Terrestrial Astronomy

That one needs a little astronomy, besides geometry, to explore the morphology of living, growing buds will not surprise those engaged in biodynamic husbandry.

Lawrence Edwards' studies of Projective Geometry led him to investigate[1], by direct observation and careful measurement, actual buds of many species to ascertain whether or not buds are formed as families of path curves. These curves arise from the transformation of space into itself in the most elementary way and are the simplest altogether possible.

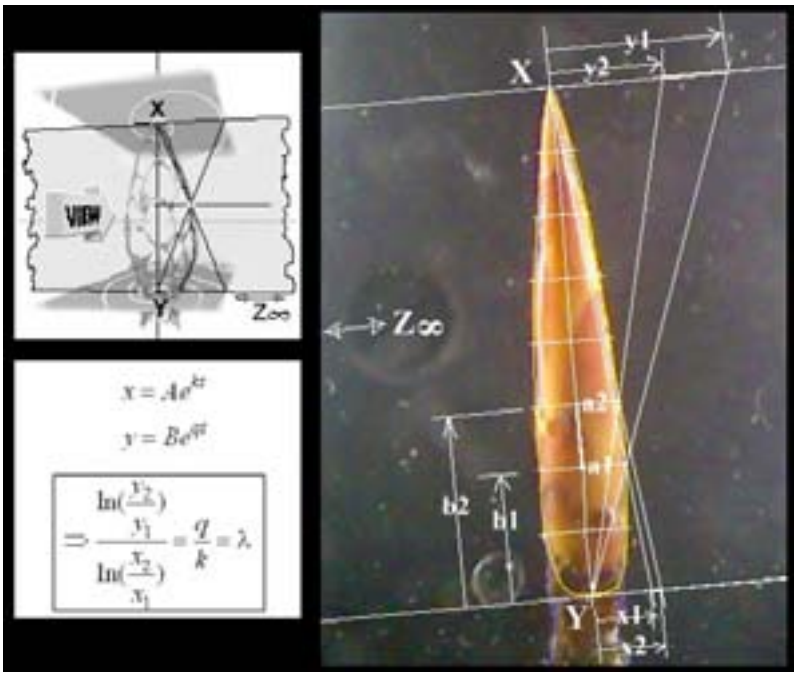


Diagram 1: Path Curves and the Bud.
The bud profile projects into well-defined exponential series on two sides of an invariant triangle with one vertex (here Z) usually at infinity and the other two (X and Y) at the tip and the base of the bud. The Shape Factor, λ, is the ratio of the characteristic multipliers of these series.

His results encouraged him to think that there was a very good case indeed for taking these utterly fundamental curves as the actual curves of real buds, good enough to justify using them to study how the forms of buds develop through a season. He gathered detailed temporal information.

While doing this, he caught hints of small, transient but *regular* changes of the form of all the buds, of whatever species he happened to be measuring. Intrigued, he investigated and tracked the changes and found that (subject to the usual scientific disclaimers) they were real events—and that they occurred fortnightly. Diagram 002 is a direct copy one of his λ graphs, pertaining to a Beech bud; the bold trace is a three day running mean of the raw data. The fortnightly rhythm is clearly to be seen as a series of minima (or, less formally, "λ dips").

