THE DYNAMICS OF A TWO MASS SYSTEM.

FORWARD.

The following is presented in a form which I believe can be read and understood by almost any interested person. The mathematics used in the arguments presented is straightforward and simple enough so that it should not prevent an interested person with a reasonable general education from with application, reading, understanding and passing judgement on the work.

In examining the following, it should always be remembered that to say that an hypothesis is correct means no more than to say that the consequences derived from it are confirmed by experiment and observation. Impeccable mathematics and logic means nothing if applied to false premises. Provisional hypotheses such as derived below can only be elevated to the status of working hypotheses if all of the conclusions derived from them agree without exception with observation. "Rubbish in, rubbish out" applies as much in general scientific investigation as it does in computing.

This work is divided into three parts as follows:

1). An introduction. This is just a list of the anomalies observed in the current theory of gravitation which led the author on to further investigation.

2). The actual investigation. This is divided into sections with headings indicating the problems dealt with in those sections and the conclusions derived from them. In some cases justification for the derived conclusions is presented in the section however, in cases where the procedures required are long enough and involved enough to cause distraction in the continuity of the presentation, full justification is detailed in the Appendix. Cross references from the sections to the relevant parts of the appendix are provided in the sections where needed.

3). The appendix. Here the general mathematics, on which the conclusions are based is presented.

The author makes no claims for the conclusions and provisional hypotheses derived in the following work other than that they warrant testing according to strict scientific method as indicated above. Those passing these tests must warrant elevation to the status of working hypotheses.

.... M. Sims.

INTRODUCTION.

THE PROBLEM: The following list of anomalies have been observed regarding the inverse square law and the first law of motion.

1). The sun raises a tide which is only 46% of that raised by the moon yet calculations based on the inverse square law and the relevant data indicate that the solar tidal influence should be about 165 times greater than the lunar tidal influence. See below:

Data derived from "Physical and Chemical Constants" by Kaye and Laby.

Solar mass : Earth mass = 330,000 : 1.

Earth mass : Lunar mass = 85.1 : 1. so Lunar mass : Earth mass = (1/85.1) : 1.

Solar distance 92,000,000 miles.

Lunar distance 228,000 miles.

According to the inverse square law: $F = K.M_1.M_2/d^2$

Therefore the force of gravitational attraction between the sun and the earth should be $K \times 330{,}000 \times 1 / (92{,}000{,}000)^2$.

and the force of gravitational attraction between the moon and the earth should be

$$K \times (1/85.1) \times 1 / (228{,}000)^2$$

So the ratio of the solar attraction on the earth to the lunar attraction on the earth is:

$$\frac{K \times 330{,}000 \times 1 / (92{,}000{,}000)^2}{K \times (1/85.1) \times 1 / (228{,}000)^2} = \frac{330{,}000 \times 85.1 \times 228{,}000^2}{92{,}000{,}000^2}$$

= 165 so the sun should have 165 times the attraction on the earth than should the moon.

Now, everybody knows that tides on the earth are said to be caused by the attraction of the sun and of the moon. While nobody claims that the height of the tide is linearly proportional to the gravitational attraction, it is obviously beyond the realm of possibility that a smaller gravitational attraction could raise a bigger tide than a bigger one. However that is exactly what we see;- the solar tide is only 46% of the lunar tide, despite the fact that according to the inverse square law the solar attraction is over 165 times the lunar attraction. Thus the inverse square law, when applied to valid data does not produce results that agree with observation.

I note that the lunar angular velocity relative to the earth is 13 times the solar angular velocity relative to the earth and that the square of 13 is 169. This suggests that the tidal effect may be related to the relative angular KEs as these are determined by the squares of the relative angular velocities. In other words, the tidal effect may be a phenomenon in the realm of dynamics and not one in the realm of statics as it would be if determined by the inverse square law. This possibility will be examined later in the work.

2). According to the inverse square law the mass balance should be in unstable equilibrium yet we see it in stable equilibrium, as seen below.

Fig. 1 shows the mass balance with exactly equal masses in each scale pan. When the pans are horizontal they are both at equal distances d from the center of the earth and the gravity force on each is $F = M_{earth}.M_{mass}/d^2$.

Fig. 1.

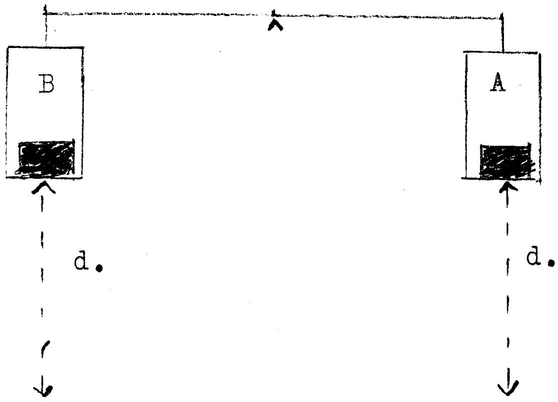

Fig. 2.

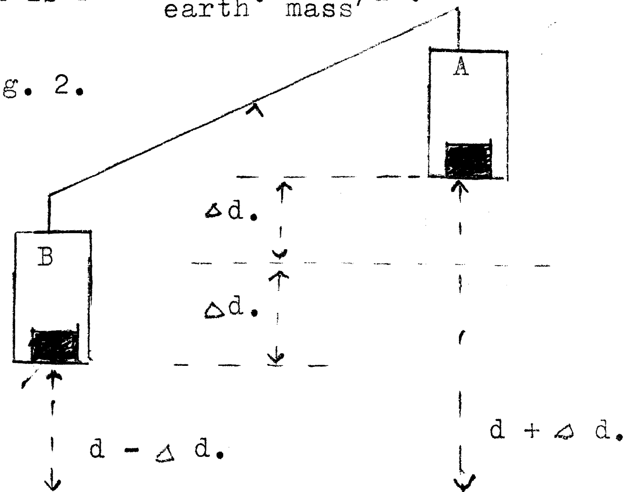

Fig. 2 shows the position when the pans are displaced so that the distance from the center of the earth to pan a is increased to $d + \Delta d$ while the distance from the center of the earth to pan B is reduced to $d - \Delta d$. Then the gravitational force on pan a is $M_{earth}.M_{mass}/(d + \Delta d)^2$ while the force on pan b is $M_{earth}.M_{mass}/(d - \Delta d)^2$.

Since $M_{earth}.M_{mass}/(d + \Delta d)^2$ is obviously less that $M_{earth}.M_{mass}/(d - \Delta d)^2$ in this situation pan a should rise and pan b should lower, rotating them into vertical alignment. But this is not what we actually see in the real world. Instead of rotating into vertical alignment they rotate to horizontal alignment and come to stable equilibrium there.

Thus, we again see the application of the inverse square law produce a conclusion that does not agree with observation in the real world.

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3). $F = G.M_1.M_2/d^2$ the formula for the force of gravitation does not have the dimensions of a force and is thus invalid. See below:

I notice that some physics textbook authors do not include reference to dimensional analysis in their courses. Thus some readers of this matter may not be familiar with dimensional analysis so at right I attach a photocopy of a page introducing the subject.

It will be seen from this that the dimensions of force $(F) = M.L.T^{-2}$ while, according to the law of gravitation the force of gravity is $F = G.M_1.M_2/d^2$. Since G is a constant the dimensions of the force of gravity $(F) = M^2.L^{-2}$. Thus the force of gravity does not qualify as a valid force and cannot be equated with, added to or subtracted from any valid force. Under these conditions it can have no valid standing in physics.

DIMENSIONS.

(This section may be omitted on first reading, unless dealt with in your classes. But a knowledge of the section is frequently of help in the solving of problems.)

The relationship between derived quantities and fundamental quantities, and so also that between derived and fundamental units, can conveniently be expressed by means of dimensional formulæ and equations.

(M), (L), and (T) represent the quantities mass, length and time, without regard to magnitude. Thus a velocity, which is essentially derived from a length divided by a time, is dimensionally $\frac{(L)}{(T)}$, and is written $(L)(T)^{-1}$. As the drawing of the cages for the letters is a nuisance, we usually disregard them, and put LT^{-1}.

Acceleration being a velocity divided by a time, has the dimensions $\frac{LT^{-1}}{T}$, *i.e.*, LT^{-2}.

Writing (F) for the dimensions of force, we know (Table I, p. 15), or will shortly know, that $F \propto Ma$, where a is the acceleration produced.

Hence $(F) = M.LT^{-2}$

Also, $W \propto F.s.$ (Table I, page 15.)

So $(W) = MLT^{-2} \times L = ML^2T^{-2}$, giving the dimensions of the quantity (work). Similarly the dimensions of any other quantity may be obtained.

Two physical quantities which have different dimensions cannot be equated, nor can we add and subtract quantities which have different dimensions; for instance, a mass can never be equal to a length, nor a force to a velocity; neither may we add a force to a velocity.

Thus in all physical equations the dimensions of the terms on the two sides of the equation must be the same.

For example, to convert one system of units to another the dimensional method may be used. To derive the relationship between the joule and foot poundal the method is as follows:

$$\frac{1 \text{ foot poundal}}{1 \text{ erg}} = \frac{M\,L^2T^{-2}}{M\,L^2T^{-2}}\ \frac{\text{in British units}}{\text{in c.g.s. units}}$$

$$= \frac{454}{1} \times \frac{(30 \cdot 5)^2}{(1)^2} \times \frac{(1)^{-2}}{(1)^{-2}} = 422 \times 10^3$$

$\therefore$ 1 foot poundal $= 422 \times 10^3$ ergs $= 4 \cdot 22 \times 10^{-2}$ joules.

(Taking 1 foot as equal to 30·5 cms., and 1 pound as equal to 454 grms. See p. 28.)

4). A serious error is revealed in the logic and in the procedure by which Newton is said to have derived the inverse square law. The two pages below are from a publication detailing the way in which he is said to have done so.

Newton did not treat his apple in the same way in which he treated the moon. He correctly allowed that the moon is rotating with a period of 27.3 days at an average distance of 3.84×10^{8} meters but he totally ignored the fact that the apple just above the surface of the earth is also rotating, in this case with a period of 1 day at a distance of 6.38×10^{6} meters. If he was going to argue that the moon's rotation induced a centrifugal force of $M_{moon} \times 2.73 \times 10^{-3}$ he should also have calculated the centrifugal force on the apple due to it's rotation;- as follows:

$r_{moon} = 6.38 \times 10^{6}$ meters. $T_{moon} = 1$ day $= 24 \times 3600$ secs.

Then V_{apple} = circumference of orbit / period = 2.pi.r/T = 2.31×10^{2} meters/sec.

Thus the centrifugal force on the apple = $M_{apple} \times V^{2}_{apple} / r_{apple}$

$= M_{apple} \times 231^{2} / (6.38 \times 10^{6}) = M_{apple} \times 84.2$

Thus Newton's hypothetical gravitational attraction would have to produce an acceleration of 84.2 meters per sec^{2} just to keep the apple in orbit before it started to accelerate it toward the center of the earth. As this residual acceleration is observed to be 9.81 meters / sec^{2} the actual acceleration produced by the earth's attraction must be $9.81 + 84.2 = 94$ M/sec^{2}. Now, the ratio of the lunar distance to the earth's radius is $3.84 \times 10^{8} / 6.38$ X1 $= 60$. Thus for the inverse square law to hold as outlined above the centripetal acceleration at the moon would have to be $94/60^{2} = 2.6 \times 10^{-2}$ m/sec^{2} and not 2.72×10^{-3} m/sec^{2} as calculated according to the lunar period and distance. Therefore Newton failed to correctly establish the validity of the inverse square law using this method.

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Table 7.1

Planet	*Mean radius of orbit* r (*metres*)	*Period of revolution* T (*seconds*)	r^3/T^2
Mercury	5.79×10^{10}	7.60×10^6	3.36×10^{18}
Venus	1.08×10^{11}	1.94×10^7	3.35
Earth	1.49×10^{11}	3.16×10^7 (1 year)	3.31
Mars	2.28×10^{11}	5.94×10^7 (1.9 years)	3.36
Jupiter	7.78×10^{11}	3.74×10^8 (11.9 years)	3.36
Saturn	1.43×10^{12}	9.30×10^8 (29.5 years)	3.37
Uranus	2.87×10^{12}	2.66×10^9 (84.0 years)	3.34
Neptune	4.50×10^{12}	5.20×10^9 (165 years)	3.37
Pluto	5.90×10^{12}	7.82×10^9 (248 years)	3.36

Kepler's three laws enabled planetary positions, both past and future, to be determined accurately without the complex array of geometrical constructions used previously which were due to the Greeks. His work was also important because by stating his empirical laws (i.e. laws based on observation, not on theory) in mathematical terms he helped to establish the equation as a form of scientific shorthand.

Gravity and the moon

Kepler's laws summed up neatly *how* the planets of the solar system behaved without indicating *why* they did so. One of the problems was to find the centripetal force which kept a planet in its orbit round the sun, or the moon round the earth, in a way which agreed with Kepler's laws.

Newton reflected (perhaps in his garden when the apple fell) that the earth exerts an inward pull on nearby objects causing them to fall. He then speculated whether this same force of gravity might not extend out farther to pull on the moon and keep it in orbit. If it did, might not the sun also pull on the planets in the same way with the same kind of force? He decided to test the idea first on the moon's motion—as we will do now.

If r is the radius of the moon's orbit round the earth and T is the time it takes to complete one orbit, i.e. its period, Fig. 7.20, then using accepted values we have

$$r = 3.84 \times 10^8 \text{ m}$$

$$T = 27.3 \text{ days}$$

$$= 27.3 \times 24 \times 3600 \text{ s}$$

(The time between full moons is 29.5 days but this is due to the earth also moving round the sun. The moon has therefore to travel a little farther to reach the same position relative to the sun. Judged against the background of the stars, the moon takes 27.3 days to make one complete orbit of the earth, which is its true period T.)

The speed v of the moon along its orbit (assumed circular) is

$$v = \frac{\text{circumference of orbit}}{\text{period}} = \frac{2\pi r}{T}$$

$$= \frac{2\pi \times 3.84 \times 10^8}{27.3 \times 24 \times 3600} \text{ m s}^{-1}$$

$$= 1.02 \times 10^3 \text{ m s}^{-1}$$

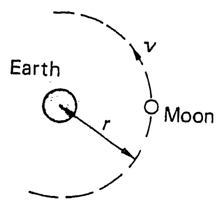
The moon's centripetal acceleration a will be

$$a = \frac{v^2}{r} = \frac{(1.02 \times 10^3 \text{ m s}^{-1})^2}{3.84 \times 10^8 \text{ m}}$$

$$= 2.72 \times 10^{-3} \text{ m s}^{-2}$$

Error in logic. See below.

The acceleration due to gravity at the earth's surface is 9.81 m s^{-2} and so if gravity is the centripetal force for the moon it must weaken between the earth and the moon. The simplest assumption would be that gravity halves when the distance doubles and at the moon it would be 1/60 of 9.81 m s^{-2} since the moon is 60 earth-radii from the centre of the earth and an object at the earth's surface is 1 earth-radius from the centre. But $9.81/60 = 1.64 \times 10^{-1} \text{ m s}^{-2}$, which is still too large.



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The next relation to try would be an inverse square law in which gravity is one-quarter when the distance doubles, one-ninth when it trebles and so on. At the moon it would be $1/60^2$ of $9.81\ \mathrm{m\ s^{-2}}$, i.e. $9.81/3600 = 2.72 \times 10^{-3}\ \mathrm{m\ s^{-2}}$—the value of the moon's centripetal acceleration.

Law of universal gravitation

Having successfully tested the idea of inverse square law gravity for the motion of the moon round the earth, Newton turned his attention to the solar system.

His proposal, first published in 1687 in his great work the *Principia* (Mathematical principles of natural knowledge), was that the centripetal force which keeps the planets in orbit round the sun is provided by the gravitational attraction of the sun for the planets. This, according to Newton, was the same kind of attraction as that of the earth for an apple. Gravity—the attraction of the earth for an object—was thus a particular case of gravitation. In fact, Newton asserted that every object in the universe attracted every other object with a gravitational force and that this force was responsible for the orbital motion of celestial (heavenly) bodies.

Newton's hypothesis, now established as a theory and known as the *law of universal gravitation*, may be stated quantitatively as follows.

Every particle of matter in the universe attracts every other particle with a force which is directly proportional to the product of their masses and inversely proportional to the square of their distances apart.

The gravitational attraction F between two particles of masses m_1 and m_2, distance r apart is thus given by

$$F \propto \frac{m_1 m_2}{r^2} \qquad \text{or} \qquad F = G\frac{m_1 m_2}{r^2}$$

where G is a constant, called the *universal gravitational constant*, and assumed to have the same value everywhere for all matter.

Newton believed the force was directly proportional to the mass of each particle because the force on a falling body is proportional to its mass ($F = ma = mg = m \times$ constant, therefore $F \propto m$), i.e. to the mass of the *attracted* body. Hence, from the third law of motion, he argued that since the falling body also attracts the earth with an equal and opposite force that is proportional to the mass of the earth, then the gravitational force between the bodies must also be proportional to the mass of the *attracting* body. The moon test justified the use of an inverse square law relation between force and distance.

The law applies to *particles* (i.e. bodies whose dimensions are very small compared with other distances involved), but Newton showed that the attraction exerted at an external point by a sphere of uniform density (or a sphere composed of uniform concentric shells) was the same as if its whole mass were concentrated at its centre. We tacitly assumed this for the earth in the previous section and will use it in future.

The gravitational force between two ordinary objects (say two 1 kg masses 1 metre apart) is extremely small and therefore difficult to detect. What does this indicate about the value of G in SI units? What will be the units of G in the SI system?

Testing gravitation

To test $F = Gm_1m_2/r^2$ for the sun and planets the numerical values of all quantities on both sides of the equation need to be known. Newton neither had reliable information about the masses of the sun and planets nor did he know the value of G and so he could not adopt this procedure. There are alternatives however.

(*a*) *Deriving Kepler's laws.* The behaviour of the solar system is summarized by Kepler's laws and any theory which predicts these would, for a start, be in agreement with the facts.

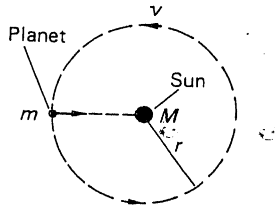

Fig. 7.21

Suppose a planet of mass m moves with speed v in a circle of radius r round the sun of mass M, Fig. 7.21. Hence

$$\text{gravitational attraction of sun for planet} = G\frac{Mm}{r^2}$$

If this is the centripetal force keeping the planet in orbit then

Dimensions of L.H.S. invalid.

$$G\frac{Mm}{r^2} = \frac{mv^2}{r}$$

$$\therefore \frac{GM}{r} = v^2$$

Invalid equation. See 3. above.

If T is the time for the planet to make one orbit, t V = 2.pi.r/T so G.M/r = 4.pi^2.r^2/T^2 so G.M = 4.pi^2.r^3/T^2 so r^3/T^2 = where K = G.M/4.pi^2. Newton claimed that this result verified M$_1$.M$_2$/

While the above demonstration appears convincing on the surface, closer examination shows that since G.Mm/r^2 is not a valid formula for a force (see 3. above) it cannot validly be used in the above equation, so the conclusion that r^3/T^2 = K is invalid. A valid derivation of the r^3/T^2 = K relationship will be provided later using premises unrelated to the law of gravitation.

5). The revolution of satellites around their primaries is explained according to the law of gravitation and first law of motion. Detailed analysis of this explanation reveals that, far from keeping the satellite in orbit, the law of gravitation would cause it to spiral in to the primary, as shown below.

FIG. 5

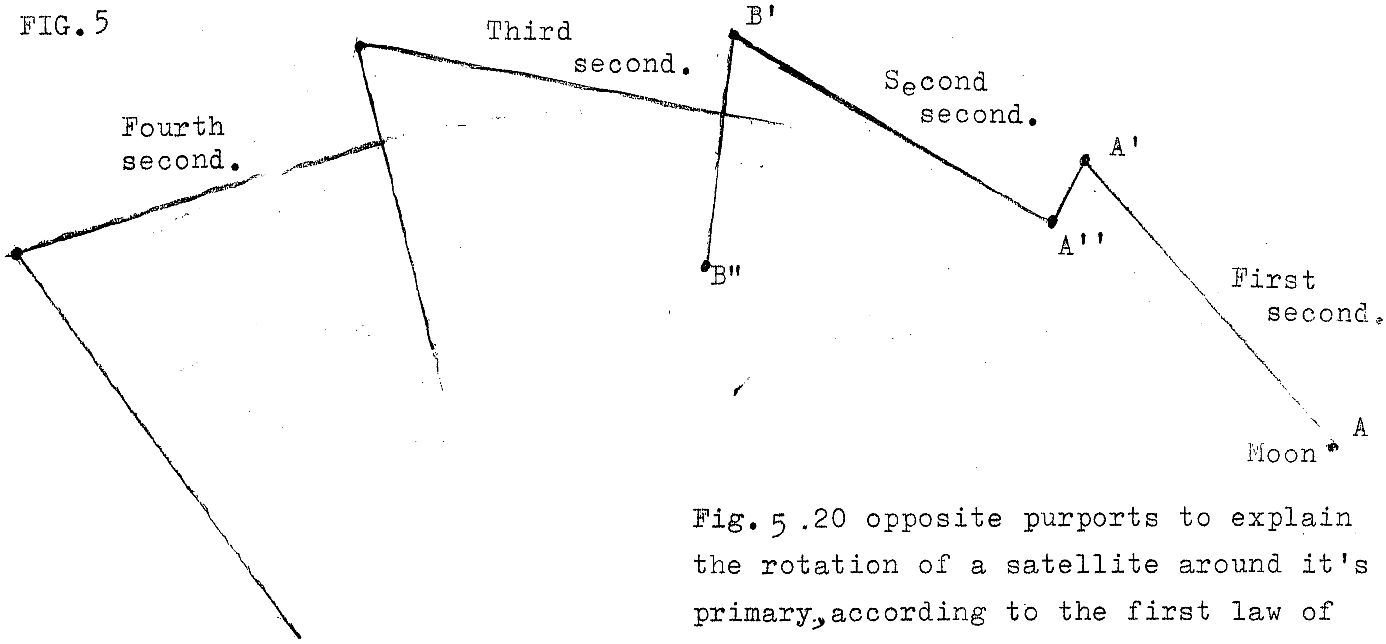

Fig. 5 .20 opposite purports to explain the rotation of a satellite around it's primary, according to the first law of motion and the law of gravitation.

