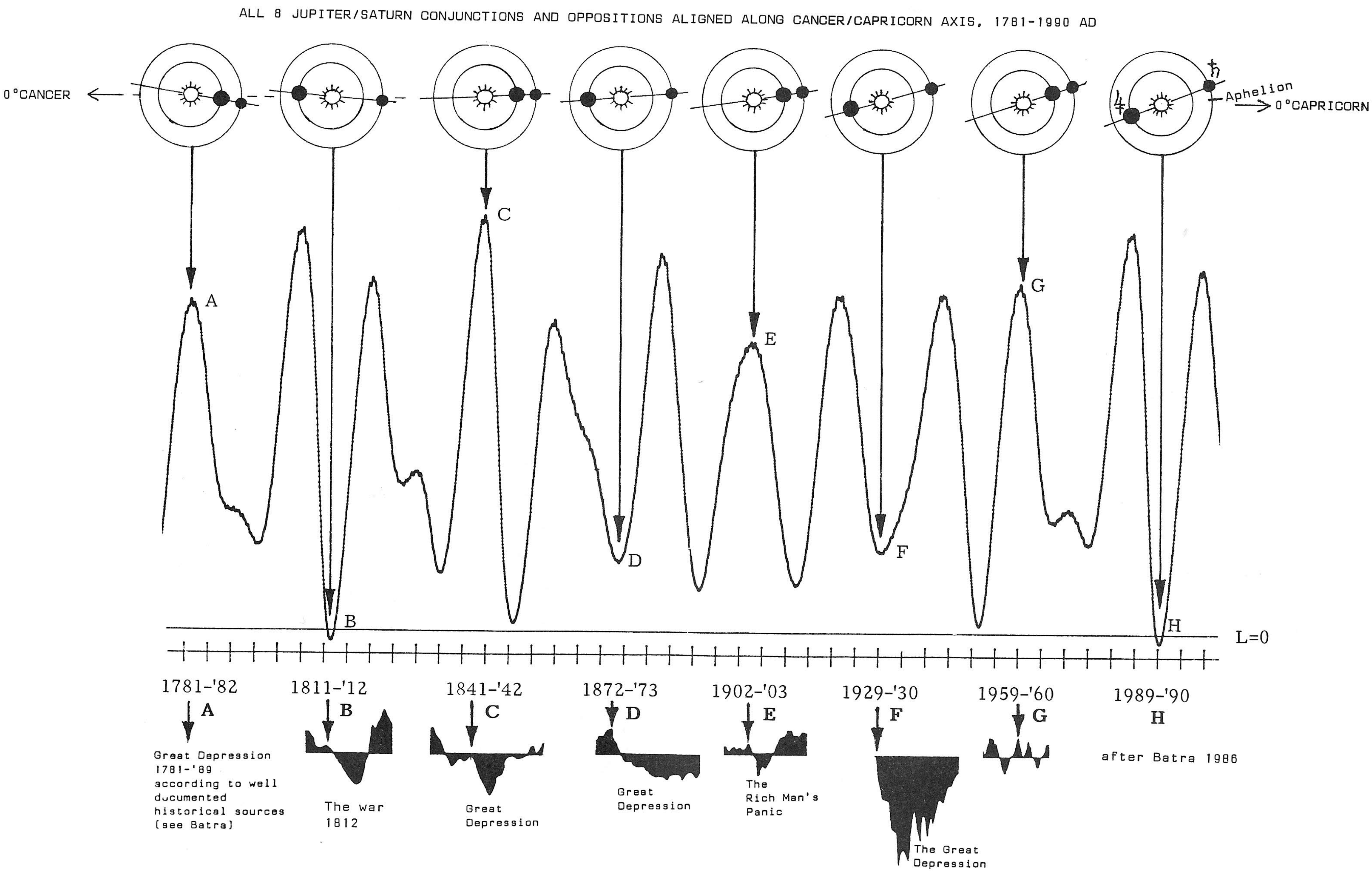
Batra predicts that the global economy will soon be paralysed by a catastrophic depression, beginning in 1989-'90 and continuing throughout the following 6-7 years. He bases this forecast on the observation that whereas the 1960's avoided a severe depression, a whole series of economic indicators during the 1980's show trends that in every detail correspond with developments during the 1920's. In particular, this concerns changes in the concentration of wealth, believed by Batra to be the basic mechanism triggering the depression process.