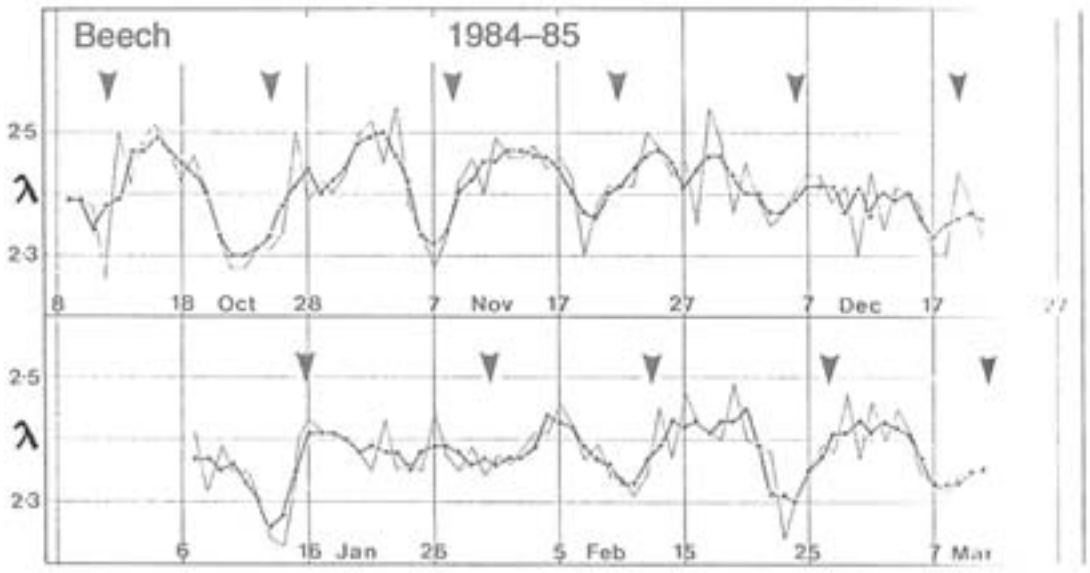


Diagram 2:
Form-variation of a Beech bud at Strontian, Scotland, 1984 -1985

When in the later nineteen eighties I joined Mr Edwards in this work, and began to measure buds in Aberdeen, on the East coast of Scotland, I found that they too exhibited regular, transient form changes *at the same, fortnightly, calendar moments* as Mr Edwards' buds around Strontian on the West coast of Scotland. Now scientists are really quite encouraged when two or more working independently and in separate locations report similar results. In due course it would be found that buds measured in England, Switzerland, Romania, Australia and the USA also show these transient changes. The implication is that all around the globe, ever so slightly – but quite measurably – buds beat like hearts.

The down arrows in diagram 2 exactly mark the epochs of the lunar alignments with Saturn that occurred in the period of the observations. It will be seen that they pace the epochs of the λ minima quite accurately, albeit with a temporal displacement of about two days.

Such Earth and Moon alignments (whether opposition or conjunction) with bodies of the Solar System, like the "bud events" (the dips), come about fortnightly, once per body per half-orbit of the Moon, with timings that vary with the continually changing spatial distribution of the bodies with respect to the lunar orbit.

Lawrence Edwards discovered that bud events correlate with these alignments – and, as far as can be ascertained, with absolutely nothing else, such as interbody distance, or tidal pattern, or season.

This is entirely remarkable, *because it is quite out of keeping with ordinary physical expectation*. We will come back to this.

It is even more remarkable that the correlation of buds with alignments is specific.
Bud events of Beech, for example, are found generally to correlate with the lunar alignments of Saturn while those of Oak generally correlate with the lunar alignments

of Mars. Birch – in Edwards' expression – "acknowledges" Venus. It turns out that specific correlations are not confined to tree buds. The humble Snowdrop "answers" to the Sun. Knapweed flower buds acknowledge Jupiter (the binding in this case seems quite strong: the impact of comet Shoemaker-Levy on Jupiter in 1994 quite measurably disturbed the form of Knapweeds in Strontian for some weeks).

Diagram 4 below depicts two "semi-lunar rasters". They chart calendar events against half-orbits of the Moon. Both pertain to the same grand period, and the same calendar events, and represent about 5 months of observation of a Beech bud in my garden on the West boundary of Aberdeen, Scotland, in the years 1998 and 1999.