Fig. 5 indicates what would actually happen under these conditions using the data in the previous pages on the earth and the moon.

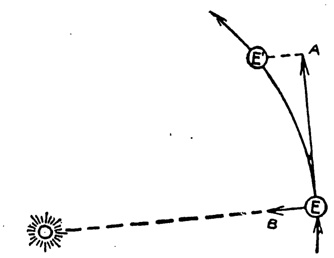

FIG. 5 ·20. The Earth's Revolution Explained by the Laws of Motion. At the position *E* the earth if undisturbed would continue on to *A*, by the first law of motion. It arrives at *E'* instead, having in the meantime fallen toward the sun the distance *EB*.

If the moon starts at position A it would proceed to position A' through a distance of 1.02×10^3 meters in 1 sec, according the first law of motion. In the same tim it would be accelerated by gravitational attraction toward the center of the earth through a distance determined as follows: $v = u + gt$ and $s = ut + \frac{1}{2}.a.t^2$ so

$s = 0 + \frac{1}{2}.\ 2.72 \times 10^{-3} \times 1^2 = 1.36 \times 10^{-3}$ meters, bringing it back on orbit at A

So far so good, but now look what happens in the second sec.
The moon's velocity toward the earth is now $v = u + gt = 0 + 2.72 \times 10^{-3} \times 1$ $= 2.72 \times 10^{-3}$ meters/sec^2. Note that the moon's instantaneous tangential velocity, V has not been changed during the first sec. but that it's velocity toward the center of the earth v has increased from 0 to 2.72×10^{-3} m/s^2 because of the acceleration due to gravity. Thus during the second sec. the moon would move through a distance of 1.36×10^{-3} meters to B' according to the first law of motion but because it had a velocity of 2.72×10^{-3} m/s^2 at the start of the second sec it would travel through a distance of $s = u.t + \frac{1}{2}.g.t^2$ $= 2.72 \times 10^{-3} \times 1 + \frac{1}{2} \times 2.72 \times 10^{-3} \times 1^2 = 3/2 \times 2.72 \times 10^{-3}$ meters.

Note that this distance is three times too far to bring the moon back to it's orbital distance and leaves it 2.72 X 10^{-3} meters inside it's orbital distance. Similarly it can be shown that at the end of the third second it will be 2.72 X 10^{-3} X 2 meters inside the orbital distance and that in general after N seconds it will be 2.72 X 10^{-3} X (N-1) meters inside the orbital distance and so that it would gradually spiral into the earth.

From the above discussion it is obvious that the only way in which a combination of the first law of motion and the law of gravitation could produce a stable orbit would be for the gravitational attraction to act for just one second and then be swiched off, leaving the moon's velocity towards the center of the earth at 1.36 X 10^{-3} meters per second.

SINCE THIS ISIMPOSSIBLE WE MUST CONCLUDE THAT THERE ARE OTHER FACTORS OPERATING TO KEEP THE PLANETS ETC. IN THEIR ORBITS.

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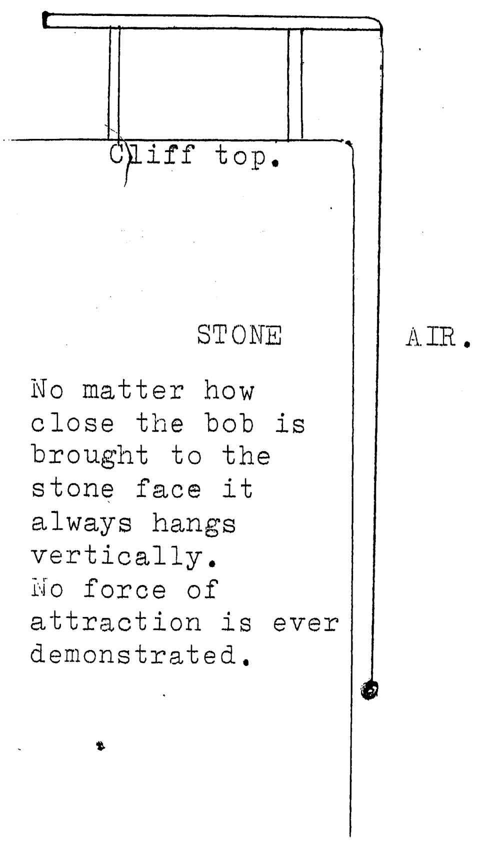
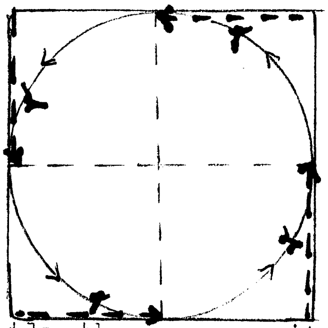
6). One of the first ways thought up to teast Newton's theory of gravitation was to hang a blumbob dowh the face of a cliff so that the great mass of the stone on one side of the bob would be far greater than the mass of air on the other side. Then, as the bob was brought closer to the stone face, it should at some stage be attracted out of the vertical, toward the face.



Although the experiment was conducted many times the bob was always found to hang vertically no matter how close it was brought to the stone; even a separation of less than 1mm brought no deviation from the vertical. Protagonists of the theory apparently found it convenient to ignore this result.

According to the current theory of gravitation, the gravitational force between, say the earth and the moon, is equalled by the centrifugal force due the the moon's rotation, thus keeping it in stable orbit. Since the moon's centripetal acceleration is 2.72×10^{-3} meters/sec and it's mass is M gms, the equivalent force keeping it in orbit is $2.72 \times 10^{-1} \times M$ dynes. The figure opposete indicates the



distance through which this force must operate over one lunar revolution. This equals 4 times the orbital radius Since W=F.S the work that the above force must do over 1 lunar revolution would have to be:

$M \times 2.72 \times 10^{-1} \times 3.84 \times 10^{10} = 4.16 \times 10^{10}$ ergs.

Note that after one complete revolution the moon is in exactly the same position and with exactly the same velocity that it had at the beginning of that circuit. This means that 4.16×10^{10} ergs has been expended just to maintain the status quo. If the efficiency of this operation is measured as: the change achieved/the energy expended $= 0/(4.16 \times 10^{10}) = 0$. This sort of result would make planetary systems the most ineffiecient machines ever produced. Where does all of this energy come from ?. Nobody knows. Where does it go ?. ?????.

According to the laws of thermodynamics, when energy is dissipated it raises the temperature. In this case, no heating in the solar system is observed although the energy dissipation appears to be going on continually over all of the orbits of all of the planets and all of the satellites that it contains.

According to the law of conservation of energy, energy can neither be created nor destroyed, but here we see it mysteriously destroyed and then recreated over each cycle in every orbit. As this is obviously impossible some other explanation must be found to satisfactorily explain the behaveior of bodies in the solar system

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Newton can hardly be held responsible for not realising that this explanation of planetary motion violated the law of conservation of energy since neither the concept of energy nor of it's conservation existed in his time. Thomas Young first developed the concept of energy and in 1803 he demonstrated (approximately) that the energy of a mass is proportional to the square of it's velocity.

The law of conservation of energy was not articulated until the 1850s when Meyer & Helmholtz arrived at it independently of each other, about 150 years after the publication of the Principia.

8). A Deficiency in the Wording of the First Law of Motion.

Newton stated the first law of motion as follows:
"A body continues in a state of rest or of uniform motion in a straight line unless it be acted on by an external impressed force to change that state."

In view of the fact that he stated his second law as:
"The time rate of change in momentum is proportional to the impressed force and takes place in the direction in which that force acts," I have wondered why he did not state his first law as follows:
" The momentum of a body remains constant unless it is acted upon by an external impressed force to change that momentum."

Linear momentum equals m.v and since v is a vector and not a scalar quantity, momentum has direction. So "uniform motion in a straight line" means the same thing as "constant linear momentum" and the two versions of the first law would mean the same thing, at least in the case of "constant linear momentum".

I think that a possible reason that he chose the version that he did was due to the fact that in 1687, much of the scientific infrastructure which we take for granted, did not exist so he had a problem in communication. Very few people at the time would have understood the difference between scalar and vector quantities, so he introduced Galileo's Italian word for speed, velocità, which he wrote as "velocity", to differentiate between the scalar "speed" and it's vector equivalent. Then, to make sure that nobody remained confused, he chose to emphasise the directional aspect of his proposition he included "in a straight line

This caused no problem as long as he was dealing with linear velocity and linear momentum. Unfortunately, he never formally investigated rotational momentum in the same way that he investigated linear momentum. In fact there is no evidence to show that he ever developed the concept of rotational momentum.
If he had done so he would have realised that the rotational analog of linear velocity, that is, "the instantaneous tangential velocity", could NOT have constant direction because it is at right angles to the rotating radius vector and so it must rotate with the radius vector.

If Newton had chosen also to state his third law in the form:
"For any change in momentum there is an equal and opposite change in momentum", his three laws in this alternate form would have constituted an elegant statement of the law of conservation of momentum (and hence energy), which he obviously understood but never fomally articulated. If he had done this, he would have realised the existance of the anomalies listed above.
His percieved need to postulate a gravitational force as in case 5, to accelerate a mass from it's straight line destination to one on it's orbit (expending energy in the process) would have been seen to be unnecessary; THE LAW OF CONSERVATION OF ROTATIONAL MOMENTUM WOULD HAVE DONE IT FOR HIM WITHOUT THE EXPENDITURE OF ENERGY

If this conclusion is correct it must bring into serious doubt both the law of gravitation and the applicability of the first law of motion in it's present form for rotational dynamics.

The idea that masses, if undisturbed, travel in straight lines, is intuitive but there is almost no evidence to support this hypothesis, found in the real world. In the solar system, masses follow conic locii while further out we see a variety of forms such as spirals, discs, sombrero hats, clouds and spheres etc but we never see patterns indicating that they represent masses travelling in straight lines. On the next page we see a plate showing the path of a free electron in a Wilson Cloud Chamber which is describing a curved path while there is no apparent concentration of mass on the concave side of the path to induce the curvature seen, as would be requiréd according to the Newtonian theory of gravitation.

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At this stage critics may validly point out that I have got two very high hurdles to get over before I have any chance of getting people to believe that there is no force of attraction between masses. These are:

1). I have to postulate a credible alternate cause for the acceleration of the apple.

2). People may also point out that Cavendish in 1796, et al since have repeatedly demonstrated an attraction between masses in the laboratory, using the torsion balance.

****

With regard to 1). above; I intend to do just that during the course of this work. As far as 2). above is concerned: I point out that there was another non-gravitational factor operating on Cavendish's balance which invalidated his result. This was the 'Faucault Pendulum Effect". Cavendish would have been unaware of this other effect because it was not demonstrated until the 1850s, about sixty years after Cavendish was working.

****

I consider that by now, sufficient evidence has been brought forward to bring into serious doubt, the current theory of gravitation and the first law of motion in it's present form, to warrant a more thorough search for valid principles of dynamics.

Rotational Motion.

As the problem before us is basically one of rotational motion, I will begin by stating Newton's laws of motion in their alternate form and as they apply to rotational motion.

1). The rotational momentum of a body remains constant unless it is acted upon by some external impressed torque to change that rotational momentum.

2). The time rate of change in rotational momentum is proportional to the impressed torque and takes place in the same sense in which that torque acts.

3). For every change in rotational momentum there is an equal and opposite change in rotational momentum.

****

For two masses orbiting each other in equilibrium the following conclusions can be drawn from Newton's Laws as stated above:

4). For balance, the moments of masses rotating in equilibrium must be equal. That is, $M_1.r_1$ must equal $M_2.r_2$. But the point about which the moments of two masses are equal is their common center of gravity. Thus for equilibrium the masses must be rotating about their common center of gravity.

5). To be in equilibrium the masses must have equal siderial angular velocities.

6). From 4 above $M_1.r_1$ must equal $M_2.r_2$ and for equilibrium, from 5 above W_1 must equal W_2 so for equilibrium $M_1.r_1.W_1$ must equal $M_2.r_2.W_2$. Thus for rotational equilibrium the angular momenta of both masses must be equal.

7). For masses to rotate in equilibrium there must be no torque acting on them. Otherwise, according to 2 above they would be subject to change in angular momentum and thus would not be in equilibrium.

****

Now, consider the case of two masses orbiting each other but which are not in rotational equilibrium. That is, where $M_1.r_1.W_1$ is not equal to $M_2.r_2.W_2$.

From 7 above, the masses must now have a torque acting on them which will according to 2 above, change their angular momenta.

From 3 above the induced changes in angular momenta must be equal and opposite so the torques acting on each mass must be equal and of opposite sense.

From 5 and 6 above, the masses must remain under torque until their angular velocities are equal and thus until they are in rotational equilibrium.

8). According to the law of conservation of angular momentum the total angular momentum before the change must equal the total angular momentum after the change, so $M_1.r_1.W_1 + M_2.r_2.W_2$ must $= M_1.r_1.W_3 + M_2.r_2.W_3$ where W_3 is the equilibrium angular velocity.
But $M_1.r_1 = M_2.r_2$ so W_3 must equal $(W_1 + W_2)/2$.

9). Thus two masses rotating relative to each other but not in rotational equilibrium will automatically exchange angular momenta until their angular velocities are equal and they will come to equilibrium at an angular velocity of $(W_1 + W_2)/2$ and at distances from their commen center of gravity determined by $r_1/r_2 = M_2/M_1$.

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10). In order to determine how the equilibrium distance is governed by changes in equilibrium angular momentum it is only necessary to examine the implications of Kepler's third law.

Consider the case where a third mass M_3 is orbiting M_1 with angular momentum $M_3.r_3.W_3$ in the same way that M_2 is orbiting M_1. That is, the case where M_2 and M_3 are satellites of the primary M_1.
In this case Kepler's third law tells us that $W_3{}^2/W_2{}^2 = K.r_2{}^3/r_3{}^3$
So $K.(r_2/r_3) = (W_3{}^2.r_3{}^2)/(W_2{}^2.r_2{}^2)$.
So the equilibrium distances of the satellites from their primary are inversely proportional to the squares of their rotational momenta per unit mass around their primary.

What a surprise!. Another inverse square law relating to the planetary distances!. Not too much should be read into this however.

Since a mass does not change it's magnitude as it's momentum and it's kinetic energy are changed,

$$K.(r_2/r_3) = (W_3{}^2.r_3{}^2)/(W_2{}^2.r_2{}^2) = ((M/2)(W_3{}^2.r_3{}^2)/(M/2)(W_2{}^2.r_2{}^2)$$

so the equilibrium distance of a satellite from it's primary is inversely proportional to it's rotational kinetic energy around that primary.

Obviously also, for satellites of different mass, as is the case in the solar system, their equilibrium distances are inversely proportional to their rotational kinetic energy PER UNIT MASS around their primary.
Thus, this law can be written in several different ways.

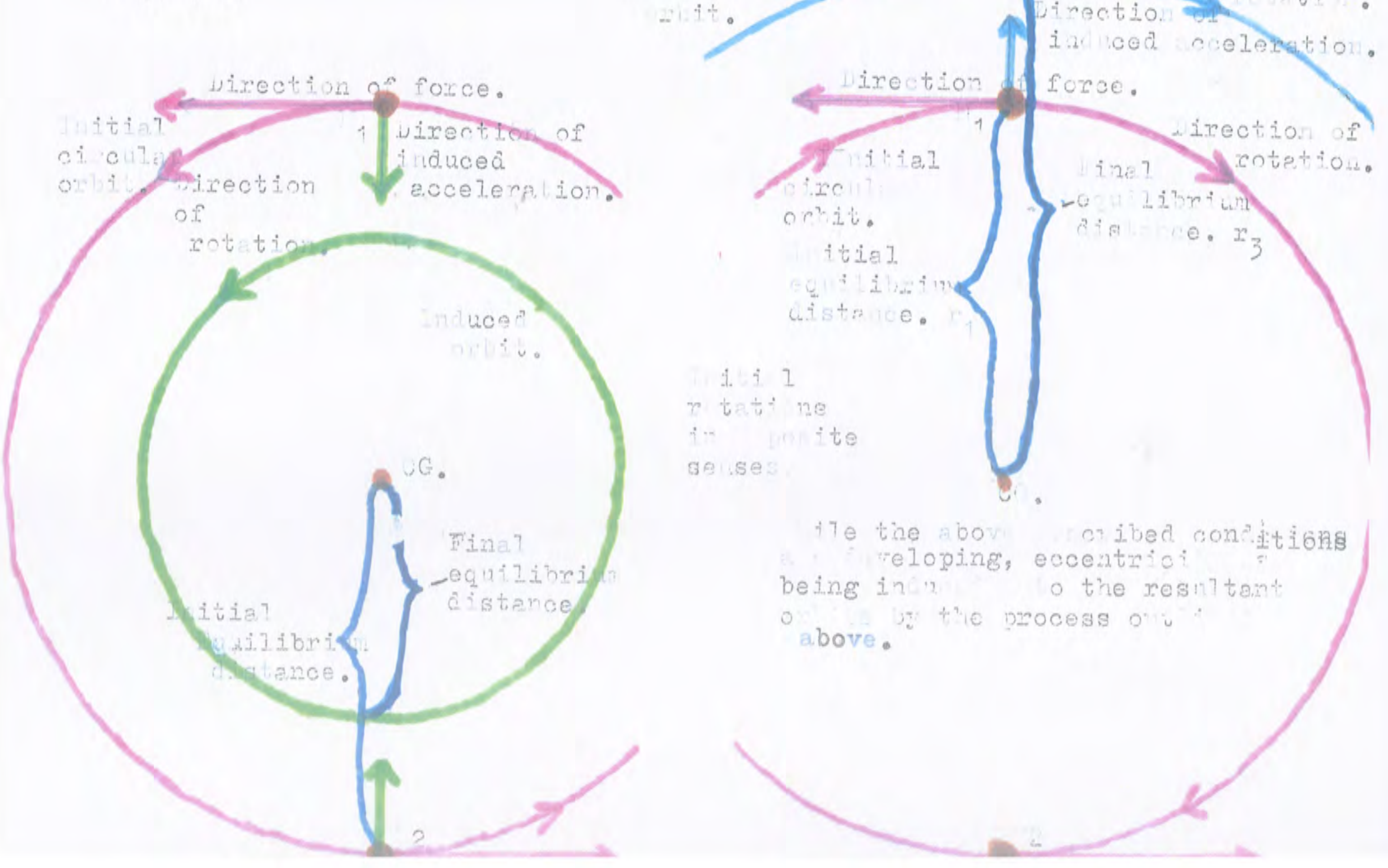
Note that since this law is a corollary of Kepler's third law, it agrees totally with observation from the solar system.
From the above it can be concluded that the equilibrium distances of masses rotating about their common center of gravity are inversely proportional to their angular kinetic energies per unit mass relative to each other.

****

Now, if while two masses are rotating in equilibrium as described above, forces are applied to them at right angles to their radii vectors, that is if a torque is applied to them changeing their angular velocities from W to W_n we know from the above discussion that a new equilibrium will be established such that $r_{1n}/r_1 = r_1{}^2.W^2/r_{1n}{}^2.W_n{}^2$ and $r_{2n}/r_2 = r_2{}^2.W^2/r_{2n}{}^2.W_n{}^2$.

Note that both the equilibrium radii and the equilibrium angular velocity are changed by the application of this torque (force). That is, a force applied along the tangent will induce acceleration, not only in the direction of the force, but also at right angles to it, that is along the radius vector. See Fig. 2 below. This situation is unique in that in classical mechanics acceleration can only take place in the direction of the force, (2nd law). Thus, application of the torque will result in changes in the equilibrium distances implying accelerations of the masses in directions required to restore the equilibrium. After the torque is removed W_n will remain constant thus maintaining the new equilibrium distances. However the masses accelerating towards these distance will have acquired velocities causing them to overshoot, setting up S.H.M.s about the new equilibrium distances.

Fig. (2).



MAGNETIC FIELDS AND GYROSCOPIC ACTION EXPLAINABLE IN TERMS OF THE ABOVEDESCRIBED ROTATIONAL DYNAMICS. If two masses are rotating as above in equilibrium with given rotational KEs per unit mass and atorque is applied changeing their rotational KEs per unit mass, their new equilibrium distances will be inversely proportional the changes in rotational KE per unit mass. That is, if the rotational kinetic energy per unit mass is increased by a factor F the equilibrium distances will be reduced by a factor F and if the rotational kinetic energy per unit mass is reduced by a factor F the equilibrium distances will be increased by the same factor.

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By placing the thumb, forefinger and middle finger of the left hand mutually at right angles it is possible to apply a rule analogous to the left hand rule of electrodynamics to predict the accelerations of the above masses under changeing rotational kinetic energy. This rule is:
Point the forefinger of the left hand along the axis of rotation from the direction which makes the rotation appear anticlockwise.
Then point themiddle fing in the direction of the applied force on the mass.
The thumb will then point in the direction of the induced acceleration.

****

The analogous left hand (motor) rule of electrodynamics is:
Point the forefinger of the left hand in the direction of the magnetic field.
Then orient the middle finger to the direction of the current in the wire.
The thumb will then point in the direction of the induced motion of the wire.

Now, the current in the wire is really a stream of electrons moveing along the wire and they would not be moveing as they are unless they were being driven by an electromotive force. Thus, the middle finger requirement of the motor rule could be written as: "Orient the middle finger to the direction of the electromotive force on the electrons in the wire".
Now, since the electrons are confined to the wire, if they are forced to move in a direction at right angles to the length of the wire, they will obviously take the wire with them. Thus, the result could be written as: "The thumb will then point in the direction of the induced motion of the electrons in the wire".

Attached sheet AA shows what happens when a gyroscope is placed on a merry-go-round so that it's axis of rotation is not parallel with the axis of rotation of the merry-go-round. The axis of rotation of the gyroscope is always seen to align itself with that of the merry-go-round.

Barnett showed that when an unmagnetised iron rod is rotated about an axis it is magnetised along that axis. He then concluded that the magnetisation is caused by the orientation of the axes of rotation of the "molecular magnetic dipoles" or the "atomic gyrocompasses" in the rod parallel to the axis of rotation of the rod, by a process analogous to the orientation of the gyroscope on the merry-go-round.

In other words, he showed that the direction of the magnetic field is really the direction of the axes of rotation of the "molecular magnetic dipoles" or the "atomic gyrocompasses" in the magnet.

If we now postulate that these "molecular magnetic dipoles" or "atomic gyrocompasses" are really just rotating electrons, we can reformulate the forefinger requirement of the motor rule as:

Point the forefinger of the left hand in the direction of the axes of rotation of the electrons comprising the "atomic gyrocompasses" in the magnet from the direction which makes the rotation appear anticlockwise.