In this context it is important to note that the same 30 and 60 year cycles that Batra finds in the economy can also be found manifested in the solar system as a whole, ie. in the interaction between the two most massive planets, Jupiter and Saturn, and in the influence they exercise over the solar oscillation.

All the severe depressions described in Batra's book - ie. those beginning 1781-'82, 1841-'42, 1872-'73 and 1929-'30 (see A,C, D and F in fig. 31) - occurred when Saturn had taken a position in the direction either of Sagittarius or Capricorn (heliocentric zodiac). In these sectors, Saturn's vector (mass x radial distance) is strongest, since at the time it lies adjacent to the point of aphelion on its orbit (the point furthest from the Sun, at present located in 3° Capricorn). The period of Saturn's orbit is 29.46 years - ie. an approximate 30 year cycle. No severe depression occurred during the period under discussion where this criterion was not fulfilled.

Another criterion, also fulfilled at the point in time when these depressions commenced, is that Jupiter - with a margin of no more than one year - had in every case either placed itself in conjunction or in opposition with the above-mentioned positions of Saturn. Regarding the solar oscillation, this means that the orbital angular momentum of the Sun (L) was then passing either an L-minimum or an L-maximum, ie. the Sun was positioned very near one of the two turning-points in its oscillatory motion (see figure 31).

Fig. 31 DECLINES IN THE AMERICAN ECONOMY ASSOCIATED WITH JUPITER/SATURN CONJUNCTIONS & OPPOSITIONS



To be noted is that during the whole period (1780-1980) there appeared a total of 21 conjunctions or oppositions between Jupiter and Saturn in various heliocentric directions, each giving rise to an L-maximum or an L-minimum. 7 of these were oriented close to the axis Capricorn-Cancer, while the remaining 14 clustered close to the axis Virgo-Pisces or Scorpio-Taurus. **All 4 economic depressions in question occurred in association with conjunction/oppositions aligned along the axis Capricorn-Cancer.**

This latter coincidence demonstrates remarkable precision; a simple statistical calculation will show that it cannot be dismissed as a work of chance (if a binomial distribution is used, the result will read $P < 0.000002$, or one chance in half a million).

Furthermore, it should be mentioned that on two of the further three occasions during the period 1780-1980 when these particular Jupiter/Saturn constellations appeared, ie. 1811-'12 and 1902-'03, there occurred historically notable declines in the economy (see B and E in fig. 31). The most recent has been termed "the rich man's panic" and was relatively short-lived, hardly qualifying as a depression. The earlier was more remarkable in the sense that the decline was quite profound, despite the fact that it occurred in the middle of the 1812 war, making it a striking exception to the rule that economic activity tends to increase during war (cf. in fig. 30: the Mexican War, the American Civil War, the First World War, the Second World War, the Korean War, the Vietnam War - the latter five being associated with particularly marked surges in the economy).

It is therefore possible to say that the 1811 L-minimum would probably have led to a severe depression, were it not for the extra stimulus provided the economy by war. A similar interpretation can be used to explain, for example, the otherwise paradoxical phenomenon that American financiers invested large sums of money in the preparations for war being made by the fascist régime in Germany during the 1930's. This particular episode epitomises the failure of the economic system to deal with private speculation, which, although aimed at profits, inevitably succeeds only in grossly distorting and inflating quite natural fluctuations in supply and demand. Better by far would be to learn the art of riding these admittedly sometimes uncomfortable waves in economic life. To struggle against forces rooted in the solar system itself does not make much economic sense in any terms.