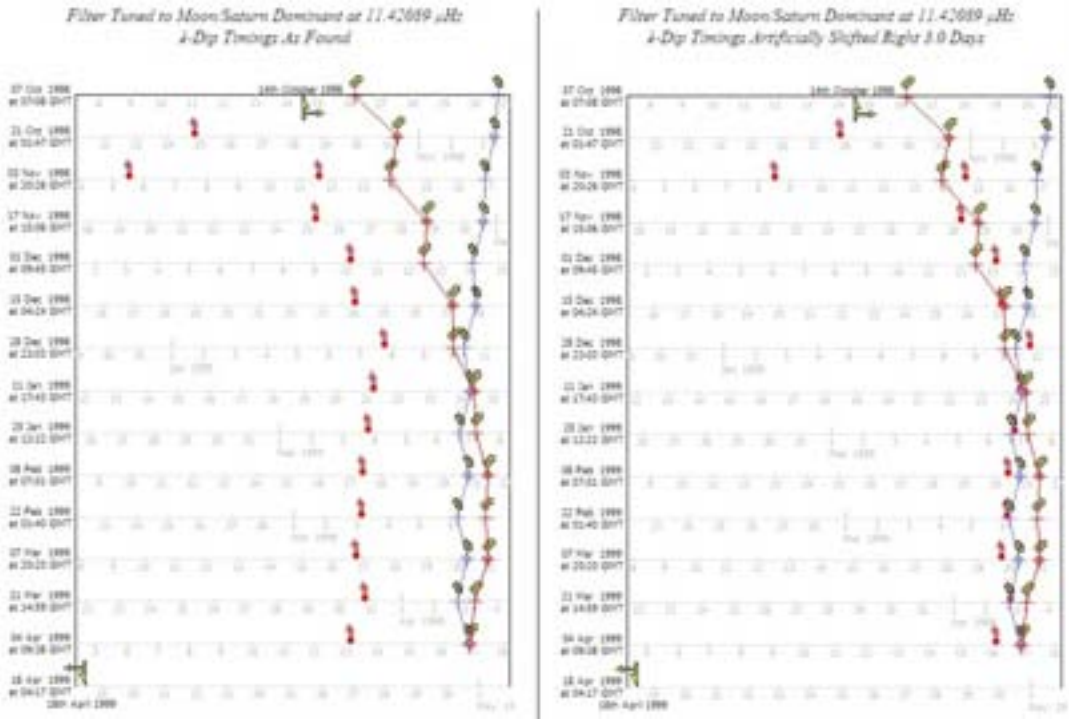


Diagram 4: Semi-lunar Rasters

These charts are built in the same way as TV pictures – hence, "raster" – and show at a glance, against a cyclic background, what may have taken months to develop. They are synchronised to the "axial moments" of the Moon, which are the calendar epochs of its passage through the major axis of its orbit, through perigee and apogee. Raster lines start and restart on them. We are surveying events timed by the lunar clock.

The down-arrows with a't' (meaning 'tuned') mark the moments of the transient minima (the "λ dips") of the Aberdeen Beech bud's profile. The other events (besides the civil dates) marked on the raster lines are lunar alignments of Mars and Saturn, annotated by their usual signs. (Their "zigzags" have to do with Kepler's Second Law, the one about equal areas in equal times.)

Now, if bud events really do have a temporal correlation with lunar alignments, the bud markers should do just what the alignment markers do, zigzags included. The leftmost raster indicates that the epochs of the dips for the Aberdeen Beech correlate

with the alignments quite well, *but not at the same epochs*. There appears to be a time shift.

The rightmost chart shows the dip markers artificially time-shifted right three days by the computer to check the match of epochs directly: and the match is quite good[2] – so we can have some confidence in both the correlation *and* the displacement.

So far we have seen two buds showing temporal displacement of λ minima with respect to the alignments: the Aberdeen Beech at the turn of 1998, with a shift of three days and the Strontian Beech some thirteen years previously, with a shift of two days. Now were these the *only* ones showing shift that we had ever encountered, we might be prompted to ask, "Is there *always* a shift? Does it pertain to all Beech buds everywhere at the same time?" These two shifts differ by a day, and occurred thirteen years apart, so we might wonder how the shift changed in that interval. We might also wonder whether or not the shift is confined to Beech buds, and if it is not, whether the shift is the same for them all, or different.