In this form the forefinger requirement of the motor rule is the same as that for the rotational dynamics rule, as stated above:

Point the forefinger of the left hand along the axis of rotation of the masses from the direction which makes the rotation appear anticlockwise.

As shown above, the other analogous requirements of the two rules are:

Orient the middle finger to the direction of the applied force on the mass.

Orient the middle finger to the direction of the electromotive force on the electrons in the wire.

The thumb will then point in the direction of the induced acceleration.

The thumb will then point in the direction of the induced motion of the electrons in the wire.

This, virtually identical nature of the two rules indicates that the dynamics underlying the motor rule must be the rotational dynamics developed above.

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Barnett Effect as Experimental Support for Ampère's Hypothesis of Molecular Currents

The simplest assumption which explains how molecular currents could exist without producing heat is to visualize electrons revolving in empty space inside an atom. Evidence for the support of this idea was provided by Barnett through an ingenious experiment. Barnett reasoned as follows: Since an electron has mass, a revolving electron will possess an angular momentum. It should behave similarly to a disk rotating about a central axis perpendicular to its plane. Such a system, endowed with angular momentum, constitutes a simple example of a so-called *gyroscope* (or top). A spinning gyroscope possesses the following interesting property: When placed on a rotating merry-go-round M in such a way

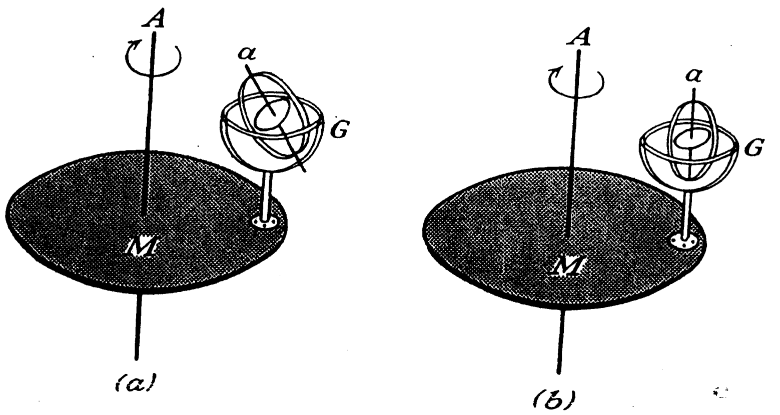

FIG. 23.18.

that the axis a of the gyroscope G is not parallel to the axis of rotation A of the merry-go-round (Fig. 23.18a), the axis of the gyroscope tends to set itself parallel to the rotational axis of the merry-go-round (Fig. 23.18b). This phenomenon underlies the principle of the gyrocompass, which consists essentially of a fast-spinning gyroscope whose axis of rotation orients itself in the plane of the geographic meridian owing to its tendency to orient itself as nearly as possible parallel to the axis of rotation of the earth. Barnett conceived of the billions of iron atoms containing circulating (revolving as well as spinning) electrons as tiny gyroscopes. He expected that by spinning a cylindrical iron bar about the cylinder axis the axes of the tiny "atomic gyrocompasses" would all orient themselves parallel to the axis of rotation. This, however, would be equivalent to orientation of the molecular magnetic dipoles. Thus, *our picture of circulating electrons predicts the possibility of magnetizing an iron bar by rotating it.* Barnett's experiment proved successful and thus confirmed the belief of physicists in the existence of circulating electrons in atoms.

Attached sheet AB shows a gyroscope balanced by a counterweight on a rotatable fulcrum.

According to the Barnett effect, we know that under these conditions the gyroscope will align itself with the earth's axis of rotation and will remain aligned with it as long as it remains spinning. However, if the counterweight is slipped toward the fulcrum putting downward force on the wheel, the gyroscope will be seen to move to the right. If the counterweight is slipped out past the balance point putting upward force on the wheel, the gyroscope will be seen to move to the left, as shown in figures 11-10A and 11-10B.

From the above, it is obvious that a third left hand rule (Gyroscope Rule) can be postulated predicting the behaveior of gyroscopes under these conditions:

Point the forefinger of the left hand along the axis of rotation of the gyroscope from the direction which makes the rotation appear anticlockwise. Orient the middle finger to the direction of the force on the wheel. The thumb will then point in the direction of the induced motion of the wheel.

The virtually identical nature of this rule to the previous two rules indicates that the dynamics underlying the motion of gyroscopes must also be the rotational dynamics developed above.

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Figures 11-12 and 11-13 pictorially detail the connection between the rotational dynamics rule and the gyroscope rule.

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So far the investigation has been confined to masses initially in circular rotation. It must now be broadened to include masses following con-focal conic locii.

Peculiar behavior of spinning bodies. Most people are fascinated by a spinning top. Let us see whether we can work out some of the fundamental principles connected with its behavior. It surely seems a bit strange that a top with its axis inclined keeps spinning instead of falling over in accordance with the conditions of static stability.

We may perhaps best approach the problem by experimenting with a model of a *gyroscope* (Fig. 11–10). The essential part of this machine is a wheel M with a heavy rim which is free to rotate with very little friction about an axle. The axle turns between two points set in a circular frame which forms one side of a lever. The lever is free to rotate about a horizontal axis at right angles to the axle, and the whole frame is pivoted on a steel needle so as to turn freely about a vertical axis. Thus the gyroscope is a heavy rimmed wheel set in a frame so that it may possess three kinds of rotation simultaneously. A sliding weight W is used to counterpoise the rotating wheel.

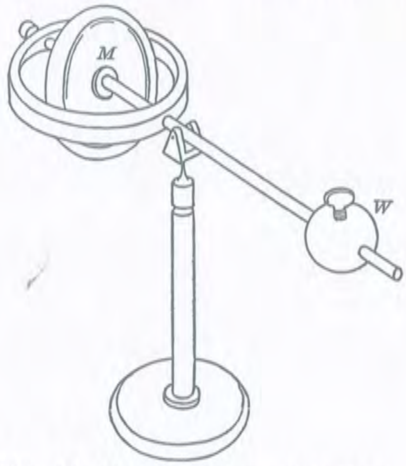


FIG. 11–10. Model of gyroscope.

Suppose now that we set the wheel in rapid rotation and move the whole apparatus slowly around the room. We observe that the axle of rotation preserves its direction unaltered as we move. If, while the wheel is still spinning, we try to change the direction of the axle of spin, we experience a curious wriggle of the wheel as if the thing were alive. To study this strange behavior, let us slide the weight W toward the center so that the axis of spin is tilted down. We find now that the wheel begins slowly to move around in a horizontal circle. But when we slide the weight W outward from the wheel so that the axis of spin is tilted upward, we find that the wheel again moves around in a horizontal circle, but in the opposite direction. This sideways motion of the axis of spin is called precession.

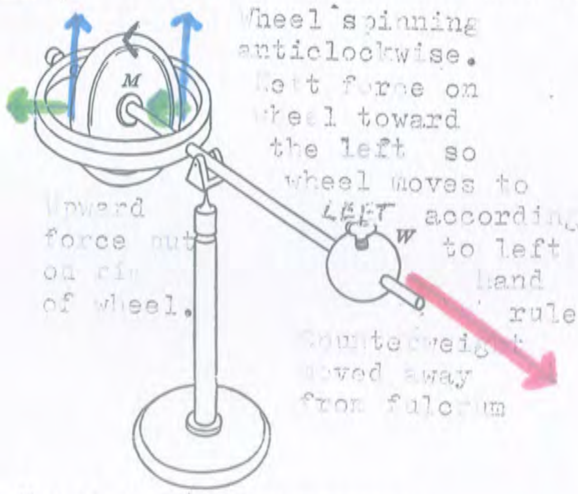


FIG. 11–10. Model of gyroscope.

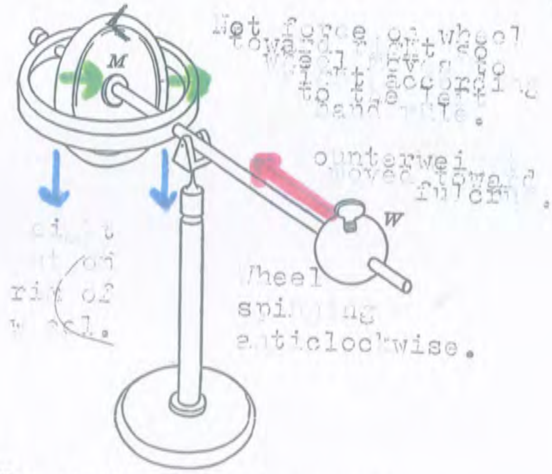


FIG. 11–10. Model of gyroscope.

Fig. 11-12 shows the situation representing the rotational dynamics rule. The two masses are subject to a torque, so the forces on opposite masses are in opposite directions. The torque sets a new equilibrium distance and the masses are accelerated toward it. The gyroscope wheel represented in Fig. 11-13 is a ridid mass so a torque changeing the equilibrium distance of the mass does not move it to the new equilibrium distance. It simply raises larger stress in the wheel to retain it's original shape.

However, the downward weight on the wheel does not constitute a torque. The weight is DOWNWARD on both sides of the rim. Applying the left hand rule to both sides of the rim indicates a force to the right in both cases. These forces in the same direction on both sides of the rim cannot raise deforming strain in the wheel so it moves in the direction of the nett force. Thus it is seen that the left hand rule of rotational dynamics explains the precession of gyroscopes.

Fig. 11-12

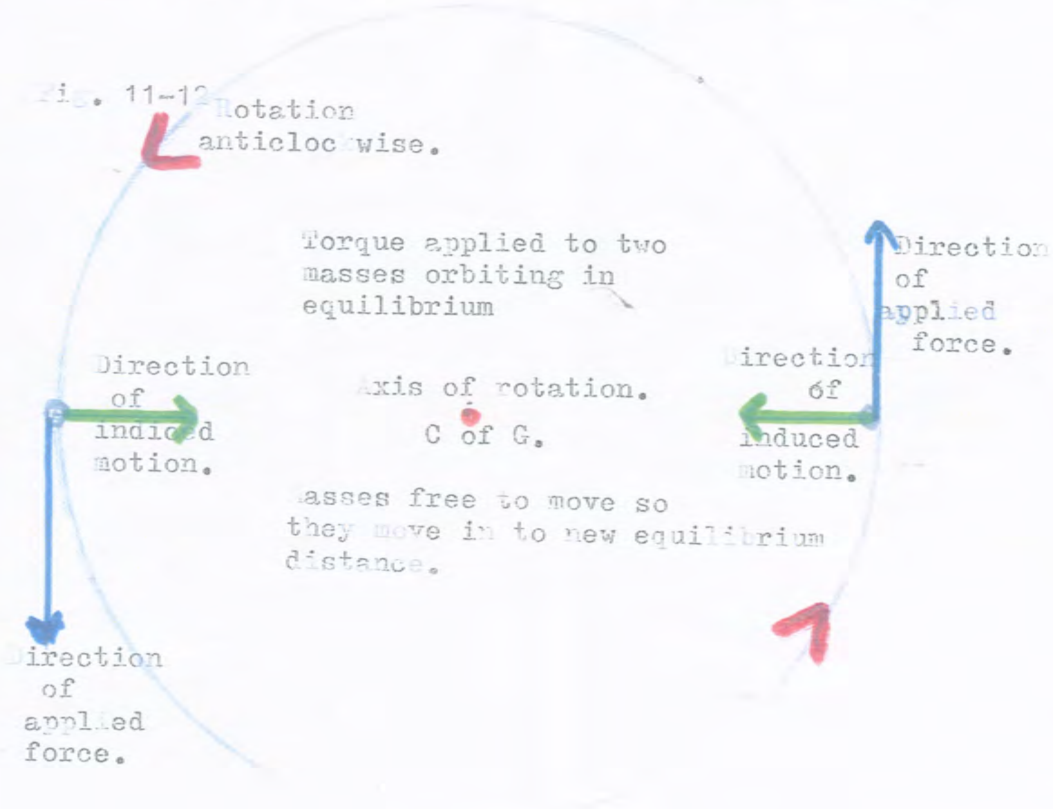
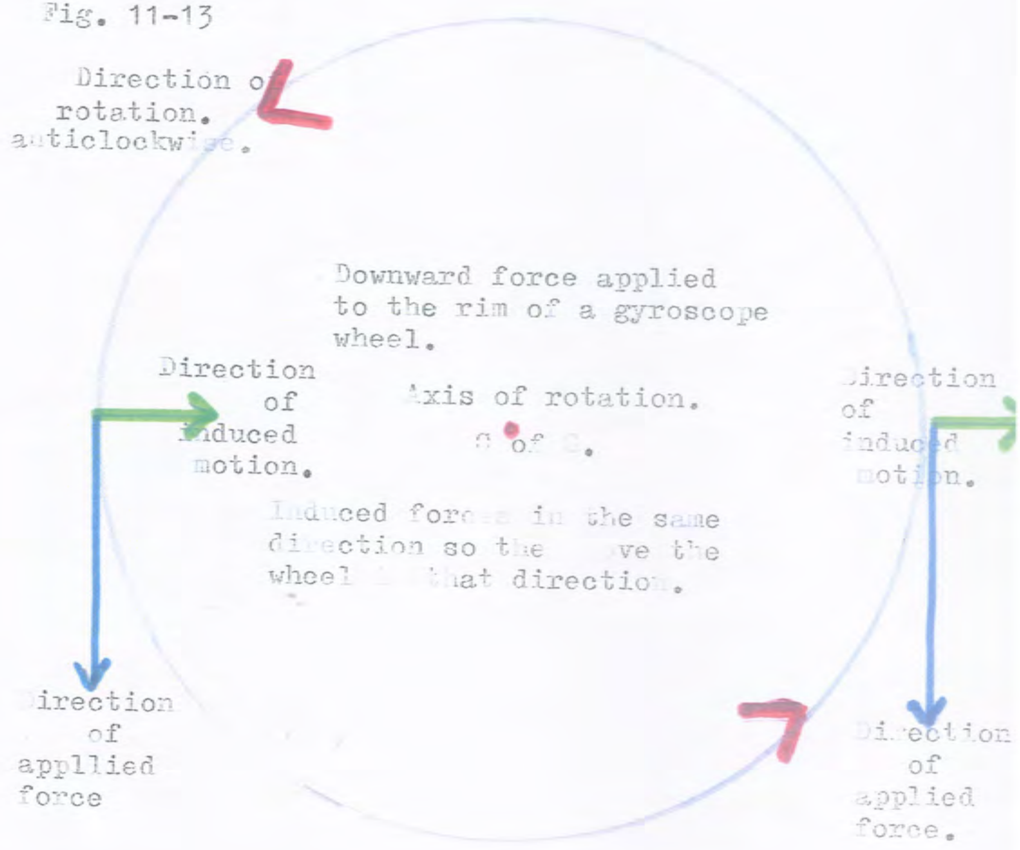


Fig. 11-13



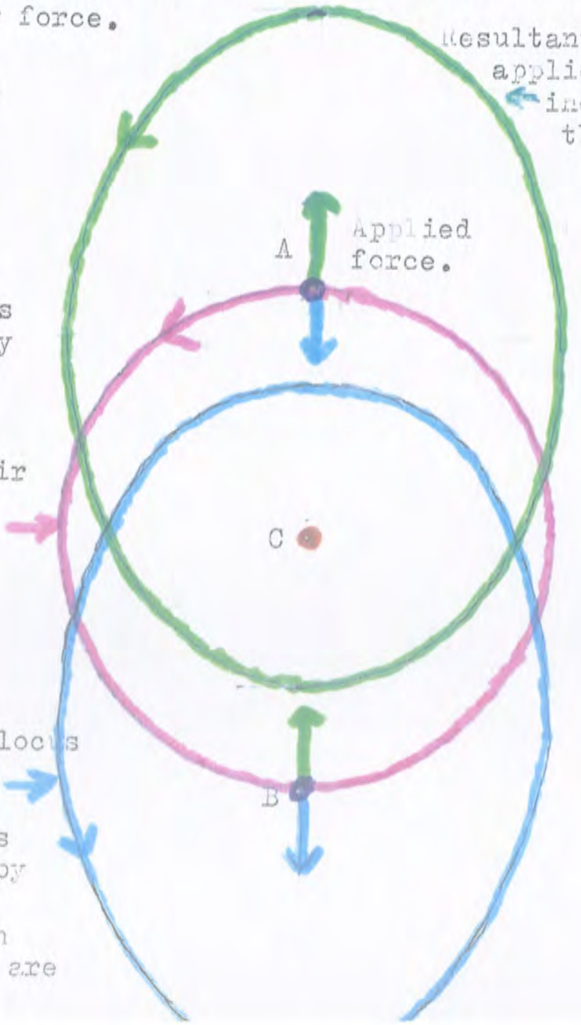
THE GENERATION OF CONIC LOCII.

Consider the case of two masses rotating in equilibrium and consequently with equal angular momenta. That is: $M_1 . r_1 . W = M_2 . r_2 . W$.

Some of the possibilities are:

1). Forces can be applied to either or both masses in directions either directly toward or directly away from their common center of gravity. See fig.(1). In this case the forces have no components along the tangent and so cannot act as torques. Thus they cannot change the angular momenta of the masses and so cannot change the rotational equilibrium condition. These forces will, however, displace the masses along their radius vectors, away from their equilibrium distances. Thus, when these displacing forces are removed the masses must experience accelerations in the directions restoring them to their equilibrium distances. It is obvious that by the time that the equilibrium positions are reached the masses will have been accelerated to velocities along their radius vectors. In this case their momenta will carry them past their equilibrium distances and they will then experience reverse accelerations which would be proportional to their displacements from equilibrium. This mechanism would obviously set up simple harmonic motions of the masses about their equilibrium distances, along the axis of the line joining them through their common cg. As this line is rotating with the same angular velocity as that with which the masses are rotating, the axis of the S.H.M. must rotate with it. That is, the resultant motion of the masses would be a compound harmonic motion in which the circular motion is compounded with a simple harmonic motion of the same period and with amplitude equal to the maximum displacement generated by the original displacing force.

Fig. (1).



The common center of gravity is not moved by the application of equal and opposite forces on the two masses. The greater the force the greater the induced eccentricity. If only one mass is subjected a force as shown, eccentricity will still be induced into both orbits but the common cg. will move to the newly established common focus.

The eccentricity developed is independent of the sense of the original rotation.

In the diagram it is assumed that forces of opposite direction are applied. In either case, locii as shown are developed.

THE GENERATION OF CONIC LOCII FROM CIRCULAR LOCII.

Consider the case of the application of forces in various directions on two masses rotating circularly in equilibrium. The possibilities are:

Case (1). Forces can be applied to either or both masses in directions either directly toward or directly away from their common center of gravity. See Fig (1). In this case the forces have no components along the tangent and so they cannot act as torques. Thus they cannot change the angular momenta of the masses and so they cannot change the rotational equilibrium condition. These forces will however, displace the masses along their radii vectors and consequently away from their equilibrium distances. Thus, when the displacing forces are removed the masses must experience accelerations in the directions restoring them to their equilibrium distances. It is obvious that by the time that the equilibrium distances have been reached the masses will have been accelerated to velocities along their radii vectors. In this case their momenta will carry them past their equilibrium distances and they will experience reverse accelerations which would be proportional to their displacements from equilibrium. This mechanism would obviously set up simple harmonic motions of the masses about their equilibrium distances, along the line joining them through their common c.g.. As this line is rotating with the same angular velocity as that with which the masses are rotating, the axis of the S.H.M. must rotate with it. That is, the resultant motion of the masses would be a compound harmonic motion in which the circular motion is compounded with a simple harmonic motion of the same period and with amplitude equal to the maximum displacement generated by the original displacing force.

Note that the common center of gravity is not moved by the application of equal and opposite forces on the two masses. If force is applied to only one mass the common c.g. will be moved in the direction of that force. Later it will be shown that the eccentricity induced is equal to the energy of the induced oscillation divided by the total energy of the induced compound harmonic motion.

Case 2. Forces can be applied to either or both masses at right angles to those specified in case (1). That is, they can be applied tangentially in which case they will constitute a torque as shown on page A11 above. There we saw that under these circumstances, after the torque is removed a new equilibrium angular velocity will be established as well as new equilibrium distances while the masses accelerating toward these distances will have acquired velocities causing them to overshoot, setting up S.H.M.s about the new equilibrium distances.

From cases (1) and (2) it is obvious that the application of forces either along the radius vector or tangentially to it will result in a new equilibrium distance with the masses oscillating in S.H.M. about their equilibrium positions.

Case 3. Forces can be applied to either or both masses in directions neither along the radius vector nor tangentially to it.
In this case, any such forces can be resolved into components along the radius vector and along the tangent. Thus the application of these forces must also result in the establishment of new equilibrium distances with the masses oscillating in S.H.M. about these new distances.

From the above, it can be seen that if two masses are orbiting each other in equilibrium, the application of ANY force to them IN THE PLANE OF ROTATION will result in the establishment of new equilibrium distances with the masses oscillating in S.H.M. about their new equilibrium distances along the axis of the line joining them through their common center of gravity. As this line is rotating with the same angular velocity as that with which the masses are rotating, the axis of the S.H.M. must rotate with it. That is, the resultant motion of the masses would be a compound harmonic motion in which the circular motion is compounded with a simple harmonic motion of the same period and with amplitude equal to the maximum displacement generated by the original displacing force.
It would be interesting to know if a compound harmonic motion such as that described above would result in con-focal conic locii for the masses involved. Appendix (1) is devoted to this investigation and it shows that this IS the case.

ORDERS OF ROTATION AND TWO HYPOTHETICAL LAWS RELATING TO THEM.

The case discussed above relating to a gyroscope on a merry-go-round involves rotation within rotation and we see many instances of this phenomenon in the physical world. The satellites of the planets are rotating about their particular planet while the planet is rotating about the sun. Furthermore, the sun itself appears to be rotating about the center of gravity of our galaxy. Thus, we see rotation within rotation within rotation in the solar system. It might be said that we see several orders (or degrees) of rotation within the solar system. Accordingly, I will designate the sun's rotation about the center of gravity of our galaxy as a first order rotation about the c.g. of the galaxy; the rotation of the planets about the sun as a "second order" rotation about the c.g. of the galaxy and the rotation of the satellites about their planets as a "third order" rotation about the c.g. of the galaxy.