The only exception to the rule that Jupiter/Saturn conjunctions and oppositions along the axis Capricorn/Cancer are always accompanied by economic depressions, or tendencies to such, is the 1959-'60 case (an L-maximum - see case G in fig. 31), when no marked decline in the economy took place (possibly a result of the supportive role played by the massive investment in space technology at the time). It can thus be maintained that 5 or 6 out of a total of 7 possible Jupiter/Saturn constellations of this type showed themselves to be critical from the point of view of economic stability.

An astro-physical aspect that may provide an explanation for why these particular constellations can have an especially disturbing effect on the Sun concerns the fact that the axis Capricorn/Cancer is aligned parallel with the plane of the galaxy. This means that the movement of the Sun on the occasions in question cuts the galactic field in a very special fashion. One could suspect that some factor connected with this - i.e. the Sun's relationship to the galactic magnetic field - makes the Sun especially uneasy on such occasions. Our present state of knowledge does not allow any more specific conclusions in this respect. Nevertheless, the matter would be worth further investigation.

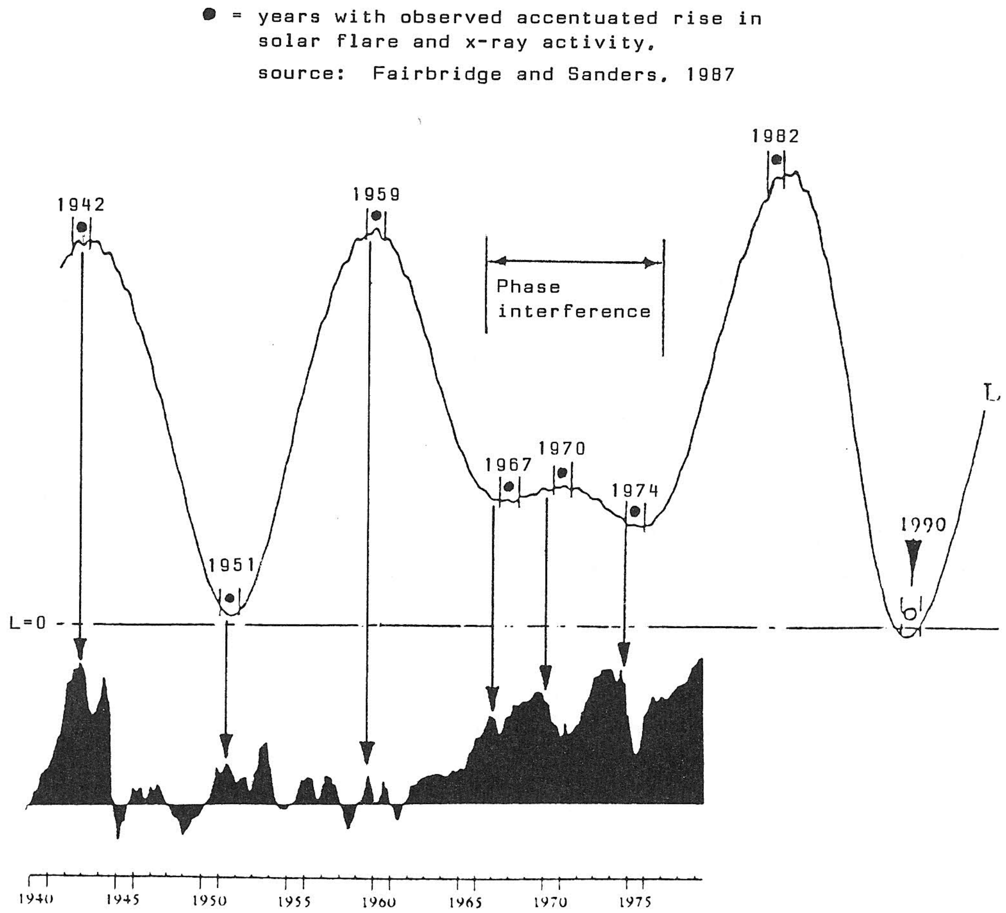
Finally, it should be noted that most of the more marked economic declines that occurred during the period under investigation were chronologically associated with L-max. or L-min. events. Table 1 (see below) shows that 8 out of 13 declines (besides the 6 accounted for in fig. 31) were positioned in time less than 1.5 years distant from such L-events. This means that 14 out of a total of 20 declines can be explained by the theory. If this result is tested as to significance, one obtains $\mathbf{P < 0.0015}$ (for those unfamiliar with probability calculus, it should be mentioned that the chances of the observed correlation being accidental are in this case less than 1 in 600. Statistical convention prescribes such a correlation to be highly significant, since it lies well below the minimum level of accepted significance $P = 0.05$, i.e. 1 chance in 20).