As soon as he detected temporal displacement, Mr Edwards asked, and (over a 17 year period extending from 1983 to very nearly the beginning of the 21st century) methodically answered all the above questions concerning what came to be called the Phase Shift. Diagram 5 graphs his findings from that period.

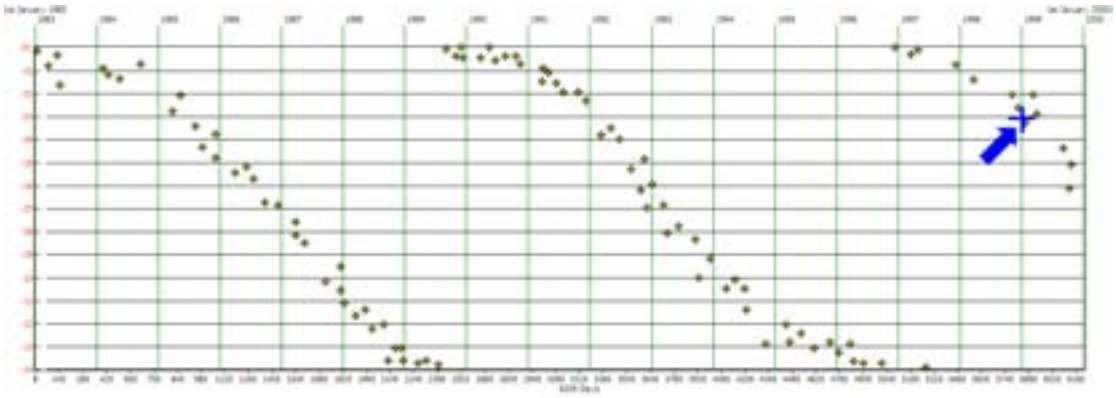


Diagram 5: The Phase Shift from1983 to 2000

In Edwards' words, each cross on the chart denotes, "the Phase Shift of a single species for a season". That is, the arithmetic average of the shifts observed for the bud instances of a species in a season was placed on the chart at their temporal centroid. The crosses represent several thousands of instances of several tens of species of bud, observed and measured almost daily over an interval of nearly twenty years. This chart is unusually well supported.

The chunky blue arrow points to the blue cross marking the three day shift of the Aberdeen Beech above. Once again, it is *scientifically* encouraging that buds from opposite coasts of Scotland appear to have behaved almost identically, this time in respect of temporal displacement.

What does this graph say to us?

It says that the Phase Shift is clearly not time-invariant, but it is substantially the same for all species at any given moment. In other words, it betokens ***a universal slip*** **of the buds' dip-epochs with respect to their alignment epochs.**

It says that the shift, being only either zero or negative, is never a lag, but a strictly-increasing *lead*. In other words, the forms of the buds change *increasingly earlier* than their allied alignments, *while keeping to their allied rhythms.* If this were a musical matter, one would say they were continually slipping from synchrony to syncopation and back.

It says that the buds were "on time" near the start of 1983, and again on time seven years later at the start of 1990, and yet again seven years after that, at the start of 1997. Thus, while we do not have the absolute count of the cycles, we do know when three of them began, and we know that two of these cycles had a period of almost exactly seven years.

So, with this, was the pattern found? Would a cycle come *every* seven years? Such questions demand prediction (surely the *sine qua non* of Science); for prediction it is necessary to know how cycles happen at all. This has been a focus of my research for several years[3].

Because form is intrinsically non-physical, like the geometry which purports to describe it, it was a long time before I conceded that I should perhaps take account of mass – of all properties possibly the most quintessentially physical. When at last I did so and modified my program to work out out the location, velocity and acceleration of the Center of Mass (CM) of the planets of our Solar System, I stumbled upon what is probably a key correlation.