When this is done, it is possible to state two hypothetical laws of motion relating higher orders of rotation to lower orders of rotation. The first of these laws, which I will designate "Barnett's Law" in deference to it's discoverer is:

When masses have second order rotation relative to a mass with first order rotation about some axis, the axes of rotation of the masses with second order rotation will rotate so that they align themselves with the axis of first order rotation and so that the senses of rotation are the same about all axes.

There is a lot of observational evidence supporting this hypothetical law, some of which is:

1). As noted above, the alignment of the axis of rotation of a gyroscope on a merry-go-round with the axis of rotation of the merry-go-round.

2). The magnetisation of an iron rod along it's axis of rotation when it is rotated. As Barnett pointed out, this phenomenon is due to the reorientation of the "molecular magnetic dipoles" within the iron to the axis of spin of the rod.

3). The phenomenon of the earth's magnetic field. This was obviously formed when the originally randomly oriented "molecular magnetic dipoles" within the iron in the earth's core were oriented to the axis of rotation of the earth, just as in the case of the iron rod above.

4). A coil of wire carrying a current produces a magnetic field.

If we assume that the electrons circulating in the "molecular magnetic dipoles" in a straight wire are randomly oriented they could be said to have only one order of rotation. However, if the wire is coiled into a series of loops and an EMF is applied across it's ends, the electrons in the "molecular magnetic dipoles" will be forced to travel around the loops of wire while they are at the same time in primary rotation. Thus, they will be given second order rotation just as in the case of the dipoles in the spun rod, and their axes of rotation will be oriented at right angles to the plane of the coils. This will produce a magnetic field indistiguishable from that produced in the spun rod.

5). This law might be seen to afford a partial explanation of the form which we now see taken by the solar system.

If the planets with their satellites originally condensed from a swirling mass of gas around the sun, it might be expected that the resulting aggregations would be found more or less randomly distributed in three dimensions and with their axes of rotation also randomly distributed in all directions relative to the axis of rotation of the sun. However, according to the above law, the higher order rotations of the planets and their satellites would, over time, align their axes of rotation parallel with the first order axis of rotation of the sun, more or less as we see today. The fact that the axes of rotation of the planets and their satellites are not exactly parallel with the axis of rotation of the sun might be due to the fact that insufficien time has yet elapsed since condensation to complete the process.

****

The phenomenon of the existance of "magnetic fields" and their direction was explained above. I think that the phenomenon of "magnetic attraction" can be explained according to another hypothesis which I will designate: "The second law of higher order rotation" which might be stated as follows: When masses have higher order rotation relative to a mass with first order rotation about some axis, and after the axes of rotation of the masses with higher order rotation have aligned themselves with the primary axis of rotation, the planes of rotation of the masses with higher order rotation will align themselves with the plane of rotation of the primary mass. There is some observational evidence supporting this hypothesis, such as:

1). The phenomenon of magnetic attraction. This could be the result of "molecular magnetic dipoles" who's axes of rotation are aligned, moveing so as to more closely align their planes of rotation.

2). The application of this law in conjunction with the first law, seemingly completes the explanation of the form that we now see taken by the solar system. That is, the planes of rotation of all of the planets and of their satellites being close to the plane of the ecliptic. The fact that these planes are not exactly aligned with the plane of the ecliptic, may be due, as pointed out above, to the possibility that insufficient time has yet elapsed since condensation, to complete the process.

****

The validity of the second law could be tested experimentally by constructing a rotatable frame carrying gyroscopes aligned with the axis of rotation of the frame and which have freedom of movement parallel with that axis. Then, if the gyroscopes were set so that their planes of rotation were not in line and the frame was rotated, it could be observed if the gyroscopes moved to bring their planes of rotation all into the same plane.

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TWO CASES OF THE COMPOUND HARMONIC MOTION INVOLVING AN S.H.M. AND A ROTATION. A17

IF e equals the ratio of the energy of the S.H.M. to the total energy of the C.H.M. then e = energy of oscillation/(energy of oscillation + energy of rotation).
In this case, if the energy of rotation has the same sign as the energy of oscillation, it is obvious that e must be less than 1.
However, if the energy of rotation has the opposite sign to the energy of oscillation, e must be greater than 1.
When the oscillation and the rotation are in phase their energies will have the same signs and when the oscillation and the rotation are of opposite phase their energies will be of opposite signs, corresponding to the above situation.
Thus it might be concluded that a C.H.M. in which e is less than 1 involves an oscillation and a rotation IN PHASE while a C.H.M. in which e is greater than 1 involves an oscillation and a rotation which are of OPPOSITE PHASE.

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A POSSIBLE EXPLANATION OF CHEMICAL AND ATOMIC BONDING AND OF CHEMICAL REACTIONS.

From the above, it is obvious that for all values of e less than 1, that is when the oscillation is in phase with the rotation, the resulting locii will be elliptic and the two masses will orbit each other indefinitely. Thus, they will be "bonded" together. For values of e greater than 1, that is when the oscillation is of opposite phase to the rotation, the total rotation will be less than circular by an angle of $(2.\sec^{-1}e)^{\circ}$, so that the two mosses will not be "bonded" together. Instead, they will approach each other along hyperbolic locii to a nearest approach of 2.(e-1) and then will recede along their locii to infinity, performing a "pass" during which they are rotated through an angle of $(360 - 2.\sec^{-1}e)^{\circ}$.
This observation affords a possible insight into the nature of chemical and nuclear reactions. A chemical compound is held together by electron "bonds" in which the component elements are held together by pairs of electrons orbiting each other about their common center of gravity. Since temperature is merely a measure of the average linear KE of the components of the substance concerned, if the temperature of a substance is raised above it's decomposition temperature, it seems that the increased impact between neighbouring moleoules may chenge the

phase of some oscillations, inducing breakup of the relevant "bonds". In exothermic reactions, the released elements could become free missiles, further raising the temperature of the mass and inducing further breakup, producing more heat than was required to produce the change. Endothermic reactions could be explained by the hypothesis that the energy required to change the phase of the original oscillation is greater than the erergy released on dissociation.

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THE ENERGY RELEASED INTO THE ENVIRONMENT ON TRANSITION FROM A CONFOCAL ELLIPTIC TO A CONFOCAL HYPERBOLIC REGIME.

Two masses orbiting each other in equilibrium may have both rotational and linear (oscillatory) kinetic energy relative to each other. However, this energy which these masses have relative to each other is not significant relative to other masses which may be in the vicinity, since they cannot interact with these other masses. However, it was shown above, that if the phase of their oscillation is reversed relative to their rotation, the masses will part company and go their separate ways along their respective assymptotes. They may then interact with other masses in the vicinity, imparting some or all of their energy which they had relative to each other, to these other masses. Oscillatory KE before transition will obviously convert to linear KE (heat) after transition. Since r.W must remain constant during transition, as the distance between the original masses increases W will be reduced in the ratio of 1/r, so that at considerable distances the masses will be virtually travelling in straight lines along their assymptotes. The amount of energy required to cause dissociation would depend on the difference between the ambient temperature of the masses and their dissociation temperature, which might be the temperature at which interaction between neighbouring elliptic systems is sufficient to cause some phase reversal, initiating dissociation. At this point in exothermic reactions the energy released to the envirinment would be sufficient to fuel further dissociation, thus sustaining the reaction.

Conversely, if sufficient linear and rotational kinetic energy is transferred from neighbouring systems to two particular masses which happen to be in the right positions relative to each other, they may converge along their assymptotes until they start orbiting each other in stable con-focal elliptic orbits. It might be inferred that this process is happening from the observation of some chemical reactions, such as the formation of ammonia from elemental hydrogen and nitrogen in the Haber-Bosh process, whereby ammonia is formed from hydrogen and nitrogen under pressure. When the process is up and running, the energy expended on the pump maintaining the partial pressures of the combining gasses in a given time, must be equal to the energy of association of the ammonia formed in the same time. The energy lost from the external systems must be equal to the energy "tied up" in the orbiting systems.

Turning to the nuclear field; the energy made available to external systems after nuclear dissociation was convincingly demonstrated first in 1945. Obviously, from the above discussion, nuclear association or "fusion" can only occur if energy from external systems is "tied up" in the orbiting components of the newly fused nucleus.

I regard the above observations as a more than adequate demonstration that it is not possible to obtain useful energy from nuclear fusion.

I know of no observational evidence supporting the assertion that matter can be turned into energy.

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So far we have dealt only with masses in relatively simple circular and con-focal elliptic rotation and it is now time to consider the reactions of masses in more complicated modes of rotation relative to each other.

In the solar system we see the planets rotating with constant angular momentum about their respective common centers of gravity with the sun, while at the same time oscillating along their rotating diameters with the sun, about equilibrium positions which are not at their centers of rotation but are at considerable distances from them, with amplitudes which are fractions of these distances. These fractions are always between 0 and 1 and will be known as their oscillation factors and designated as f.

The result of this combined motion, is that the paths of the planets are ellipses, one of the focii of each of which is at the common CG. with the sun, the eccentricity of each ellipse being equal to it's corresponding oscillation factor (f), and where the equilibrium distance occurs at an angle of $\theta = \cos^{-1} f$ from the major axis of the ellipse.

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Since the above situation seems to involve a simple harmonic motion of an unusual type, I will attempt to develop a theory about simple harmonic motion adapted to the above situation.

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Figure 1 recapitulates the standard notion of simple harmonic motion along an axis, generated by a rotation about an origin on that axis, so that at any time $x = \cos\theta$.

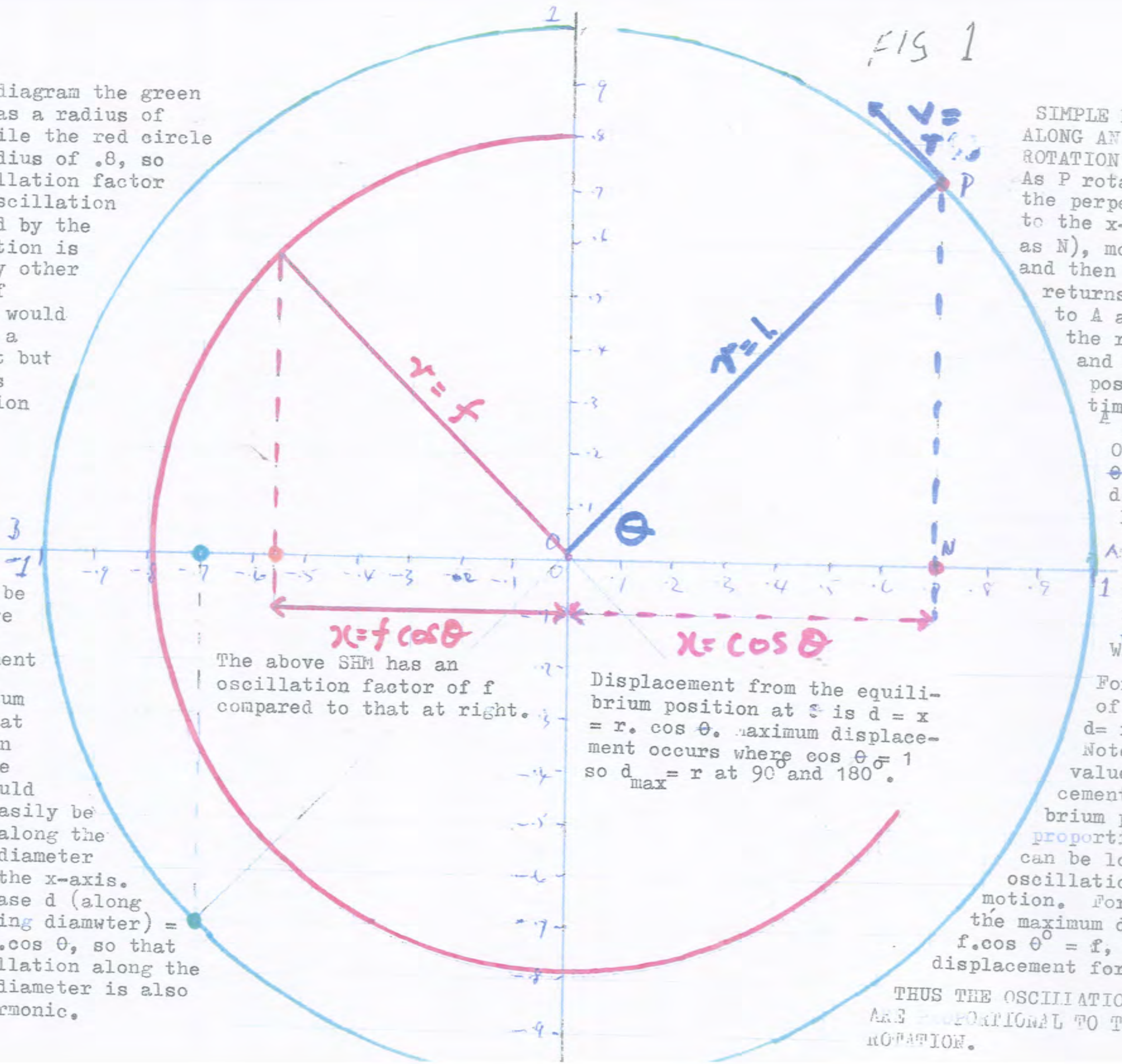
It also introduces the concept of an oscillation factor, in which the displacement along the x-axis at any time is $f.\cos\theta$, where f is the oscillation factor which is taken, as in the solar system as being between 0 and 1. This concept will later be required when we try to accomodate the investigation to the reality of the solar system.

****

It must be obvious that displacement from the equilibrium position can just as easily be measured along the rotating diameter as it can be along the x-axis. In both cases the significant thing to note is that for simple harmonic motion, the displacement from the equilibrium position at any angle of rotation, must equal the projection of the rotation at that angle onto the x-axis. So in both cases $d = f.\cos\theta$.

SIMPLE HARMONIC MOTION ALONG AN AXIS INDUCED BY ROTATION ABOUT THAT AXIS.

FIG 1



As P rotates the foot of the perpendicular from P to the x-axis AOB, (shown as N), moves from A to O and then to B and then it returns to O and then to A as P completes the revolution. Let P and N be in the positions shown at time t after leaving A with the radius OP making an angle θ with AO and the distance ON being X.

The displacement from the equilibrium position at θ is x=r.cos θ = d. When r=1, d=x=cosθ. For any other value of r, say f, then d= x = f.cos θ. Note that for all values of r, the displacement from the equilibrium position at θ, is proportional to r which can be looked upon as the oscillation factor of the motion. For a radius of f, the maximum displacement is f.cos 0^o = f, while the maximum displacement for a radius of 1 is

In this diagram the green circle has a radius of unity while the red circle has a radius of .8, so the oscillation factor of the oscillation generated by the red rotation is .8 . Any other radius of rotation would generate a different but analogous oscillation factor.

The above SHM has an oscillation factor of f compared to that at right.

Displacement from the equilibrium position at θ is d = x = r. cos θ. Maximum displacement occurs where cos θ = 1 so d_{max} = r at 0^o and 180^o.

It might be noted here that the displacement from the equilibrium distance at the origin and on the x-axis could just as easily be measured along the rotating diameter as along the x-axis. In this case d (along the rotating diamwter) = d = x = f.cos θ, so that this oscillation along the rotating diameter is also simple harmonic.

THUS THE OSCILLATION FACTORS OF SHM ARE PROPORTIONAL TO THEIR RADII OF ROTATION.

Figure 2. is a diagram of that situation. It illustrates two con-focal simple harmonic oscillations along a rotating diameter instead of along the x-axis. One of the oscillations, shown in red represents $d = \cos\theta$ while the other, shown in green represents $d = f.\cos\theta$, where $0 < f < 1$, making them analogous to the situation shown in fig. 1.

While both of the oscillations of fig. 1 and fig. 2 are simple harmonic, it will be seen that the locii generated in fig.2 are totally different from those generated in fig. 1.

This is because in fig. 2 we are dealing with the superimposition of a simple harmonic oscillation onto a simple rotation, thus generating a (compound) simple harmonic motion. In fig. 1 the locii are collinear straight lines along the x-axis from +f to -f and vice versa when the oscillation factor is f. In fig. 2 the locii are two circles contiguous at the origin, centered on $\pm f/2$ and of radius $f/2$. Since $\cos\theta$ is positive in the 1st and 4th quadrants the displacement is positive there and since $\cos\theta$ is negative in the 2nd and 3rd quadrants the displacement is negative there. Thus when the rotation is, say anticlockwise, the procession around the locii must be in the direction of the arrows shown in fig. 2.

For two masses oscillating at opposite ends of the rotating diameter their respective motions would be represented by $d = \pm(f.\cos\theta)$.

It will be seen that the circular motions generating simple harmonic motions of oscillation factor f, must have radii of f and not of unity.

In both diagrams the equilibrium position occurs at angles of 90° and 270° where the projection onto the x-axis is zero. In some future diagrams it will be seen that the equilibrium distance of the oscillation does not occur at 90° nor at 270° but can occur at other angles of rotation, say alpha degrees and alpha + 180 degrees. Then, for simple harmonic motion, the projection of the displacement onto the x-axis would have to be measured from the equilibrium positions at alpha degrees and at alpha + 180 degrees and not from 90° or 270° as in figures 1 and 2.

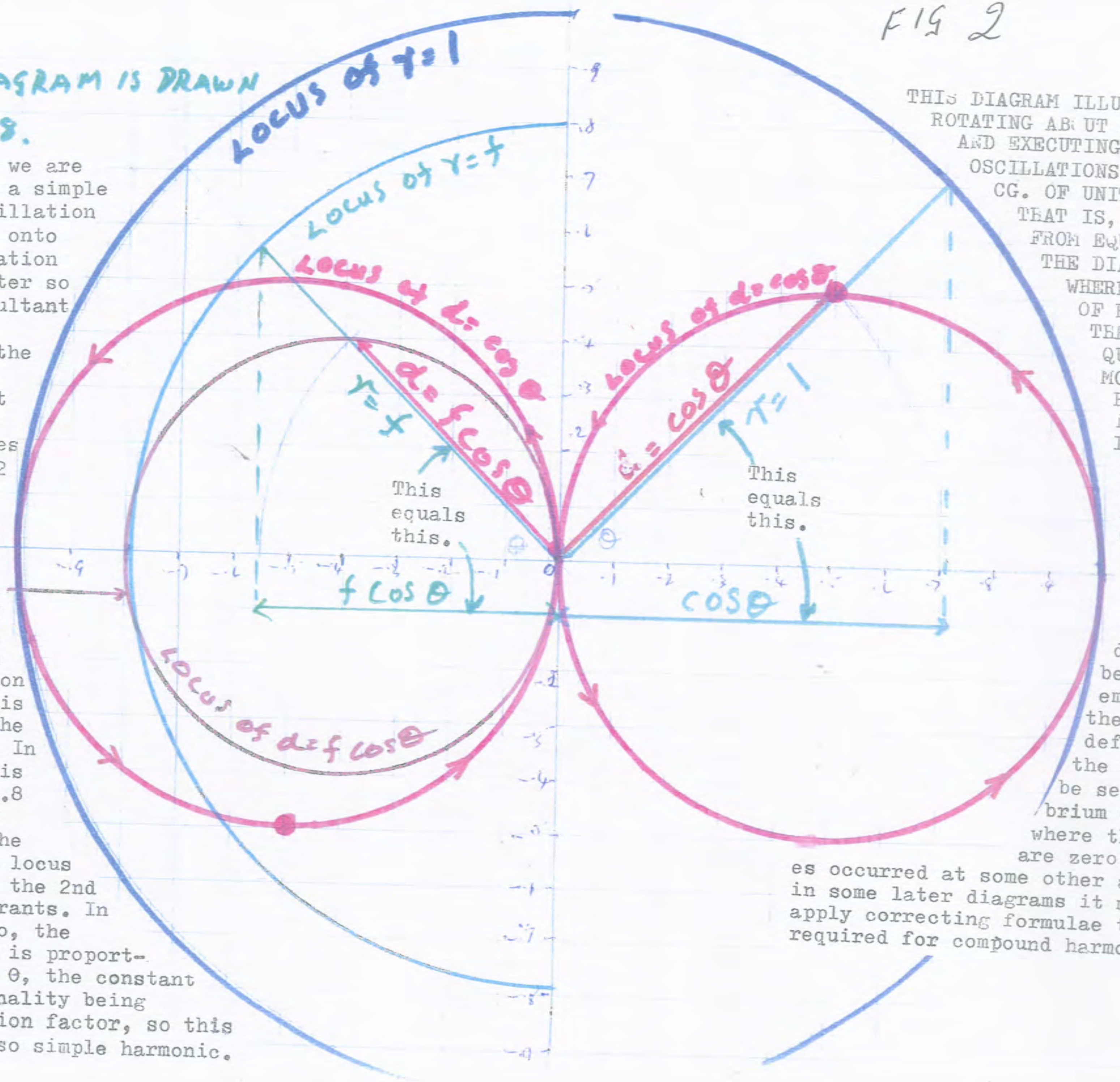
Then for (compound) simple harmonic motion, the displacement at any angle θ would have to be $d = f.(f.\cos\theta - \cos \text{alpha})$.

FIG 2

THIS DIAGRAM IS DRAWN FOR f = ·8.

In this case we are dealing with a simple harmonic oscillation superimposed onto a simple rotation of the diameter so that the resultant motion is a compound of the two motions. The resultant locus comprises 2 circles of radius r/2 and centered at ±r/2 on the x-axis.

The brown circle shows the locus of d = f.cos θ, that is when an oscillation factor of f is applied to the oscillation. In this case f is taken to be .8 and to avoid cluttering the diagram this locus is drawn only for the 2nd and 3rd quadrants. In this case too, the displacement is proportional to cos θ, the constant of proportionality being the oscillation factor, so this motion is also simple harmonic.



THIS DIAGRAM ILLUSTRATES TWO MASSES ROTATING ABOUT THEIR COMMON CG. AND EXECUTING SIMPLE HARMONIC OSCILLATIONS ABOUT THAT COMMON CG. OF UNITY AS THEY ROTATE. THAT IS, THE DISPLACEMENT FROM EQUILIBRIUM ALONG THE DIAMETER IS COS θ WHERE θ IS THE ANGLE OF ROTATION. d=cos θ. THERE CAN BE NO QUESTION THAT THIS MOTION IS SIMPLE HARMONIC BECAUSE THE DISPLACEMENT IS EQUAL TO THE PROJECTION OF THE ROTATION ONTO THE X-AXIS AS IN THE CLASSIC CASE OF DIAGRAM 1.