Table 1. Declines in business activity associated with L-events 1780 - 1980

Business declines	Associated L-events
1795	Lmin 1795
1801	-
1808	-
1820	Lmax 1820
1837	Lmin 1835
1857	Lmax 1858
1865	-
1883	Lmax 1882
1893	Lmin 1892
1896	-
1907	-
1911	Lmin 1911
1920	Lmax 1921

Also after the great depression in the 1930's, the development of the U.S. economy demonstrates a distinct sensitivity to L-maxima or L-minima (even to sub-maxima and sub-minima connected with the phase interference 1967-1975). All such passages during the period 1940-1975 were accompanied in the same or the following year by observable declines in the economy of varying strength. This is illustrated in fig. 32.

Fig. 32 US business cycles compared with development of solar orbital angular momentum, 1940-1975



In conclusion, it can be said that there is convincing evidence to demonstrate a link between human economic activity and clearly defined, physical processes in the solar system, a connection which we certainly do not yet fully understand, but which can be observed with such clarity that their governing role cannot be doubted.

It must, therefore, be considered highly likely that a profound and prolonged depression will strike the global economy sometime during 1989-'90.

This moment in time not only fulfills the same criteria that prevailed during previous depressions; it is also distinguished by an exceptionally extreme L-minimum ($L < 0$; see H in fig. 31) - an emphatic blow on the base drum of the solar system, its echoes likely to ring throughout the entire terrestrial sphere, thereby unsettling human-beings to the extent that economic collapse becomes inevitable. It should be emphasised that this judgement is formed on purely empirical/statistical grounds, and should not be confused with any particular hypothesis regarding what it is in the economic system that "actually" sets in motion the depression process. No limited analysis of such nature can be expected to fully explain this many-faceted problem. The range of inquiry must extend from the stars to the very mind of man.

More down to Earth, and nearer at hand, it would perhaps be worth quoting the following from a bulletin of technical market analysis produced by James Capel & Co. of London, a respected brokerage house in England. Dated 19th. July 1989, the report ("Sackcloth and Ashes", written by Robin Griffiths/Andrew Rose/Debora Boys) provides a succint account of the present situation in Japan:

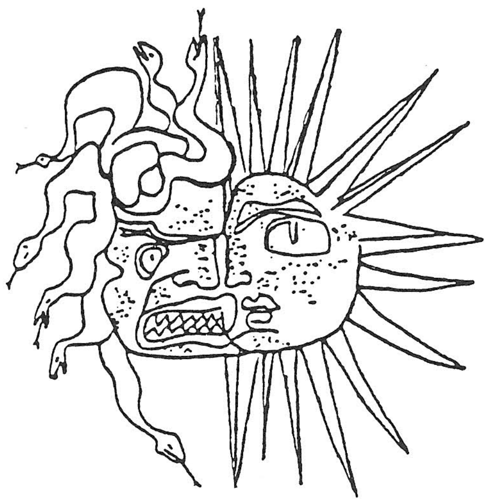
> *"In our table that ranks the chart performance of all World markets Japan currently comes fifth from bottom. The once mighty Yen is now a weak currrency. The political situation is in turmoil, as one crisis or scandal replaces another. All that emerges with certainty is that there is rapid change going on in that area which temporarily at least introduces uncertainty. This is always bearish for the short-term. Finally as if this weren't enough there is the possibility of catastrophe caused by nature. Not one but two significant areas of volcanic instability have simultaneously sprung to life. In the south island of Kyushu the huge Mount Aso is erupting impressively enough to make front page news, but also within a hundred miles of Tokyo there is an undersea eruption off Itoh. This can cause tidal waves conjuring images of the Great earthquake and the destruction of the city. In the nightmare there is then a Global recession following the next great crash as the inevitable knock-on effect from this event."*

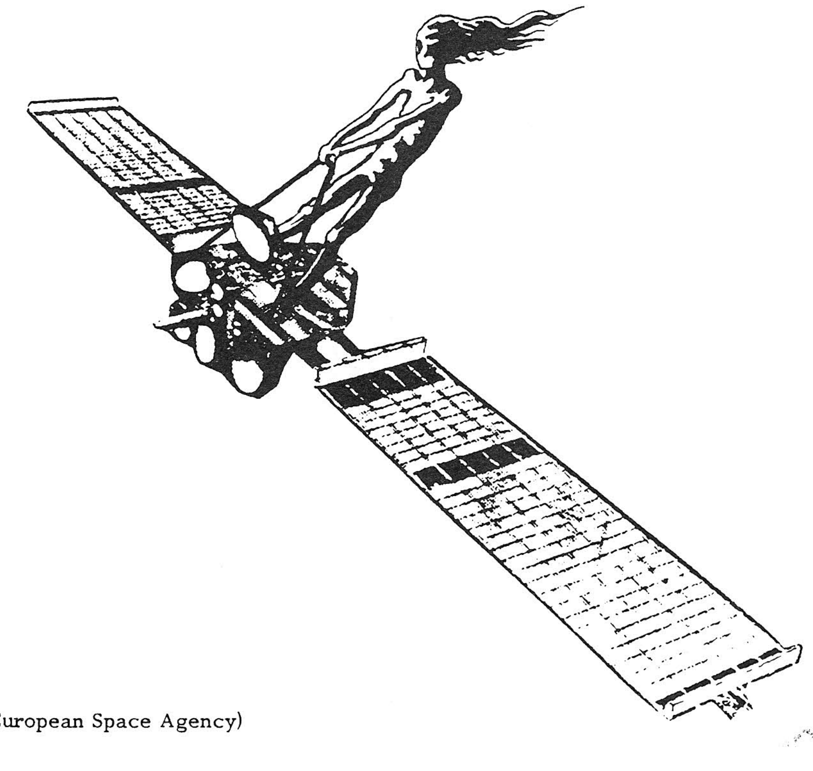
This newly awakened volcanic instability in the Japanese region does not, in itself, constitute conclusive proof that the process outlined in the main text and in Appendix 4 has already begun. But it does provide strong indicative evidence, which the course of events over the next few months will certainly either confirm or invalidate.

At any rate, this upsurge of activity (when seen in relation to earlier seismic effects during the winter in S.W. China, N. India, Armenia etc., suggesting uneasiness in the Eurasian Plate to be a contributary cause) represents precisely the reaction one would expect in the early stages of an anomalous solar passage. Apart from seeming to confirm the general validity of the predictions, these developments also indicate <u>where</u> in the tectonic plate system of the Earth the worst blow is likely to fall. In view of the observations in connection with fig. 27 on p. 39, and bearing in mind the current excitation of the Eurasian Plate, one might reasonably argue that what we are witnessing is the beginning of a prolonged clash between that plate and the adjacent Pacific Plate, a development that would affect a very large part of the Earth's surface.