The program could already find the Center of Position (CP) – just the pure position, without regard to mass – of the planets and could draw the line from the Sun to the CP (the *heliocentric radius*). I had the program show the vectors of motion of the Center of Mass and sat back to watch what they did in the period covered by Mr Edwards' Phase Shift chart.

Eventually it dawned that **the acceleration vector** of the CM

- **lies parallel to the heliocentric radius whenever the λ dips are on time (that is, in full synchrony), and**
- **lies at right angles to that radius whenever the λ dips are seven days early (that is, in full syncopation).**

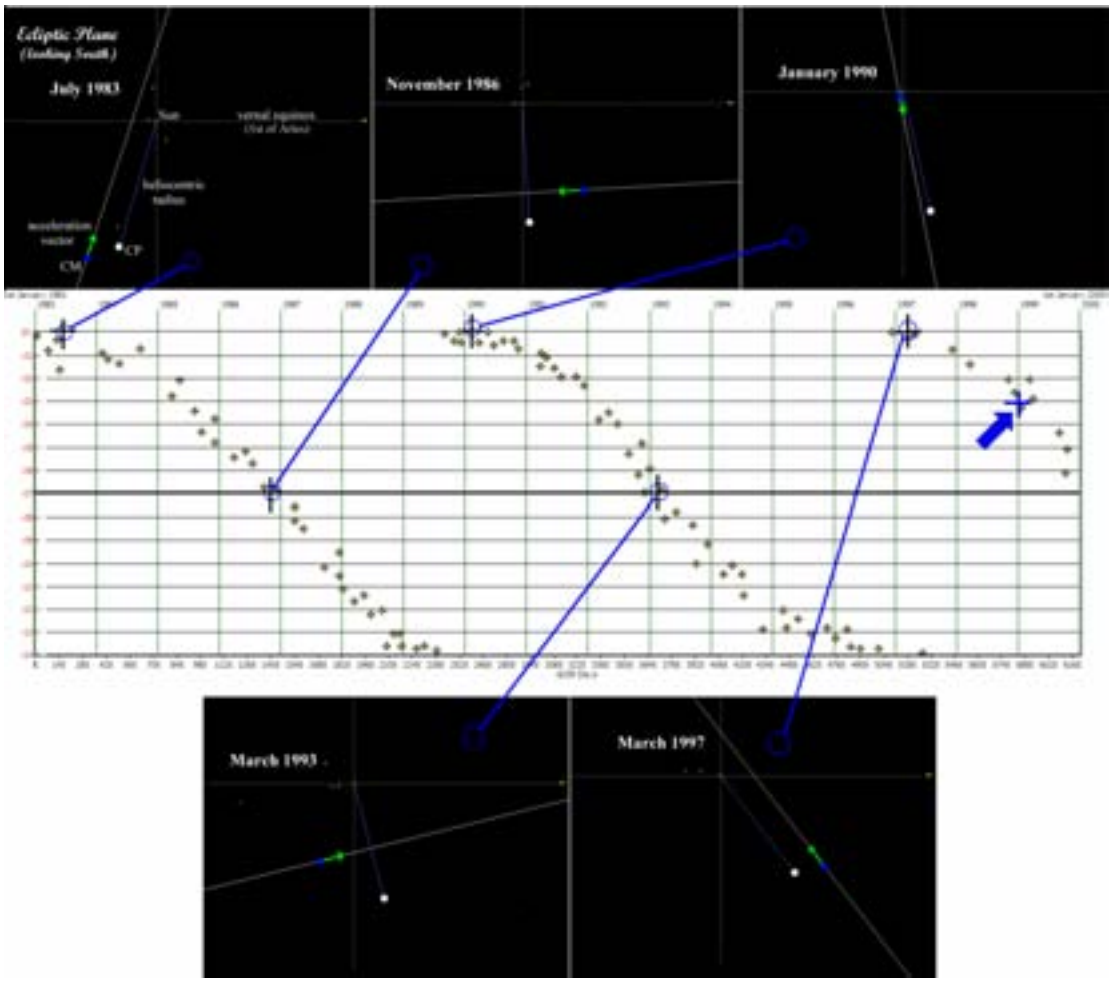


Diagram yyy: Directional and Temporal correspondences

But what about predicting the phase shifts *between* these salient points?