In both Figs. 1 & 2 the motions are defined as "harmoni because the displacements are equal to the projections of th defining rotation ont the x-axis, and it wil be seen that the equilibrium distances occur where these projections are zero. If those distances occurred at some other angles (as they do in some later diagrams it may be necessary t apply correcting formulae to the conditions required for compound harmonic motion.

Figure 3 illustrates a situation somewhat but not totally analogous to those seen in the solar system. In this diagram two (equal) masses are seen rotating about their common CG. while at the same time are executing simple harmonic oscillations about an equilibrium distance which is not at the center of the rotation.

The right hand side of figure 3 illustrates an oscillation of cos θ while the left hand side illustrates an oscillation of factor f so that $r = f.\cos\theta$. The oscillations are simple harmonic about the equilibrium distance because they are proportional to cos θ.

But look what happens when we measure the displacement, not from the equilibrium distance but from the origin at the center of rotation, as we did in figs. 1 and 2 In this case $r = 1 + f.\cos\theta$ and not $f.\cos\theta$. so this oscillation is not simple harmonic.

The locii generated by $r = 1 + \cos\theta$ and $r = 1 + f.\cos\theta$ as shown in fig 3 are of course cardiods so cardoids do not represent simple harmonic oscillations.

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In view of the fact that cardoid locii do not seem to represent simple harmonic oscillations in the accepted sense, it would be interesting to see if a motion about an equilibrium distance NOT AT THE CENTER OF THE DEFINING ROTATION can be derived which IS SIMPLE HARMONIC in the accepted sense. That is, to see if the displacement from the equilibrium distance along the rotating diameter can be made equal to the projection of that displacement along the x-axis.

Figure 4 illustrates an attempt to do this. In this figure the equilibrium distance is taken to be unity and it occurs at an angle of alpha, so that the projection of the equilibrium distance onto the x-axis is cos alpha.

Let us now say that we wish to achieve an oscillation factor of f = cos alpha. In this case the projection of the equilibrium distance at it's angle of rotation, onto the x-axis = cos alpha = f.

Since the equilibrium distance was defined above as unity, the radius of rotation at any given angle θ is $r = 1 + d$ where d is the displacement along the radius at the angle θ, and the projection of r onto the x-axis is $r.\cos\theta = x$.

It will be seen from fig. 4 that the difference in the projection of r onto

FIG 3

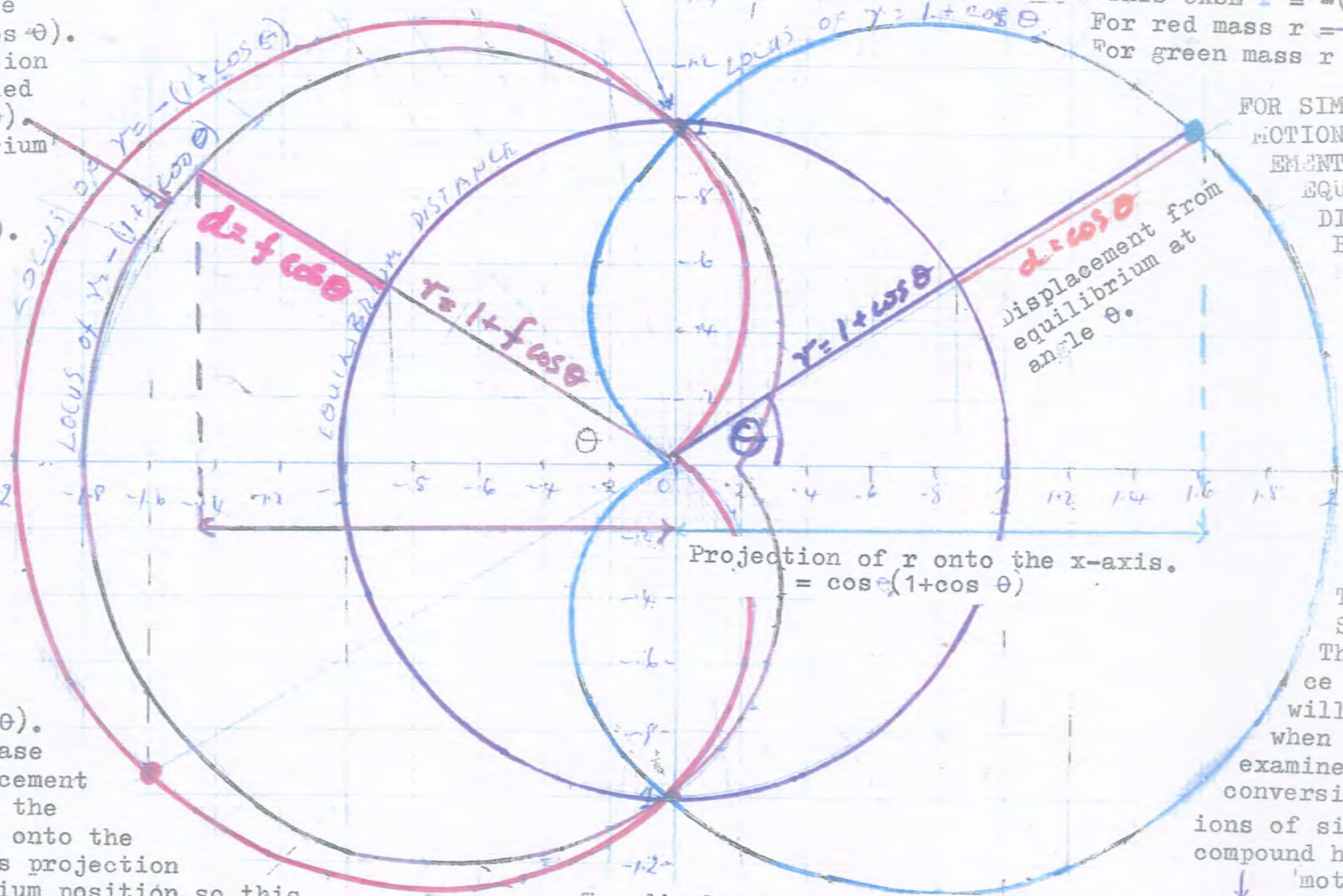
These figures are of course con-focal cardoids. When both the equilibrium distance and the amplitude of oscillation are unity, $r = \pm(1+\cos\theta)$. When the oscillation factor f is applied $r = \pm(1+ f.\cos\theta)$. When the equilibrium distance is not unity but a $r = \pm a(1+f.\cos\theta)$.

The equilibrium distance occurs at $\cos\theta = 0$. That is when $\theta = 90^{o}$ or 270^{o}, when the projection of r onto the x-axis is 0.

THIS DIAGRAM ILLUSTRATES TWO MASSES DESIGNATED GREEN AND RED, ROTATING ABOUT THEIR COMMON CG. AND EXECUTING OSCILLATIONS ABOUT THEIR EQUILIBRIUM DISTANCES OF MAXIMUM AMPLITUDES EQUAL TO THOSE DISTANCES. IN THIS CASE $r = \pm(1+\cos\theta)$.

For red mass $r = -(1+\cos\theta)$.

For green mass $r = +(1+\cos\theta)$



FOR SIMPLE HARMONIC MOTION THE DISPLACEMENT FROM THE EQUILIBRIUM DISTANCE MUST BE EQUAL TO OR PROPORTIONAL TO THE PROJECTION OF R ONTO THE X-AXIS.

THIS IS NOT THE CASE IN THIS INSTANCE. See below. The significance of this fact will be evident when we later examine the KE-PE conversion implications of simple and compound harmonic motion.

When the oscillation factor f is applied, $d = f.\cos\theta$. and the projection of r onto the x-axis is $\cos\theta(1+f.\cos\theta)$. Thus, in this case also the displacement is not equal to the projection of r onto the x-axis from it's projection at the equilibrium position, so this motion cannot be simple harmonic either.

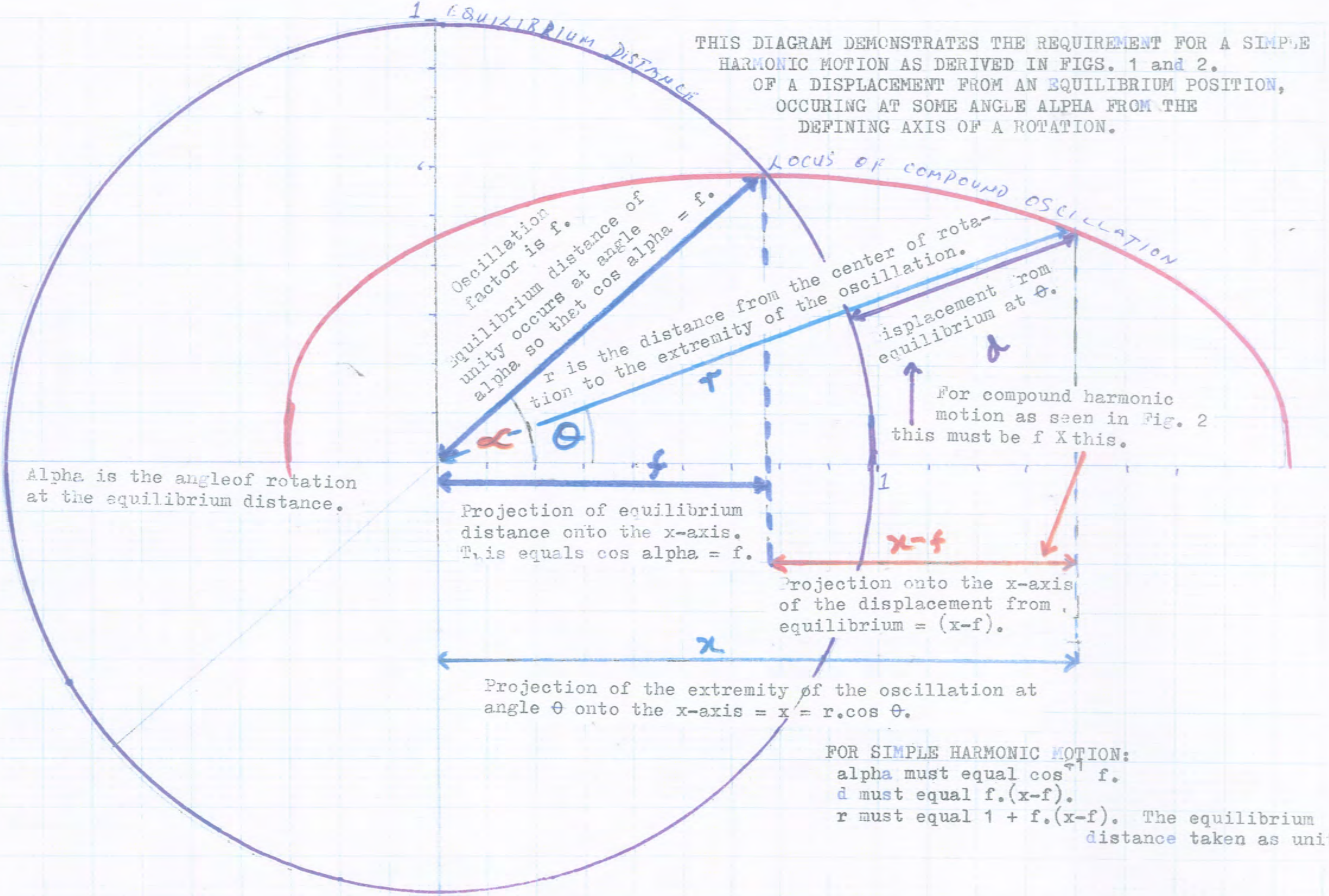
The displacement from the equilibrium distance at the angle of rotation $\theta = d = \cos\theta$, while the displacement of the projection of r onto the x-axis at the angle of rotation θ is $\cos\theta(1+\cos\theta)$. Thus the displacement is not equal to, $r\cos\theta$

FOR ANY VARIATION OF THE CARDOIDS $r = \pm a(1+f\cos\theta)$ THE MOTION CANNOT BE COMPOUND HARMONIC

THUS COMPOUNDING A SIMPLE HARMONIC OSCILLATION OF $d = \cos\theta$ ABOUT AN EQUILIBRIUM DISTANCE OF UNITY WITH A ROTATION OF THAT DISTANCE DOES NOT PRODUCE A COMPOUND HARMONIC MOTION AS SEEN IN Fig. 2.

FIG 4

THIS DIAGRAM DEMONSTRATES THE REQUIREMENT FOR A SIMPLE HARMONIC MOTION AS DERIVED IN FIGS. 1 and 2. OF A DISPLACEMENT FROM AN EQUILIBRIUM POSITION, OCCURING AT SOME ANGLE ALPHA FROM THE DEFINING AXIS OF A ROTATION.



FOR SIMPLE HARMONIC MOTION:

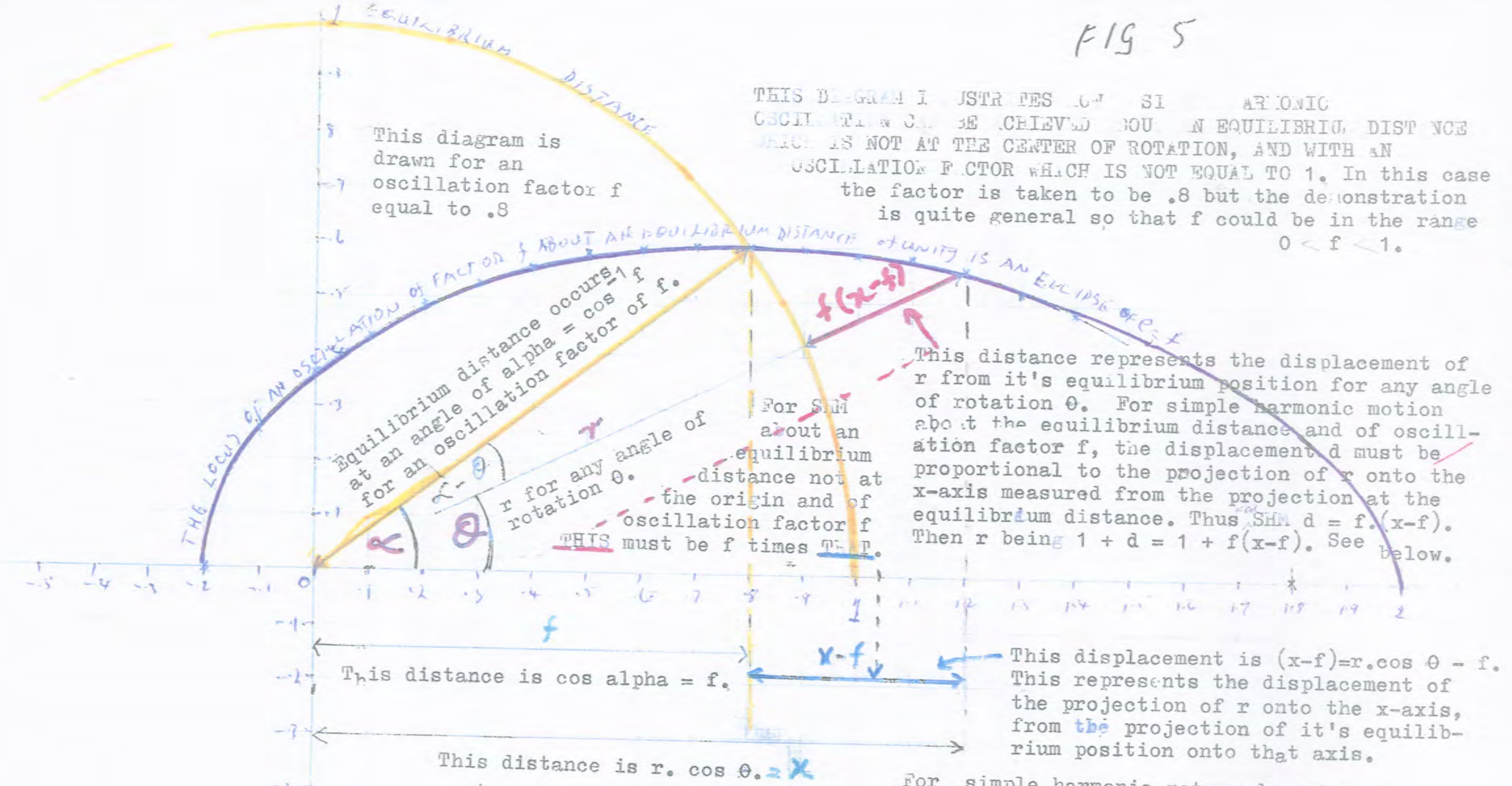
alpha must equal $\cos^{-1} f$.

d must equal f.(x-f).

r must equal 1 + f.(x-f). The equilibrium distance taken as unity.

FIG 5

THIS DIAGRAM ILLUSTRATES HOW SIMPLE HARMONIC OSCILLATION CAN BE ACHIEVED ABOUT AN EQUILIBRIUM DISTANCE WHICH IS NOT AT THE CENTER OF ROTATION, AND WITH AN OSCILLATION FACTOR WHICH IS NOT EQUAL TO 1. In this case the factor is taken to be .8 but the demonstration is quite general so that f could be in the range $0 < f < 1$.



For simple harmonic motion d must be proportional to (x−f) and for SHM of oscillation factor f, d must = f.(x−f). Since the equilibrium distance is taken as unity, $r = 1 + f.(x-f)$.

$r = 1 + fx - f^2$ so $r - f.x = 1 - f^2$

Then $1 = (1-f^2)/(r-f.x)$ so $r = r(1-f^2)/(r-f.x)$

So $r = (1-f^2)/((r-f.x)/r) = (1-f^2)/(1-(f.x/r))$

So $r = (1-f^2)/(1 - f.\cos\theta)$.

BUT THIS IS THE EQUATION OF AN ELLIPSE OF ECCENTRICITY f.

THUS THE LOCUS OF A SIMPLE HARMONIC MOTION OF OSCILLATION FACTOR f ABOUT AN EQUILIBRIUM DISTANCE OF UNITY FROM THE CENTER OF ROTATION IS AN ELLIPSE OF ECCENTRICITY EQUAL TO f and of unit semi-major axis.

the x-axis at $\theta°$ MINUS IT'S PROJECTION ONTO THE X-AXIS AT ALPHA° is x-f. Now, FOR SIMPLE HARMONIC MOTION AS DEFINED BY figures 1 and 2, the displacement along the rotating diameter FROM THE EQUILIBRIUM POSITION must be f times it's PROJECTION ONTO THE X-AXIS. Thus d must equal f.(x-f).
But r = 1 + d so r must equal 1 + f.(x-f) as seen in figures 4 and 5.
Thus, the law for the motions of masses at opposite ends of a rotating diameter IN SIMPLE HARMONIC MOTION about an equilibrium distance which is not at the origin and of oscillation factor f, is given in rectangular coordinates as:
$r = \pm(1 + f.(x-f)$. This law can be converted into polar coordinates with the pole at the center of rotation as follows:

$r = 1 + f.(x-f)$

$r = 1 + fx - f^2$

$r - f.x = 1 - f^2$

$1 = (1-f^2)/(r-f.x)$

$r = r.(1-f^2)/(r-f.x)$

$r = (1-f^2)/(1- f(x/r))$ But $x/r = \cos\theta$.

$r = (1-f^2)/(1-f.\cos\theta)$

$r = (f.(1-f^2))/(f.(1-f.\cos\theta))$

$r = -(1 + f.(x-f))$

$r = -1 -fx + f^2$

$r + f.x = -(1-f^2)$

$1 = -(1-f^2)/(r+f.x)$

$r = -r.(1-f^2)/(r+f.x)$

$r = -(1-f^2)/(1+f.(x/r))$ But $x/r=\cos\theta$.

$r = -(1-f^2)/(1+f.\cos\theta)$

$r = -(f.(1-f^2))/(f.(1+f.\cos\theta))$

Where $h = (1-f^2)/f$

$r = f.h/(1 - f.\cos\theta)$ ...... (1) $r = -f.h/(1+f.\cos\theta)$ ..... (2)

Equations (1) and (2) are of identical form to those representing ellipses of unit semimajor axis and of eccentricity f. See fig. 5.
$r = f.h/(1-f.\cos\theta)$ represents an ellipse with the left hand focus at the origi[n] while $r = -fh/(1+f.\cos\theta)$ represents an ellipse with the right focus at the ori[gin].
THIS CLEARLY DEMONSTRATES THAT THE LOCII OF SIMPLE HARMONIC MOTIONS ABOUT EQUILIBRIUM DISTANCES OF UNITY AND OF OSCILLATING FACTOR f ARE CON-FOCAL ELLIPSES, THE POLAR FORMS OF WHICH ARE: $r = f.h/(1-f.\cos\theta)$ etc. See fig. 5.
It will be shown later that for two equal masses orbiting each other about their common CG. and oscillating in simple harmonic motion along their common rotating diameter, about equilibrium distances of unity from that CG. and with oscillation factor of f, must be con-focal ellipses arranged as in fig.128 and with respective instantaneous radii of rotation $r = \pm(1-e^2+ex)$, where x is the displacement from the common CG. along the major axis.

WHY MUST OSCILLATION ABOUT AN EQUILIBRIUM POSITION BE SIMPLE HARMONIC ?.

In an oscillation in which kinetic energy is transformed into potential energy and vice versa, the law of conservation of momentum/energy requires that during oscillation the total of the momentum/energy be conserved. That is, the change in kinetic energy must be exactly equal to and of opposite sign to the change in potential energy generated AT ALL POINTS THROUGHOUT THE OSCILLATION.

To simplify the following discussion I will take the masses involved to be unity.

It was shown above that for simple harmonic oscillation of factor f and consequently of amplitude f, (where f is between 0 and 1), the equilibrium distance must occur at an angle of $\cos^{-1}f$ from the major axis of the oscillation.

Here, since the mass is taken as unity the velocity and the momentum are both = f.

For any displacement along the rotating diameter from the equilibrium position of f.(f-x), (where x is measured along the major axis from the origin at the common CG.), the velocity and momentum are both f - (f - (f(f-x) = f(f-x).

Thus the change in KE over this distance is $f^2(f-x)^2/2$.

******

Now the buildup of linear PE from equilibrium at f. to f(f-x) = F.s = F.f(f-x) where F is the average force raised over the distance f.(f-x).

But for the change in KE to equal the change in PE, $f^2(f-x)^2/2$ must equal F.s = a.s = a.f(f-x).

So a must equal f(f-x)/2 for the law of conservation of energy/momentum to hold.

Thus the acceleration raised must be linearly proportional to the projection of the displacement from the equilibrium position along the rotating diameter onto the x-axis, since (f-x) is a LINEAR expression.