This impression is strengthened by the fact that the strongest quake this year (8.4 on the Richter scale, on 23 May) struck the Macquarie Is. south east of New Zealand. These islands are located on the southern rim of the so-called "Ring of Fire" - the edges of the Pacific Plate, following a line north from New Zealand through Indonesia, Japan, Kamchatka and the Aleutians, and south again along the Canadian/US west coast to western California, and Central and South America. Major seismic/volcanic reactions along this line would have incalculable consequences for the global economy.

The suspicions voiced by Robin Griffiths et al above should thus perhaps be seen less as a rational attempt to assess the credibility of a possible future scenario, than as a prescient description of the actual course of events during the next few years. Interpreted either way, the matter is far too serious to be easily ignored. No one is well served by over-reluctance to consider the full implications of this particular scenario. However unpleasant the task, we have nothing to lose by being at least psychologically prepared to deal with the economic and other consequences of the 1990 solar event.





Icarus

(with apologies to Le Corbusier and the European Space Agency)

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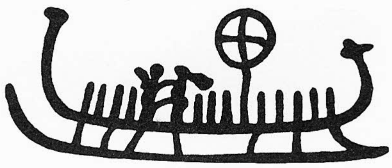

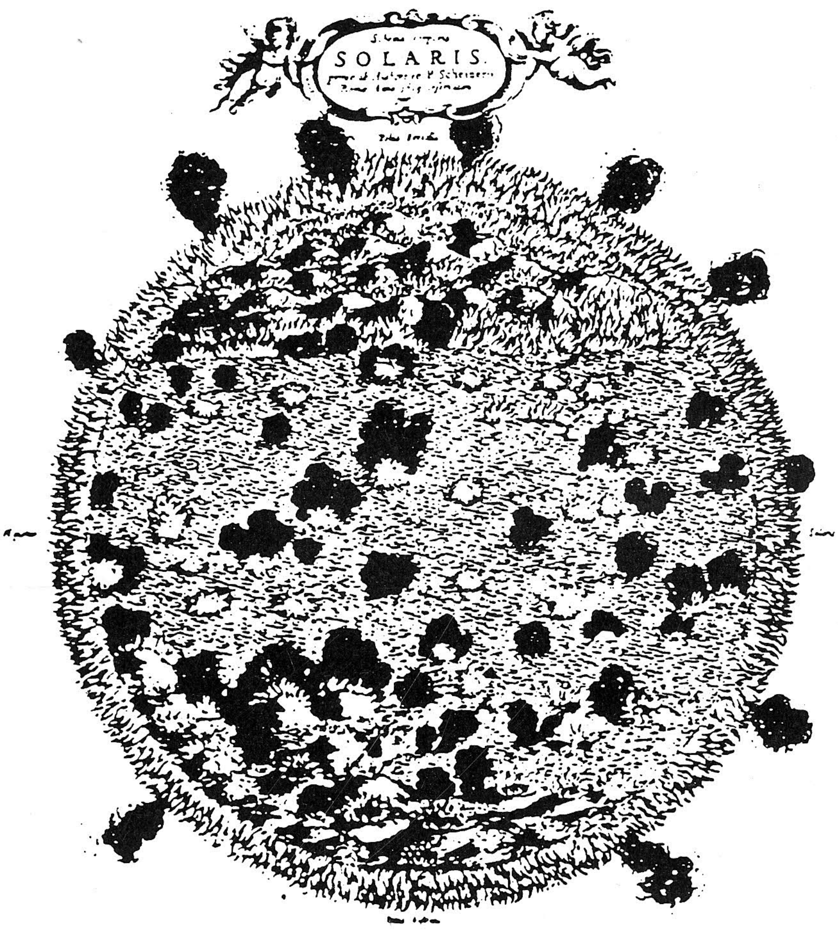

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