For this, we need what I call the "*bisectoid*". It is the directional equivalent of a *centroid*, which is the single *position* that best represents a cluster of positions. The bisectoid is the single *direction* that best represents a cluster of directions. It is the line that as nearly as possible bisects all the directions of the cluster at once. If there are just two lines in the cluster, the bisectoid *is* their bisector. It is the line corresponding to the average of the cluster's *directivities* (see box).

Directivity

The *directivity* **δ** *of* one line with respect to another is formally defined as the square of the cosine of the angle **α** between the lines,

$$\delta = \cos^2\alpha,$$

and is the measure of the *amplitude, or strength, of their alignment*. Thus, if one line is at any odd multiple of right angles to the other, the directivity is zero (0.0); if the lines are parallel, they have the same orientation and the directivity is one (1.0); if they lie at odd multiples of half a right angle (45 degrees) to each other, the directivity is one half (0.5).

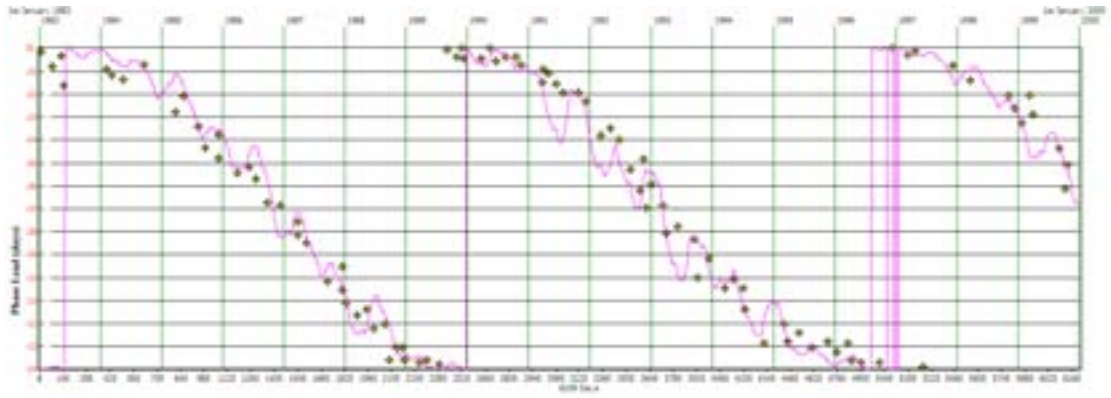
The directivity of a *cluster* of N directions is given by

$$D = \frac{1}{N}\sum_{n=1}^{n=N} cos^2\, a_n,$$

and the angle of the corresponding bisectoid is given by

$$\beta = \frac{1}{2} tan^{-1} \frac{\sum_1^N sin2a_n}{\sum_1^N cos2\, a_n}$$

The directivity or strength of alignment of the bisectoid of the CM acceleration vector and the heliocentric radius is plotted in blue on Mr Edwards' Phase Shift chart, below.



The correlation with the Phase Shift is not perfect, but it is far too good to ignore: it says that -

The timing of the rhythms of bud form against the rhythms of their lunar alignments depends in some as yet unknown way on the orientation of the acceleration *past* the Sun of all the matter of the Solar System not in the Sun.

Note that only *orientations* are involved in this correlation. Vector quantities are threefold, but only the direction of the acceleration vector seems to be active here. The other two features seem set aside, in that neither the *amount* of acceleration, nor its *sense*, plays a role. And the various *distances* of the two Centres from the Sun and from each other seem to be unimportant.