BUT THIS IS THE CONDITION FOR SIMPLE HARMONIC MOTION.

Since it was shown above that the looii of this type of simple harmonic motion are ellipses and not cardiods. etc. the above discussion illustrates why the paths of the planets etc. are all ellipses and not cardoids etc. and rationalises Kepler's FIRST Law.

The above condition has universal application in nature; for example the oscillation of masses about the equilibrium positions of springs etc. are always simple harmonic

AN INVESTIGATION OF THE RELATIONSHIPS BETWEEN THE SEVERAL RADII OF ROTATION ASSOCIATED WITH CON-FOCAL CONIC LOCII.

Fig. 1F6 shows that in the case of both elliptic and hyperbolic locii, rotation occurs about two separete centers, both of which lie on the major axes of their individual conics and which are always a distance of 2e apart along that axis. As shown, in each case, one center could be described as the center (or focus) of conic rotation, while the other center, at the alternate focus, could be described as the center of circular rotation.

Note from the figure, that the lengths of the radii from the two centers to the locii are related in simple ways and that while rotation is in the same sense about both centers in the case of the ellipse, it is in the opposite sense in the case of the hyperbola.

*****

Fig. 1F7 presents substantially the same information as that presented in fig. 1F6 but with the origin for the major axis moved to the alternate focus in both cases. Note that, while in fig. 1F6 only single conics can be accomodated, with the change included in fig. 1F7, con-focal conics can also be included. In this case, the alternate focii of fig. 1F6, become the common focii in fig. 1F7.

******

Fig. 1F8 elaborates on the situation depicted in fig. 1F7, for the case of the ellips Here, two equal masses are postulated at the ends of a rotating diameter, one red mass and the other green, each following it's appropriate orbit around their common CG. which is at their common focus.

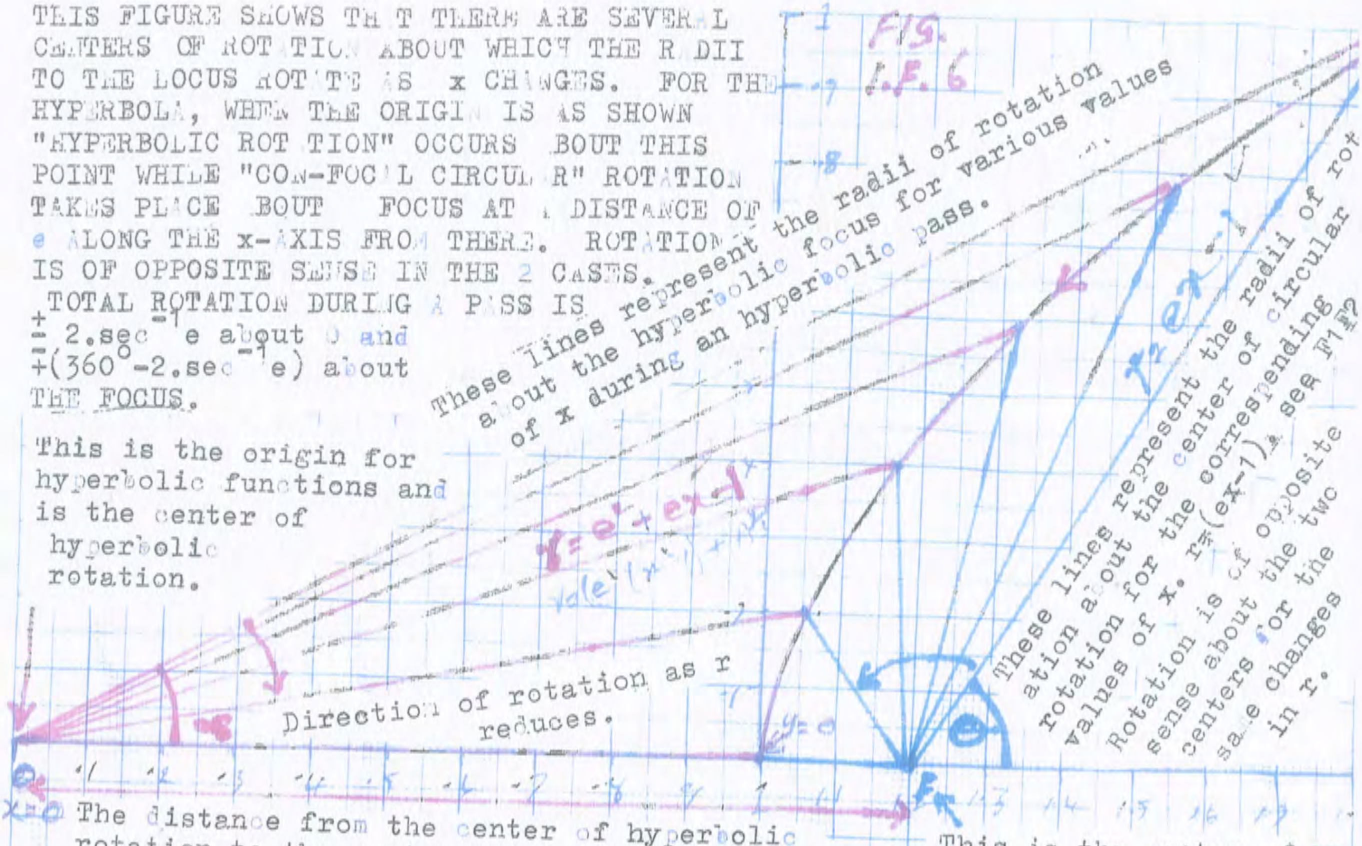
Note that in the following discussion, only masses in con-focal elliptic rotation are examined;- no hypothesis is introduced regarding harmonic motion.

It will be seen from fig. 1F8 that the displacement from the equilibrium distance along the rotating diameter toward the common focus, for the red mass is e.(e-x) while at the same time it is -e.(e-x) for the green mass.

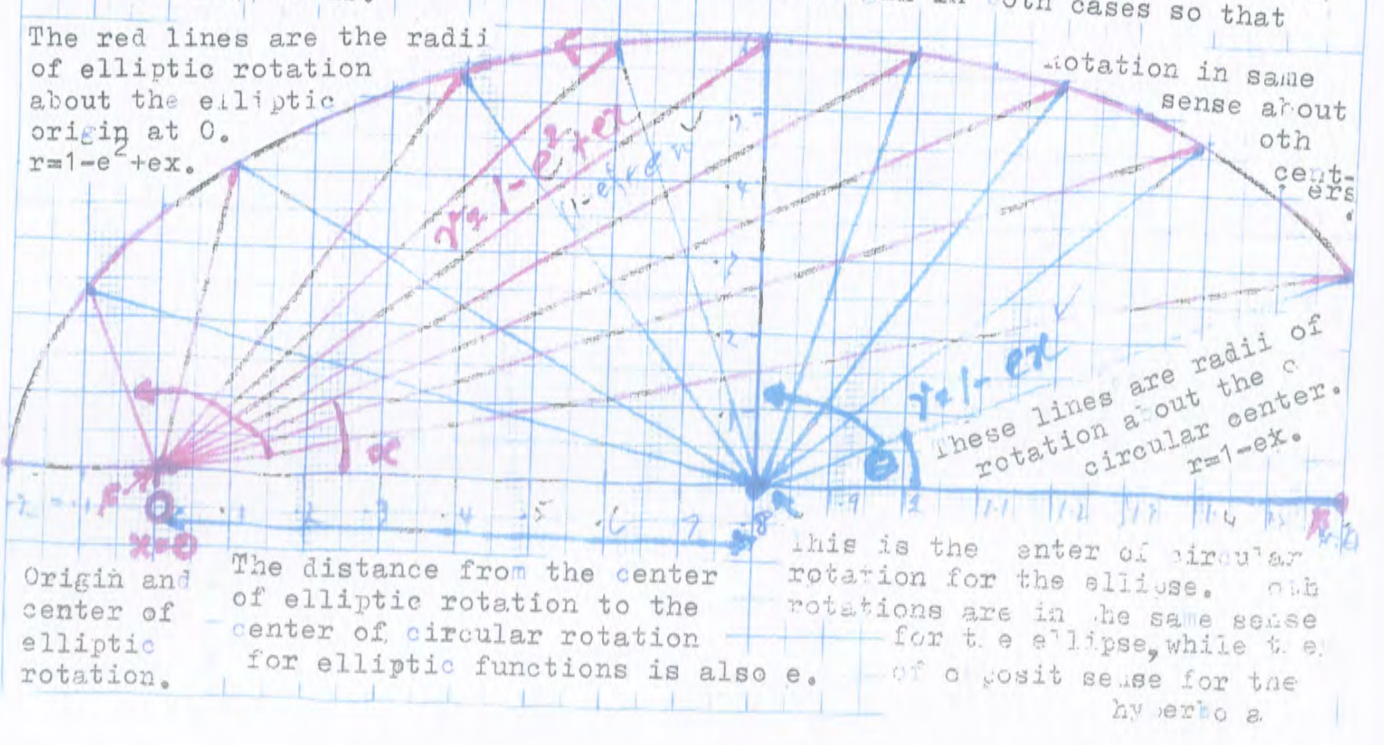
Note, that for any other rotational function except the ellipse, these relationships could not hold around the orbits and that even for ellipses they could not hold UNLESS THOSE ELLIPSES WERE CON-FOCALLY ALIGNED AS SHOWN IN FIG. 1F8.

Similarly, the displacement from the equilibrium distance along the rotating radius to the ALTERNATE FOCUS for the red mass is always -e.(e-x) while the same

THIS FIGURE SHOWS THAT THERE ARE SEVERAL CENTERS OF ROTATION ABOUT WHICH THE RADII TO THE LOCUS ROTATE AS x CHANGES. FOR THE HYPERBOLA, WHEN THE ORIGIN IS AS SHOWN "HYPERBOLIC ROTATION" OCCURS ABOUT THIS POINT WHILE "CON-FOCAL CIRCULAR" ROTATION TAKES PLACE ABOUT FOCUS AT A DISTANCE OF e ALONG THE x-AXIS FROM THERE. ROTATION IS OF OPPOSITE SENSE IN THE 2 CASES. TOTAL ROTATION DURING A PASS IS $\pm 2.\sec^{-1} e$ about O and $\mp(360^\circ - 2.\sec^{-1} e)$ about THE FOCUS.



Note that elliptic rotation is in the same sense about all three centers of rotation and in the same sense as is progression along the locus. Note also that for con-focal rotation, the center of rotation must be on the x-axis AND WITHIN THE CONFINES OF BOTH LOCII. Thus, if the locii shown are the right hand members of the con-focal pair, rotation must be about the locii shown. Since the center of hyperbolic rotation lies OUTSIDE THE CONFINES OF IT'S LOCUS, the center of con-focal rotation has to be at F. The center of con-focal elliptic rotation is at the origin in both cases so that is the common focus.



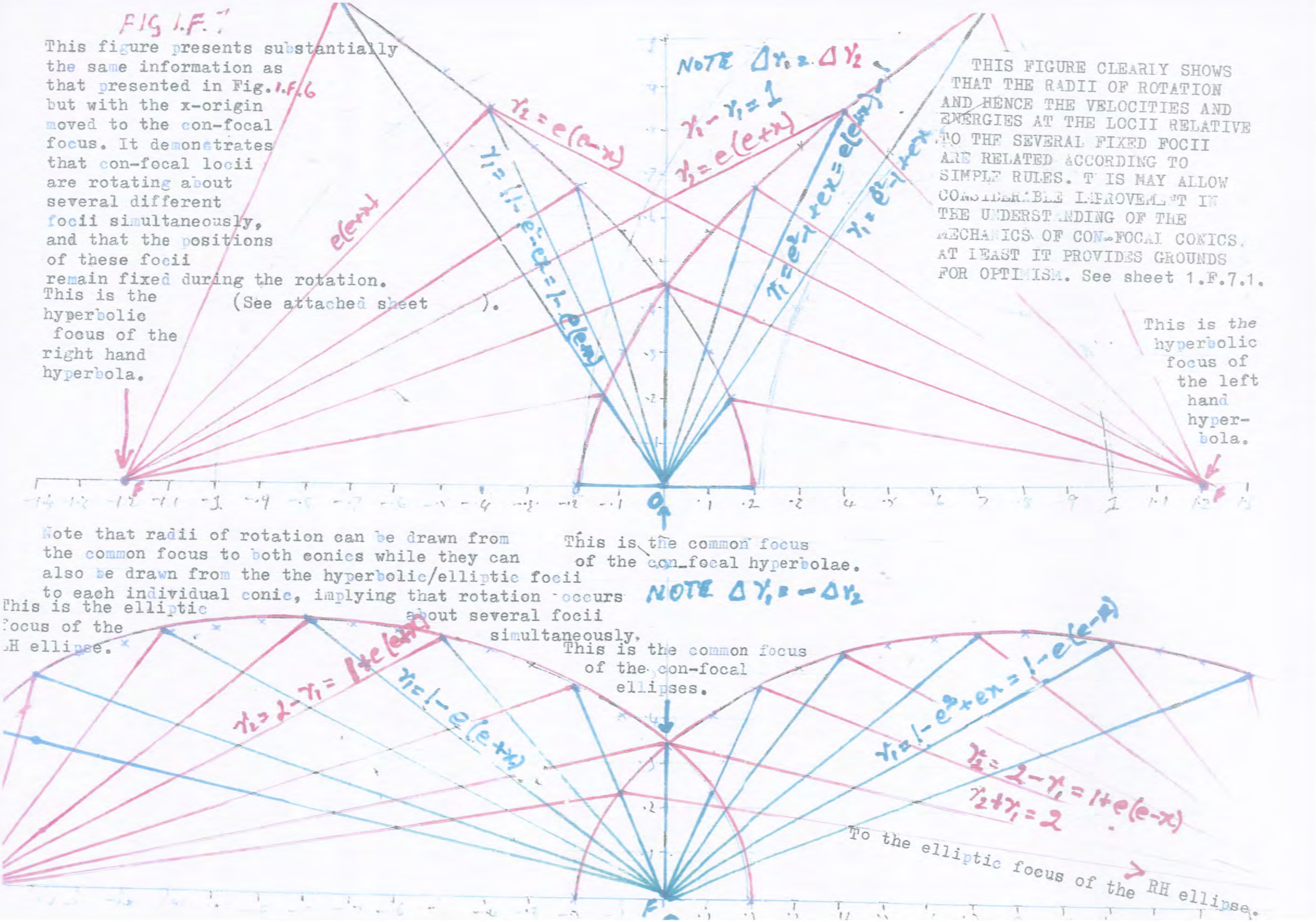
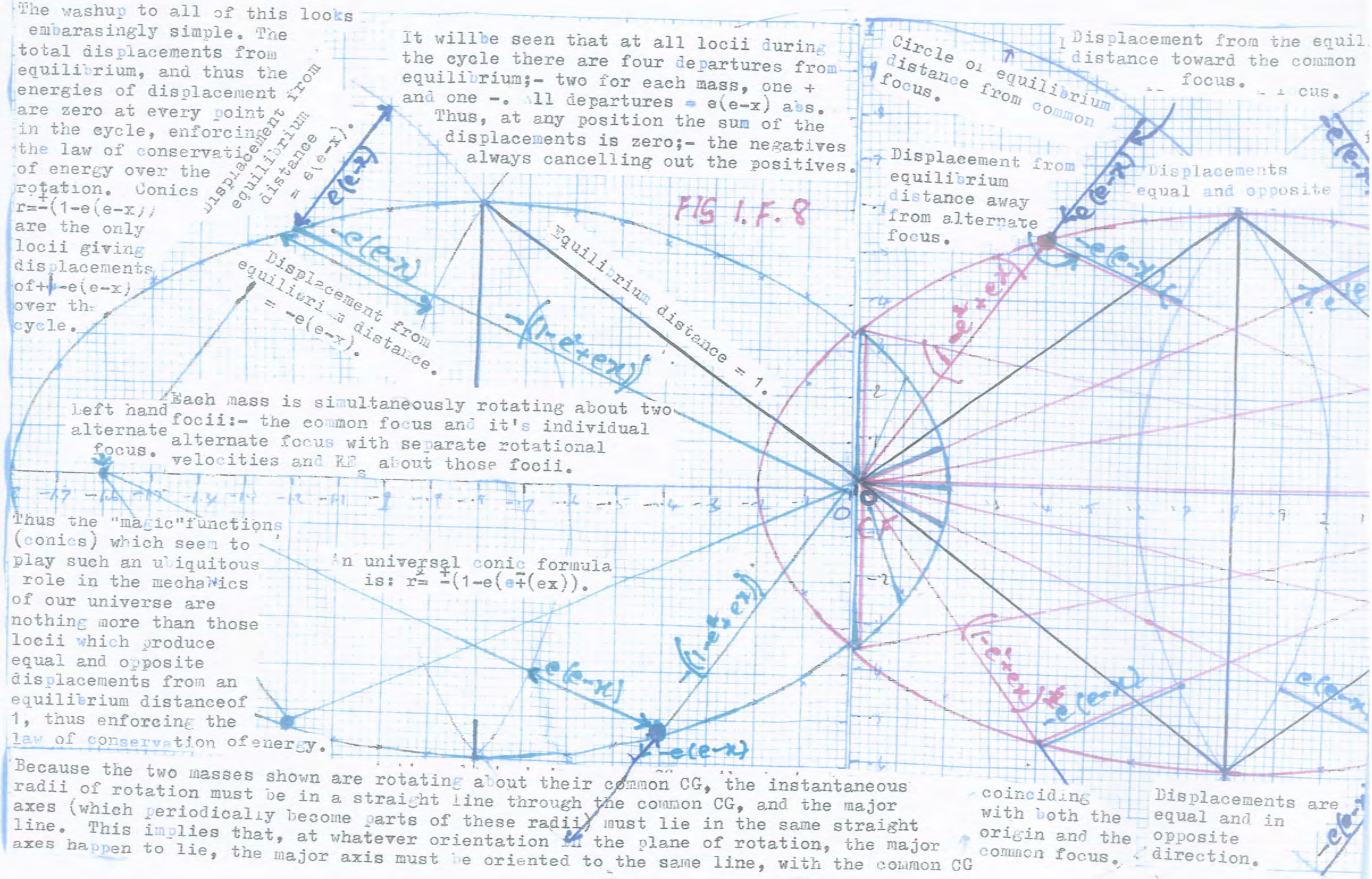


FIG 1.F.7
This figure presents substantially the same information as that presented in Fig. 1.F.6 but with the x-origin moved to the con-focal focus. It demonstrates that con-focal locii are rotating about several different focii simultaneously, and that the positions of these focii remain fixed during the rotation. (See attached sheet).
This is the hyperbolic focus of the right hand hyperbola.
THIS FIGURE CLEARLY SHOWS THAT THE RADII OF ROTATION AND HENCE THE VELOCITIES AND ENERGIES AT THE LOCII RELATIVE TO THE SEVERAL FIXED FOCII ARE RELATED ACCORDING TO SIMPLE RULES. THIS MAY ALLOW CONSIDERABLE IMPROVEMENT IN THE UNDERSTANDING OF THE MECHANICS OF CON-FOCAL CONICS. AT LEAST IT PROVIDES GROUNDS FOR OPTIMISM. See sheet 1.F.7.1.
This is the hyperbolic focus of the left hand hyper-bola.
NOTE $\Delta r_1 = \Delta r_2$
$r_2 - r_1 = 1$
$r_2 = e(e+x)$
$r_2 = e(a-x)$
e(e+x)
$r_1 = 1 - e^2 - ex = 1 - e(e+x)$
$r_1 = e^2 - 1 + ex = e(e+x) - 1$
$r_1 = e^2 - 1 + ex$
O
This is the common focus of the con-focal hyperbolae.
Note that radii of rotation can be drawn from the common focus to both conics while they can also be drawn from the the hyperbolic/elliptic focii to each individual conic, implying that rotation occurs about several focii simultaneously.
NOTE $\Delta r_1 = -\Delta r_2$
This is the elliptic focus of the LH ellipse.
This is the common focus of the con-focal ellipses.
$r_2 = 2 - r_1 = 1 + e(e+x)$
$r_1 = 1 - e(e+x)$
$r_1 = 1 - e^2 + ex = 1 - e(e-x)$
$r_2 = 2 - r_1 = 1 + e(e-x)$
$r_2 + r_1 = 2$
To the elliptic focus of the RH ellipse.
F

The washup to all of this looks embarasingly simple. The total displacements from equilibrium, and thus the energies of displacement are zero at every point in the cycle, enforcing the law of conservation of energy over the rotation. Conics $r = \pm(1-e(e-x))$ are the only locii giving displacements of $+/- e(e-x)$ over the cycle.

It willbe seen that at all locii during the cycle there are four departures from equilibrium;- two for each mass, one + and one –. All departures = e(e-x) abs. Thus, at any position the sum of the displacements is zero;- the negatives always cancelling out the positives.



Each mass is simultaneously rotating about two focii:- the common focus and it's individual alternate focus with separate rotational velocities and KE_s about those focii.

Thus the "magic"functions (conics) which seem to play such an ubiquitous role in the mechanics of our universe are nothing more than those locii which produce equal and opposite displacements from an equilibrium distanceof 1, thus enforcing the law of conservation of energy.

An universal conic formula is: $r = \pm(1-e(e\mp(ex)))$.

Because the two masses shown are rotating about their common CG, the instantaneous radii of rotation must be in a straight line through the common CG, and the major axes (which periodically become parts of these radii) must lie in the same straight line. This implies that, at whatever orientation in the plane of rotation, the major axes happen to lie, the major axis must be oriented to the same line, with the common CG coinciding with both the origin and the common focus.

displacement is e.(e-x) for the green mass.

Looking now at the displacements of just the red mass from it's two relevant focii
Displacement to the common focus is always e.(e-x) while to the alternate focus it is -e.(e-x).

Similarly, looking at the displacements of just the green mass to it's relevant focii: displacement to the common focus is always -e.(e-x) while the displacement to the alternate focus is always e.(e-x).

Note, that as x passes through e, then (e-x) changes sign so the corresponding displacements also change sign, thus ensuring that all of the above relationships hold whichever side of e that x happens to be during the cycle.

From the above discussion it is obvious that, for the red mass, the sum of the displacements along the rotating diameter to it's focii are zero at any time and that the sum of it's displacement along the rotating diameter and the displacement of it's rotating partner along that diameter is also zero at the same time. Exactly equal and opposite relationships obtain at the same time for the green mass.

From above, it is obvious that as long as both masses follow con-focal elliptic orbits as shown in fig. 1F8 their net displacements from equilibrium will be zero at all times and that this happens only if these orbits are followed.