We appear to have come across a line-to-line phenomenon.

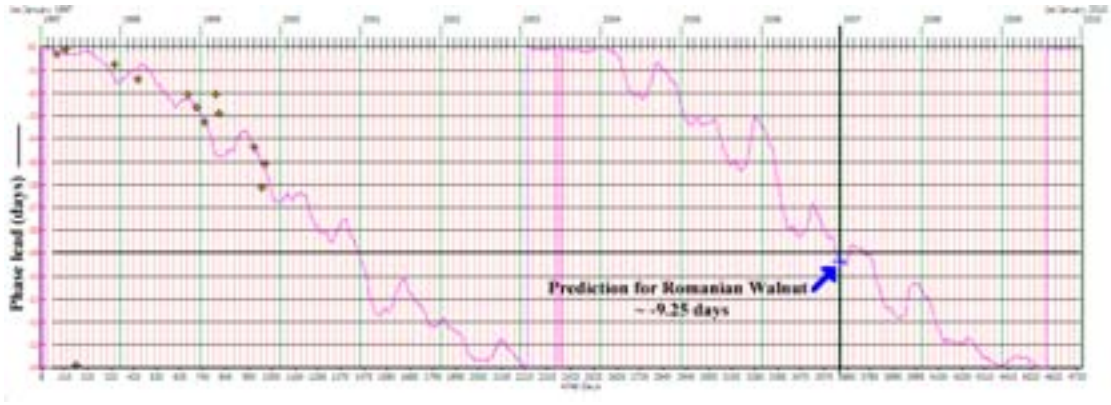
But physical phenomena are generally found to work point-to-point. Where physical relationships are concerned, distances between the points are ordinarily very relevant. And the magnitude and sense of a vector are often more significant than its direction.

Now, if, in pure geometry, we substitute lines for points, and rotations for translations, we dualise. If we dualise with respect to a conic, we polarise. Dare we then suggest that that which underlies the Phase Shift is "polar physical"? With this we are simply asking, "Are there line-to-line forces, polar to the point-to-point kind, and are they at work here?"

The notion has a specious attraction, but there are difficulties. Units and numbers are not native to the synthetic geometry of the bud, and there is no geometric axiom of equality. The conversion of geometry from synthetic to analytic is far from straightforward: it is said that the only number preserved under projection is *cross ratio*, but this will be the case only if it is possible to measure length in a strictly projective context. Since lengths are numbers arising as sums of equal units, and since these latter items, as we have just remarked, are not native to projective geometry, we have at least a conundrum, if not a circular, "bootstrap" argument or a simple impossibility. This is exactly the issue which confronts us in regard to the buds and the planets, in that construction from measureless geometry is being found

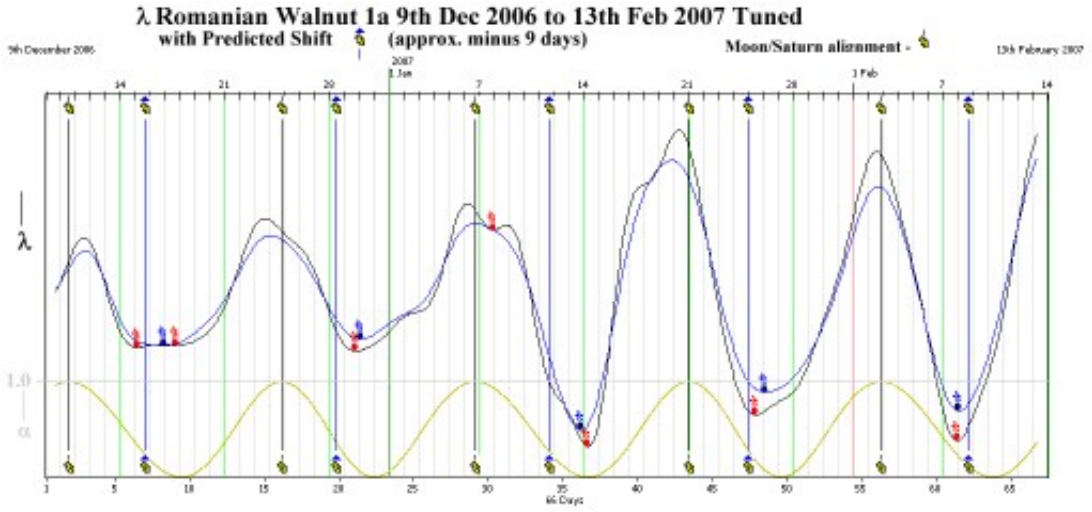
valid by best measurement. And the lines-of-vectors we would like to *use* projectively were not *found* projectively. These are current conceptual and theoretical challenges.