If the sum of the displacements are zero, a case can be made that the sum of the squares of the displacements can be zero. This case will be elaborated in the next section. where the accelerations, velocities, energies of displacement from equilibrium and the residual energies after displacement from equilibrium will be examined in the case of <u>HARMONICALLY oscillating con-focal masses.</u>

THE ACCELERATIONS, VELOCITIES, ENERGIES OF DISPLACEMENT AND RESIDUAL ENERGIES, BOTH PARALLEL AND PERPENDICULAR, OF HARMONICALLY OSCILLATING CON-FOCAL MASSES.

Clearly, there are two related categories of parameter to be examined relative to this discussion. Firstly, there are the changes parallel, due to the displacement from equilibrium and secondrarily, according to the law of conservati of energy, there are the equal and opposite changes perpendicular, in the equivalent parameters.

The parameters involved will be designated as follows:

Velocity patallel: $V_{\parallel}$.

Velocity perpendicular: $V_{\perp}$.

Acceleration parallel: $a_{\parallel}$.

Acceleration perpendicular: $a_{\perp}$.

Energy of displacement from equilibrium, parallel: $Ed_{\parallel}$.

Energy of displacement from equilibrium, perpendicular: $Ed_{\perp}$.

Residual energy, parallel: $E_{\parallel}$.

Residual energy, perpendicular: $E_{\perp}$.

In developing and testing formulae for these quantities, I will make use of the following data which has been developed independently in various parts of the investigation. When the oscillation factor $f<1$, then:

1). In con-focal harmonic motion the equilibrium distance is always unity.

2). At that distance, $V_{\parallel} = f$ and $E_{\parallel} = f^2$ for a unit mass.

3). At that distance, $V_{\perp} = (1-f^2)^{\frac{1}{2}}$ and $E_{\perp} = (1-f^2)$. Thus $E_{\parallel} + E_{\perp} = f^2 + (1-f^2) = 1$.

4). At that distance $a_{\parallel}$ must be $-f$ or $V = 0_{\parallel}$ could not be achieved at perihelion.

At the distances of furthest displacement from equilibrium, that is at perihelion and at aphelion, $r=(1\pm f)$ and $x=(f\pm 1)$.

At those distances $V_{\parallel}$ changes sign indicating that both $V_{\parallel}$ and $E_{\parallel}$ must both be zero at those points.

Since $E_{\parallel} + E_{\perp}$ must equal 1 according to the law of conservation of energy, then at those distances E Total must equal 1.

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According to basic mechanics, the energy required to move unit mass over a given distance: $W = 2F.s = V^2 - U^2$ so $W_{\parallel} = V_{\parallel}^2 - U_{\parallel}^2 = 2.F_{\parallel}.s_{\parallel}$ where $F_{\parallel}$ is the average force applied in the direction of movement along the rotating diameter, from equilibrium ,

while $s_{\parallel}$ is the distance along the rotating diameter over which that force is applied. From fig.5 this distance is seen to be f.(f-x) in the direction of movement along the rotating diameter from the equilibrium distance of 1.
In harmonic motion, the returning force raised is linearly proportional to the displacement from equilibrium ALONG THE x-AXIS, which from fig.5 is seen to be f-x. So the average force raised over a distance of $s_{\parallel}$=f.(f-x) must be c.(f-x)/2 where c is the constant of proportionality.
It will be seen from fig.5 that this constant is f for harmonic motion , so the average force raised over the displacement of $s_{\parallel}$=f.(f-x) must be f.(f-x)/2.
Thus, the energy of displacement parallel, of unit mass from equilibrium,
$Ed_{\parallel} = W_{\parallel} = 2.F_{\parallel}.s_{\parallel} = 2.f.(f-x).f.(f-x)/2 = f^2.(f-x)^2.$
Since for unit mass $E_{\parallel}=V_{\parallel}^2$, then the change in $V_{\parallel}$ over this displacement=f.(f-x).

****

Turning now, to the energy of displacement perpendicular, $Ed_{\perp}$. That is, to the change in rotational Ke, due to displacement from the equilibrium position.
From the law of conservation of energy, $Ed_{\parallel} + Ed_{\perp}$ must always equal 1, so $Ed_{\parallel}+\Delta Ed_{\parallel}$ plus $Ed_{\perp}+\Delta Ed_{\parallel}$ must equal 1. But this can only happen if $\Delta Ed_{\perp} = -\Delta Ed_{\parallel}$.
That is, if $Ed_{\perp} = -f^2.(f-x)^2$ and $Vd_{\perp} = -f(f-x)$.
Since $(-f.(f-x)^2$ is usually taken to be $f^2.(f-x)^2$ and not $-f^2.(f-x)^2$ we have a conseptual problem here related to the difference between scalars and vectors, with reference to the discussion below. This difficulty will be dealt with on pages to in the appendix, to avoid disruption of the following argument at this point.

****

These formulae can be tested for validity and correct signage, using the abovelisted data as follows: From the above data and when $f<1$:
1). $Ed_{\parallel}$ from equilibrium to perihelion $= f^2- 0^2= f^2$.
2). $Ed_{\parallel}$ from equilibrium to aphelion $= -f^2-0^2= -f^2$. (It must be remembered that $V_{\parallel}$ is in the opposite direction when the mass is travelling toward aphelion from when it is travelling toward perihelion.)
3). $Ed_{\perp}$ from equilibrium to perihelion $= (1-f^2)-1 = -f^2$.
4). $Ed_{\perp}$ from equilibrium to aphelion $= 1-(1-(1-f^2)= f^2$.
From the abovederived formulae, when $f<1$:
1). $Ed_{\parallel}$ to perihelion at $x=(f-1) = f^2.(f-x)^2 = f^2.(f-(f-1))^2 = f^2$.

2). $Ed_{\parallel}$ to aphelion where $x=(f+1)=f^2(f-(f+1))^2= f^2.(-1)^2= -f^2$. (See note above).

3). $Ed_{\perp}$ to perihelion where $x=(f-1) = -f^2.(f-(f-x))^2=-f^2.1^2 = -f^2$.

4). $Ed_{\perp}$ to aphelion where $x=(f+1) =-f^2.(f-(f+x))^2 =-f^2(f-(f+1))^2= -f^2.(-1)^2= f^2$.

THUS, IF WE AGREE, AS DEMONSTRATED IN THE APPENDIX, THAT FOR VECTORS -1^2 should =-1 THE ABOVE FORMULAE AGREE WITH THE DATA PRESENTED.

****

Having the above formulae in our posession, it is now possible, by using the above data further, to derive formulae for the actual velocities and the residual energies, both parallel and perpendicular, for all valid displacements from equilibrium along both of the relevant radii of rotation, as follows: Firstly, in dealing with the radius of rotation from the common focus: $Ed_{\parallel}$ at $(f-x)$ is $f^2.(f-x)^2$ while $E_{\parallel}$ at equilibrium is f^2 so the residual energy parallel at displacement along the x-axis of $(f-x)$ must be $f^2-f^2(f-x)^2$ which equals $f^2.(1-(f-x)^2)$. The corresponding residual velocity$_{\parallel}$ = $f.(1-(f-x)^2)^{\frac{1}{2}}$. Similarly, the residual energy perpendicular at displacement $(f-x)$ must be $(1-f^2)-(-f^2(f-x)^2) = (1-f^2)+f^2.(f-x)^2 = 1-f^2.(1-(f-x)^2)$ which equals $1-E_{\parallel}$ at displacement $(f-x)$ along the x-axis from equilibrium, as required by the law of conservation of energy. The corresponding residual $V_{\perp} = (1-f^2(1-(f-x)^2)^{\frac{1}{2}}$.

****

It will be seen that while the variables $a_{\parallel}$, $V_{\parallel}$, $Ed_{\parallel}$ and $E_{\parallel}$ are always of opposite signs to $a_{\perp}$, $V_{\perp}$, $Ed_{\perp}$ and $E_{\perp}$, they mutually change signs as x passes through f so that while the variables parallel for the red mass are positive on the common focus side of equilibrium and negative onthe alternate focus side, the reverse signage applies to the variables associated with the green mass. Also, it was noted above that the above formulae were derived for the variables with reference to displacement along the radius to the common focus. These formulae can easily be modified for application to displacements along the radius to the alternate focus by noting that the lengths of the radii to the alternate focii are effectively $1+f.(x-f)$. Thus, the displacements along the the radii to the alternate focus are $\pm f.(x-f)$ so the signs of the parameters associated with displacements along the radii to the alternate focus are always opposite to those of the equivalent variables associated with variation in the radius to the common focus.

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Fig.1F9 illustrates the values of the abovelisted variables at various positions

in the cycle, (equilibrium, perihelion, aphelion and for intermediate distances) for both masses, relative to their respective radii of rotation, when they are in con-focal harmonic oscillation, according to the above formulae.
It will be seen that for any given mass, at any point in the cycle, $\pm Ed = \mp Ed = \pm f^2.(f-x)^2$. Also $Ed_{//}$ along the radius to the CF. = $-Ed_{//}$ along the radius to the alternate focus. Also $Ed_{\perp}$ along the radius to the CF = $-Ed_{\perp}$ along the radius to the alternate focus. These observations apply to both masses where the signs are mutually changed.

****

From the above discussion it will be realised that for two unit masses in iso-energetic (harmonic) oscillation, about their common CG. and at an equilibrium distance of unity, with an oscillation factor f which is less than 1; must describe con-focal elliptic orbits of eccentricity f and of unit equilibrium radius about a common focus which is at the common CG. of the masses, and with frequency equal to that of the underlying con-focal iso-energetic oscillation. Pages to in the appendix show that for masses m_1 and m_2 in iso-energetic oscillation, the equilibrium radii of the resulting con-focal ellipses will be in the ratio of $1/m_1$ to $1/m_2$.
These findings inform us why the orbits of planet-satellite systems seen in the solar system and elsewhere, are con-focal ellipses of eccentricity equal to the oscillation factor of their underlying con-focal iso-energetic oscillation, of radii inversely proportional to the magnitudes of the masses involved and of equal frequency to that of their underlying oscillation.
I claim that the above findings rationalise Kepler's first law: "The paths of the planets are ellipses with the sun at one focus". His second and third laws will be dealt with later in the investigation, after the necessary relevant information has been presented.

* *****

It was demonstrated above (p24 etc.) that the law of motion of masses at opposite ends of a rotating diameter in harmonic motion about an equilibrium distance which is not at the origin, and of oscillation factor f is given in rectangular coordinates as: $r = \pm(1 \mp f.(f-x)$. This holds for all values of f.

It was also shown on pages 27 to 3 above, that the energies of displacement from the equilibrium position, $Ed_{\parallel}$ and $Ed_{\perp}$ are always of opposite sign and of absolute values: $|(f^2.(f-x)^2|$ for all displacements from 1, of (f-x) along the x-axis. Note also that displacements of (f-x) from 1 along the x-axis correspond to displacements of (1-f.(f-x) along the rotating diameter.

Thus $Ed_{\parallel}$ of the red mass along the rotating diameter, $\pm(f^2.(f-x)^2$ is always equal in value and opposite in sign to $Ed_{\perp}$ of the red mass along the rotating diameter, $\mp(f^2.(f-x)^2$. Thus $Ed_{\parallel} + Ed_{\perp}$ always equals zero and conservation of energy is maintained for all real displacements in this case, as long as the oscillation is maintained as shown in fig. 1F7.

Similarly, $Ed_{\parallel}$ of the green mass along the rotating diameter, $\mp(f^2.(f-x)^2$ is always equal in value and opposite in sign to $Ed_{\perp}$ of the green mass along the rotating diameter from 1, $\pm(f^2.(f-x)^2$ so the sum of these two energies of displacement is also zero.

Similarly also, $Ed_{\parallel}$ of the red mass along the rotating diameter from 1 is $\pm(f^2.(f-x)^2$ while $Ed_{\parallel}$ of the green mass along the rotating diameter from 1 is $\mp(f^2.(f-x)^2$ so the sum of these energies of displacement is also zero.

Similarly $Ed_{\perp}$ of the red mass along the rotating diameter from 1 is $\mp(f^2.(f-x)^2$ while $Ed_{\perp}$ of the green mass along the rotating diameter from 1 is $\pm(f^2.(F-x)^2$ so these energies of displacement also camcel out giving conservation of energy here too.

Thus all of these energies of displacement sum to zero for all points in the oscillation, giving, as required, total conservation of energy around the cycle. Note from above, that this can only occur if the displacements from $r = \pm 1$ are always $\mp f.(f-x)$.

The result of this discussion so far can be summarised as follows:
Two unit masses in iso-energetic (**harmonic**) oscillation about their cg. and with an equilibrium distance of unity, must describe con-focal elliptic orbits of eccentricity f and of unit equilibrium radius about a common focus which is at the cg. of the masses, and with frequency equal to that of the underlying con-focal iso-energetic oscillation.

****

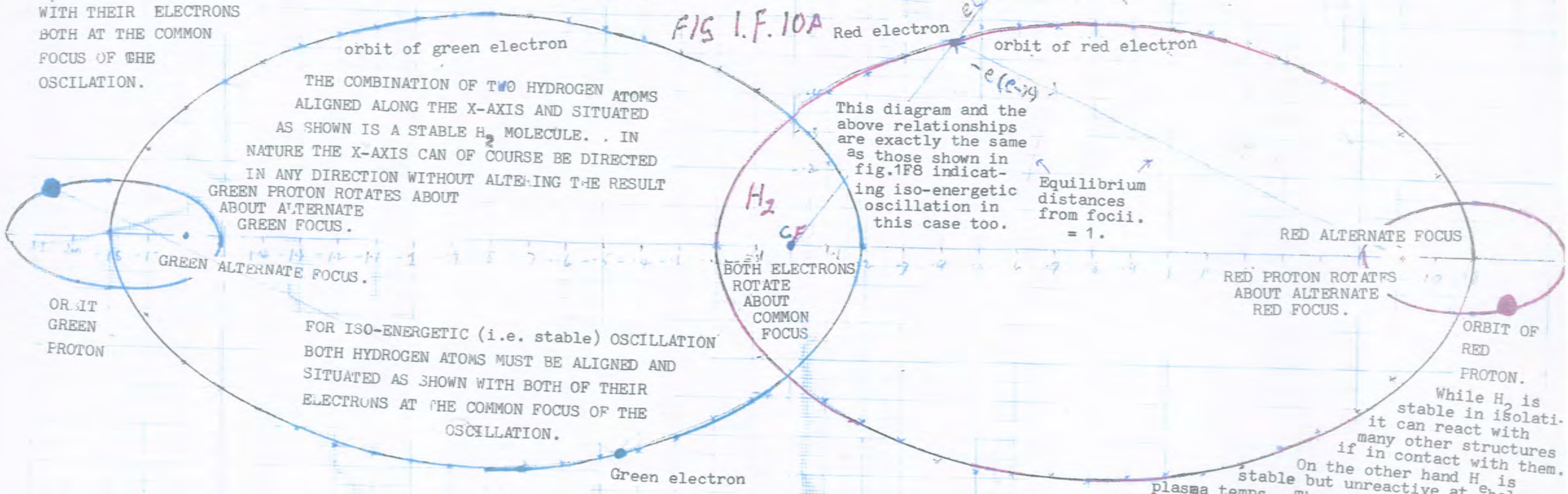
These findings inform us why the orbits of the planet-satellite systems seen in the solar system and elsewhere, are con-focal ellipses of eccentrici· equal to the oscillation factor of the underlying con-focal iso-energetic oscillation. I claim that the above findings rationalise Kepler's first law: "The paths of the planets are ellipses with the sun at one focus.

****

In view of these findings, I think that Fig.1F8 represents (in general terms the alignments and distance relationships, required between all of the primaries and their secondraries in the solar system, to generate iso-energetic oscillation in those combinations. Observation shows that this arrangement prevails throughout the solar system, so it could be a general rule for iso-energetic oscillation in a frictionless medium such as that surrounding the solar system. If this is so, the question arises as to whether this is a general rule of nature, applying also to mass systems within the atoms and the galaxies, if they are operating in a frictionless medium as they appear to be doing.
Fig.1F.10A represents a preliminary attempt to investigate this possibility. This is intended to represent an iso-energetic combination of two hydrogen atoms orbiting about their common electrons, situated at the common focus. For iso-energetic oscillation the, the protons of the atoms must be at at the alternate focii and aligned as shown. Note that a single hydrogen atom, as shown in Fig.1F.11A (or B) cannot be stable, since neither can, by itself, generate iso-energetic oscillation. If however, they are joined through their common electrons as shown in Fig.1F.10.A, they can generate iso-energetic oscillation and the mollecule so formed is stable. (H_2 is found, while H_1 is not found). Note that two hydrogen atoms in iso-energetic oscillation about their respective PROTONS, as shown in fig.1F.10.B, (that is He),is mush more stable under chemical attack than is H_2 so the proton to proton bond must be much stronger than the electron to electron bond. (See page 35). I am convinced that the bonding arrangements shown in figs.1F.10A and 1F.10B represent truely, those for H_2 and H_e respectively I have hazarded a speculation on the general bonding arrangements and the consequent structures of the elements of period 2 with less confidence than those above. Consequently, they are presented in the appendix.

THIS FIGURE DEPICTS TWO HYDROGEN ATOMS IN ISO-ENERGETIC OSCILLATION WITH THEIR ELECTRONS BOTH AT THE COMMON FOCUS OF THE OSCILATION.

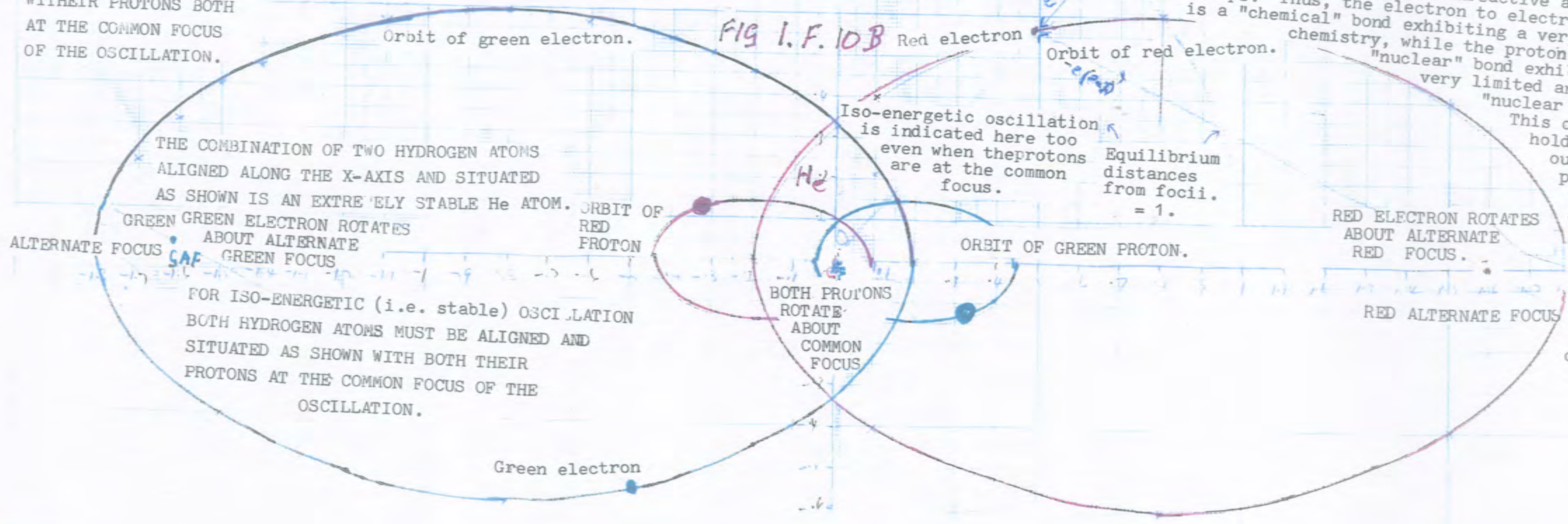
FIG 1.F.10A



While H_2 is stable in isolation it can react with many other structures if in contact with them. On the other hand H is stable but unreactive at e_{below} plasma temps. Thus, the electron to electron bond is stable but reactive while the proton to proton bond is stable unreactive at normal temps. Thus, the electron to electron bond is a "chemical" bond exhibiting a very extensive chemistry, while the proton bond is a "nuclear" bond exhibiting a very limited and specific "nuclear chemistry" This observation holds throughout the periodic table. At least 2 free electrons must be available before chemical reaction can take place.

THIS FIGURE DEPICTS TWO HYDROGEN ATOMS IN ISO-ENERGETIC OSCILLATION WITHEIR PROTONS BOTH AT THE COMMON FOCUS OF THE OSCILLATION.

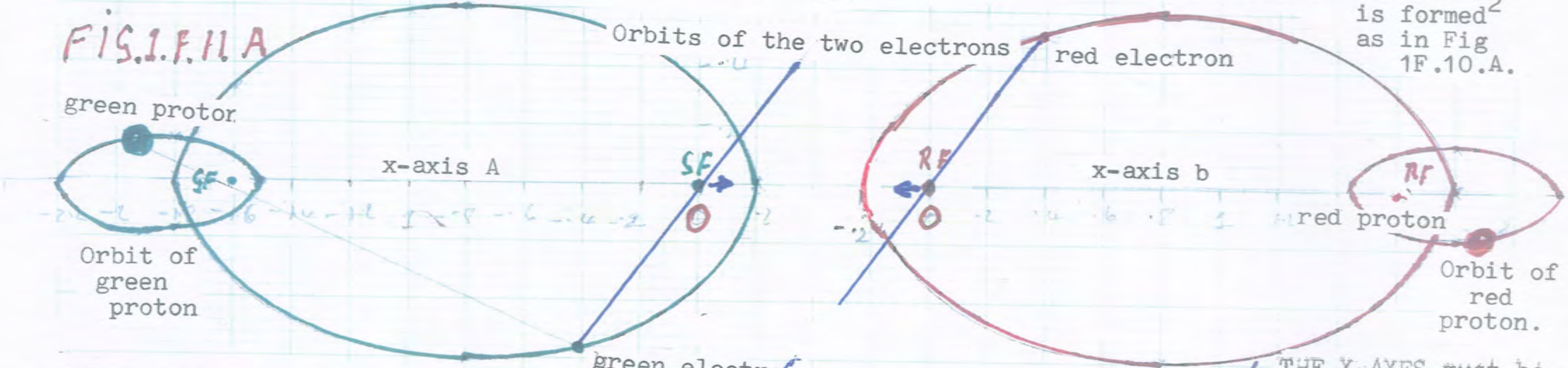
FIG 1.F.10B



THIS FIGURE DEPICTS TWO SEPARATE HYDROGEN ATOMS LYING ALONG SEPARATE X-AXES. THEY are separate axes because, even though they are depicted in line, their origins are not in the same place. In this case, diagrams like fig.1F8 cannot be constructed on this layout showing that iso-energetic oscillation and the formation of H_2 is not possible in this case.