Well, they say the proof of the pudding is in the eating. All the foregoing discussion is academic if predictions based on this model fail. We have seen one bud (the Aberdeen Beech) inside the span of Mr Edwards' chart that matched; let us see if we can successfully predict the shift for a bud that grew at the turn of 2006, a time well after the period of Mr Edwards' chart.



This Walnut bud was photographed daily in Romania; its (Fourier-smoothed and tuned) λ dips are graphed below. The red trace is derived from the raw λ data. The blue trace comes from running-mean-of-three λ data. This bud's form was clearly beating time with Saturn. The verticals between the uncapped Saturn icons mark the true epochs of lunar alignment. The verticals between the capped Saturn icons mark the epochs at which the λ dips should have occurred (some nine days ahead of the lunar alignments with Saturn) if our shift model is correct. And we see that all but one dip matched prediction reasonably well.

The near sinusoid at the bottom of this graph records the instantaneous directivity of the Earth/Moon line relative to Saturn. This is its actual amplitude.



Much about the interpretation of all these results must be omitted now, but a few things in just this connection should still be mentioned. We need continual observation of buds everywhere, for corroboration and continued research, and we need collateral, similarly-behaving phenomena, especially if we wish to tease out the almost-certain relevance to Biodynamics.

The possibility of line-to-line, polar-physical forces has been mentioned. Some would call them Etheric forces, and they may well be right to do so, as such agents are said to govern the forms of living material in extra-material ways. Curiously, these forces are *not* expected to govern simple growth, because growth has to do with size, not form. A bud can in principle grow larger without changing its form. And it is reasonable to expect that a bigger bud will contain more substance than a smaller: in fact a bud would be expected to have a mass equal to its volume times its average density.

Years ago, Mr Edwards and I collaborated on an investigation – which really should be repeated – into just how much substance there actually is in a bud, irrespective of physical expectation. Interest focussed on sap-content: Mr Edwards thought it possible that a lack of conformity to path form would reduce the life of the bud, and that the sap-content could be an indicator of the reduction. I built a simple torsion balance capable of measuring to a tenth of a milligram, and Mr Edwards used it to compare the wet and dry weights of many buds of pre-measured λ, all from the same tree. It turned out, against physical expectation, that form (not volume) *did* affect content, but not at all as anticipated. The quality of the path curve match of a bud had no relevance; rather, the sap reduced with the departure of a bud's λ from the mean λ of all the buds. So there is powerful evidence that *something* is mediating between form and substance, and that elements of astronomy are deeply involved. We may now have the means to discover what that something is.

[1] "The Vortex of Life", Lawrence Edwards, second edition, Floris Books

[2] Diagram 4: Observant readers will have noted that this bud apparently "switched allegiance" from Mars to Saturn around 24th January, when the lunar alignments of the two planets came nearly together. Now as a rule Beech works to Saturn, not Mars, but exceptions such as this one do occur, and there is growing evidence that switching happens fairly frequently. The phase shift is unaffected. So the specification of bud with body is less simple than at first it seemed, and needs further research.

[3] http://budworkshop.co.uk