IF, HOWEVER, THE TWO AXES ARE MOVED TOGETHER SO THAT THEIR ORIGINS AND THE BLUE LINES OVERLAP FIG. 1F8 is established and H_2 is formed as in Fig 1F.10.A.

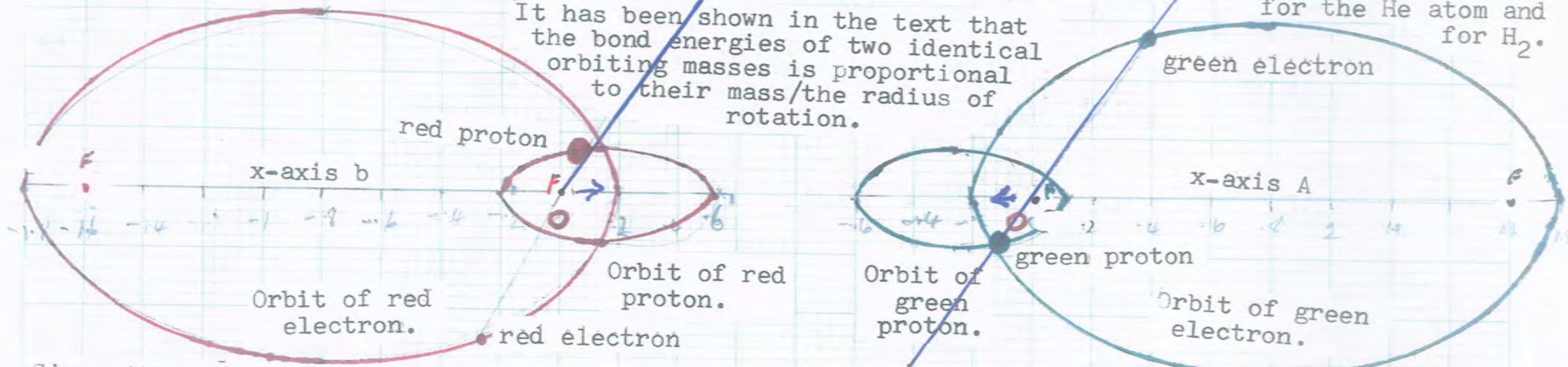
FIG.1.F.11 A



THE DIAGRAM BELOW ILLUSTRATES THE SAME PROCESS BUT IN THE CASE WHERE THE TWO PROTONS COME TO OVERLAP. IN THIS CASE THE HYDROGEN ATOMS FUSE TO AN He ATOM.

THE X-AXES must be in line for fusiou. This condition sets the in-line shapes for the He atom and for H_2.

It has been shown in the text that the bond energies of two identical orbiting masses is proportional to their mass/the radius of rotation.



Since the mass of the proton is about 1800 X the mass of the electron, then r electron must be 1800 X r proton. So bond energy of H_e must be about 1800^2 x 1800 = about 5.8×10^9 times the H_2 atom.

AN "ENERGY" APPROACH TO KEPLER'S THIRD LAW.

Kepler's third law has been shown to be valid for all of the planets and their satellites throughout the solar system with no exceptions, so I accept it as a universal law representing the equilibrium condition for those bodies. This law can be written as: $W^2.r^2 = Kc/r$. That is, the rotational Ke of any satellite at equilibriun with it's primary is inversely proportional to it's distance from the CG. with it's primary.

....

If $W^2.r^2 = Kc.r^{-1}$ then $d/dr(W^2 \cdot r^2)$ must equal $d/dr(Kc.r^{-1})$.
Thus $2.W^2.r$ must equal $-Kc.r^{-2}$.
If we look at this situation dimensionally, $M.W^2.r^2$ represents a rotational Ke with dimensions $M.L^2.T^{-2}$, while $M.W^2.r$ is recognisable as a centrifugal force with dimensions $M.L.T^{-2}$. How can this be, when Kc is a constant with no dimensions ?. Well Kc at this stage may only appear to be a constant. It may actually be a more complicated parameter involving dimensions, which would have to be $L^3.T^{-2}$ to make the above equation valid. This dimension represents distance times energy per unit mass and could represent the integral of energy over distance. That is $\int_{distance\ 1}^{distance\ 2} E.d.distance$.
This possibility will be examined later.

....

For equilibrium the centrifugal force $W^2.r$ and the centripetal force $-Kc.r^{-2}$ must be equal and of opposite sign at the equilibrium distance, as seen above. This centripetal force obeys a law involving r^{-2} which makes it an inverse square law akin to Newton's law of gravitation which has hitherto been used to explain Kepler's 3rd law, so it may be useful to examine it more closely.

....

On integrating the force $-Kc/r^2$ with respect to r , we get: $\int_{infinity}^{r} -Kc/r^2.dr =$
$= Kc/r - Kc/r_{infinity}$. But $Kc/r_{infinity} = 0 = W^2_{infinity}.r^2_{infinity}$.
Therefore $W^2.r^2$ must equal $Kc/r-Kc/r_{infinity}$. Thus the rotational Ke at r must equal the work done in moveing Kc/r from infinity to r.
But $W^2.r^2$ is undoubtedly $E_{\perp}$ so the centripetal force $-Kc/r^2$ which is accelerating $W^2.r^2$. must be acting perpendicular and not parallel, as it has hitherto been presumed to act. THE CONCLUSION SEEMS INESCAPABLE THAT $W^2.r$ (the force opposing the rotational acceleration), and Kc/r^2 (the force causing the rotational acceleration), MUST BE ACTING PERPENDICULAR AND NOT PARALLEL.

....

Since we are dealing with an equilibrium energy equation in the 3rd Law, there is nothing in it to establish the time and duration of the action of Kc/r^2. If it had acted over various distances on the various planets in the past and in so doing had established the various rotational Ke_s which we see now, and had now ceased, we could not tell from the law if this was so FOR ALL WE KNOW THE 3RD LAW COULD BE THE FOOTPRINT OF A LONG DEAD FORCE.

It is interesting to speculate that if only a small fraction (F) of this force, (say $F.Kc/r^2$), began acting a ain today and acted over just one cycle of the oscillation, the wor . done by this force would be F.Kc/r. Now, the only place from which this energy could come is the potential energy of displacement from infinity, that is F.Kc/r. Thus the residual energy of displacement must be: (1-F).Kc/r. Remember, F is a very small fraction, much< Thus insufficient energy of displacement from infinity would be left avaliable to return the oscillation to it's original equilibrium position before the force operated. Thus a new equilibrium radius of rotation would be establishe so that: $r_{2(equilibrium)} = (1-F).(Kc/r)\text{times } r_{1(equilibrium)} = (1-F).r_{1(equibib}$

If this force acted over n cycles, the equilibrium r would be reduced accordingly on every cycle and even if the factor (F) was very small on any given cycle, the accumulated reduction in the equilibrium radius of rotation could be very great if sufficient cycles (perhaps something even approaching infinity) were involved over time.

Of course, this is only speculation, but I think that this senario possibly accounts for the general configuration of the solar and other systems that we see today. The next section will be devoted to trying to refine this speculation. Since space is not a perfect vacuum;- we see various objects and other particulate matter out there, this process might not have yet totally ceased and it might be going on to an unmeasurable extent even today. Summing up the above speculation so far;- Note that the above force equality formula: $W^2.r = -Kc/r^2$ was derived by differentiating the above energy equality formula: $W^2.r^r = Kc/r$, with respect to r, over the range from ∞ to r. At first sight, this result seems to imply that a force of $-Kc/r^2$ is required to induce an energy of displacement of Kc/r OVER ONE CYCLE OF OPERATION. However, since energy in general is cumulative over more than one cycle, it is equally valid to conclude that a force of $(1/n).Kc/r^2$ maintained over n cycles would result in the same cumulative energy change of Kc/r.

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What could this hypothetical force have been ?.

Well, since all of the galactic systems are assumed to have condensed from a "dust" cloud, the friction from the cloud itself could have been the culprit After the dust cloud was absorbed, the force ceased.

KEPLER'S (IMPLICIT) 4th LAW. THIS LAW GOVERNS THE DISEQUILIBRIUM SITUATION. IT IS IMPLIED IN THE 3rd LAW.

AS note above, Kepler's 3rd law is actually an energy equilibrium equation, defining the individual equilibrium radius of rotation for each of the planets and their satellites, as defined by their individual rotational kinetic energies which are in turn determined by their energies of displacement from infinity, at equilibrium. That is;- the individual equilibrium radius of rotation (r), of each of the planets and their satellites, is determined by the energy of displacement (Kc/r), of each body, at the time.
The law explicitly defines the equilibrium condition, however, as seen below, it provides useful information about the disequilibrium situation also.
From page , $W^2.r$ is a force which changes E $(W^2.r^2)$ so it must act perpendicular. This, in spite of the fact that it is called "centrifugal force", implying that it acts parallel. On the other hand, the counterveiling "centripetal force" must act parallel since it is changeing the energy of displacement from equilibrium (Kc/r) which is a change parallel (in r).
How can this be ?. a force parallel cannot accelerate a moss perpendicular. Or can it ?. If the 3rd law is accepted, and it has been around for 400 years, it has to be accepted that a centripetal force, Kc/r^2 acting parallel, MUST in some way, change $E_\perp$, $W^2.r^2$ (which is perpendicular), to produce equilibrium at some value of r, whether Kc/r^2 acts parallel or not.
This finding has significance when applied to non-equilibrium situations.
In the following discussion, W^2 will be taken to equal Kc. See section on unit
When $r>1$, then force $W^2.r$ is greater than force Kc/r^2, so acceleration is toward r=1
When $r=1$, then force $W^2.r$ = force Kc/r^2 so there in no acceleration either wa
When $r<1$, then force $W^2.r$ < force Kc/r^2 so acceleration is toward $r=1$.
When $r>1$, then $d/dr(E_{\parallel})$ is positive while $d/dr(E_\perp)$ is negative.
When $r=1$, then $d/dr(E_{\parallel}) = d/dr(E\ ) = 0$, so there is an acceleration reversal.
When $r<1$, then $d/dr(E_{\parallel})$ is negative while $d/dr(E_\perp)$ is positive.

****

The above figures show unequivocally, that as r passes through 1, acceleration reversals take place in both $a_\perp$ and $a_{\parallel}$, so that force parallel Kc/r^2, is always directed toward the equilibrium distance r, while the force perpendicular, $W^2.r$, oscillates about an equilibrium value at r=1.

****

The above findings explain the way in which iso-energetic oscillation is established as r passes through the equilibrium position (r=1) after disequilibrium contraction from infinity. This complements the work on pages 27 through 31 above. ********* We now look at the disequilibrium case.
At equilibrium, $E_\perp = W^2.r^2 = Kc/r$ and we saw above that eqyilibrium always occurs at r=1. This implies that the forces causing acceleration, that is $W^2.r$ and Kc/r^2 must be equal and opposite at that point. Thus, $W^2 = Kc$ at r=1.
Away from equilibrium, the net acceleration toward (r=1) is the difference between these forces, that is: $W^2.r - Kc/r^2$ and we saw on page that this

net force changes sign as r passes through r=1. It was seen on p. 35 that $(W^2.r)$ is greater than (Kc/r^2) when $r>1$ and is less than (Kc/r^2) when $r<1$, assuring an acceleration reversal as r passes through 1. Thus, in the disequilibrium situation, which prevails at values of $r \neq 1$, the acceleration toward equilibrium at r=1, is the difference between these forces. That is: $a_{\parallel}$ toward r=1 is $(W^2.r)-(Kc/r^2)=d/dr(W^2.r^2)-d/dr(Kc/r)$. No matter what the value of r, this acceleration is always directed toward r=1. I designate this law; "Kepler's 4th law". The law of disequilibrium.

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Since $E_{\parallel}+E_{\perp}=1$, then $E_{\parallel}=1-E_{\perp}$. Thus $E_{\parallel}=1-W^2r^2=1-Kc/r$. So the acceleratio perpendicular, $a_{\perp}$ is $d/dr(1-W^2.r^2)-d/dr(Kc/r^2)=(Kc/r^2)-(W^2.r)$. Thus $a_{\perp}$ is always equal and of opposite sign to $a_{\parallel}$ and so it undergoes an equal and opposite sign reversal at (r=1) to that of $a_{\parallel}$. As pointed out above, these findings completely explain the mechanism which establishes con-focal harmonic oscillation about r=1, as r passes through 1.

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Since $W^2.r^2=E_{\perp}=Kc/r$, then $E_{\perp}$ is inversely proportional to the displacement of the orbiting masses at $r \neq \infty$ from their original orbiting distance of r=infinity. It must be remembered that the masses came to equilibrium at r because an amount of energy equal to Kc/r was dissipated against, (in the case of the solar system), the "dust cloud", during contraction. They only came to equilibrium at r because the resistance ceased at that point. If this is true, an equal amount of energy must be applied to the two bodies from outside the system and in the opposite directions, to take them back to their original equilibrium positions at r= infinity.
Thus $E_{\perp}=Kc/r$ can be regarded as the "energy of association" per unit mass, of two unit masses orbiting in equilibrium at $r \neq \infty$ which must be applied to the two masses, from outside the system to take them back to their original equilibrium at r=infinity. If the two masses were M_1 and M_2 instead of unity, the equivalent "energy of association" would be $Kc.M_1.M_2/r$, while the forces applied at r from outside the system, required to force this change, would be: $Kc.M_1.M_2/r^2$. The law of gravitation crops up everywher

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The above relationship affords a quick way of comparing the bond energies or the "energies of accociation", of chemical (electron to electron) and nuclear (proton to proton) bonds, and of other known structural systems. For instance, M (proton) is about 1800 times M (electron), so r for the electron at equilibrium must be about 1800 times r for the proton in equilibrium. Thus, the relative "energy of accociation" of the proton to proton bond to the relative "energy of association" of the electron to electron bond must be $(1800 \times 1800/1)/(1 \times 1/1800) = 1800^3 = 5.83 \times 10^9$.
So the nuclear bond is 5.83×10^9 times as strong as the chemical bond. This explains why nuclear bonds are so much harder to break (fortunately) than chemical bonds and why enormous amounts of energy using acceleraters etc. are required to break them.

AN HYPOTHETICAL EXPLANATION CONCERNING THE ORIGIN OF, AND THE DEVELOPMENT THEREFROM, OF THE VARIOUS PRIMARY-SATELLITE SYSTEMS NOW SEEN IN THE SOLAR SYSTE

It is generally held that the galaxies and all of their satellite systems originally condensed from a "dust cloud", so I take this to be my starting point, and I include the following assumptions about conditions at the time.

1). Since the nearest star from us is about 4 light years away, I will assume that the disc of cloud from which the solar system condensed, was about 8 light years across. By our standards, this distance is unimaginally great and can be regarded as being close to infinity, so I will regard the outer part of the disc to be an infinite distance from it's cg. at the center

2). Since $W^2.r^2 = Kc/r$, then $W^2.r^2 = E_\perp$ would be 0 at the edge of the disc and would be 1 at r=1. (See page:). This implies that the dust cloud would be rotating differentially with respect to it's radius of rotation. This inference is strengthen by the observation of spiral galaxies. Also, Since, according to the law of conservation of energy, $E_\perp + E_{\parallel}$ must equal 1, then $E_{\parallel}$ at the edge of the disc must be $1-E_\perp = 1$, and must be $1-E_\perp = 0$ at r='

3). As shown on page. , friction within the cloud would cause it's general contraction toward it's cg. together with the formation of a ring of mass aroung the cg. at r=1. Further friction within the ring could be expected to finally result in the consolidation of the ring of mass into a single mass at some point on the ring, exactly as we see the planets orbiting the sun at the present time.

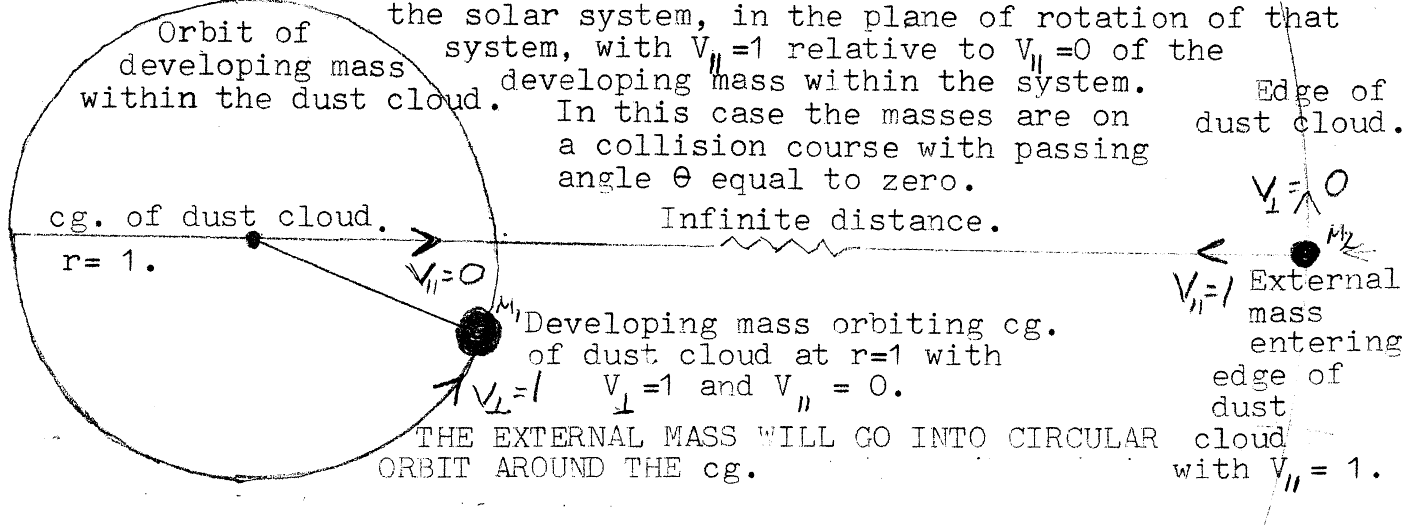
4). Into this friction induced, contracting and differentially rotating discof the "dust cloud"; another mass, possibly something like a large meteor or a comet, enters from outside the system, and in the same plane of rotation as the system, with velocity $V_{\parallel}$(taken to be 1) relative to that of the developing mass within the system.

5). Note that this velocity can have two general characteristics, as follow:

A). The two masses can be on a collision course through their cg., in which case their angle of approach would be $\theta^o = 0$ and $\cos\theta = 1$, as shown in fig.A

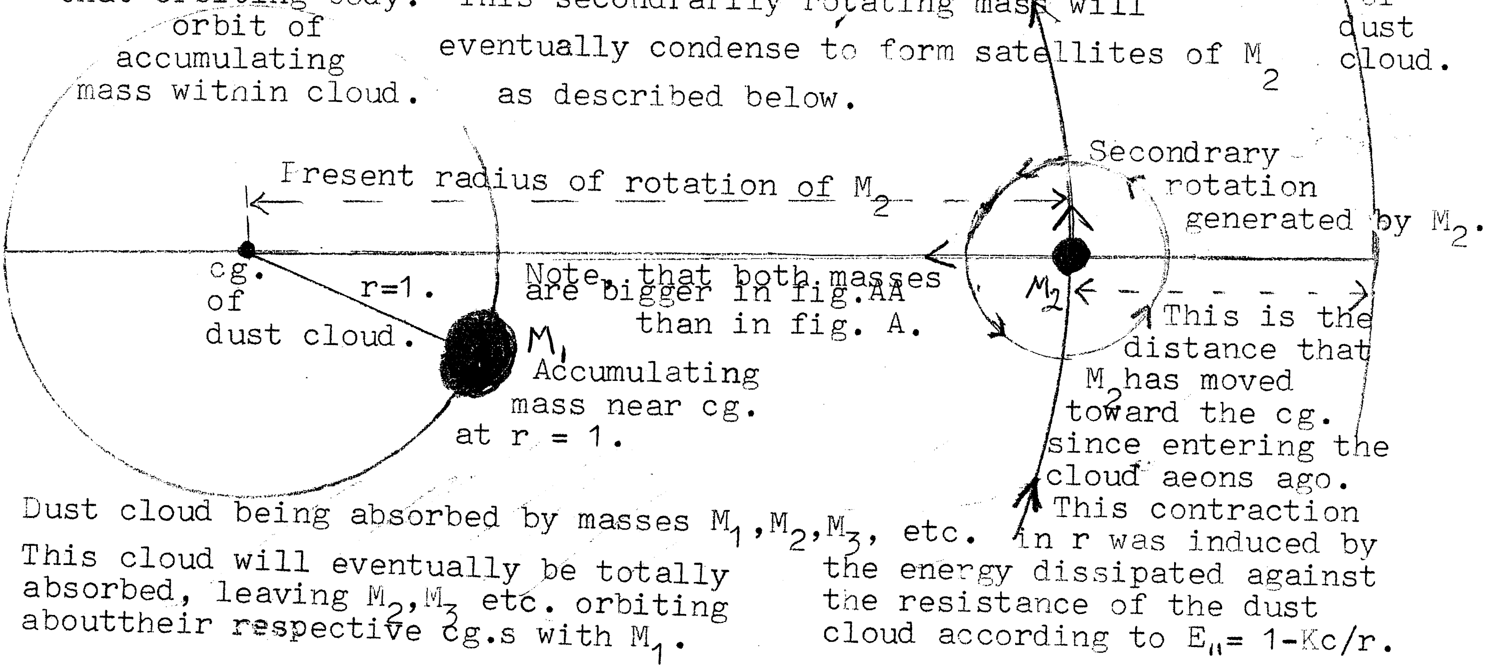
B). The two masses could be on a passing course. In this case, their passin angle would be θ^o where $0^o < \theta^o < 90^o$ and $0 < \cos\theta < 1$, as seen in fig. B below.

Fig. A. This diagram illustrates the case where an outside body enters the edge of the part of the "dust cloud" relevant to the solar system, in the plane of rotation of that system, with $V_{\parallel}=1$ relative to $V_{\parallel}=0$ of the developing mass within the system. In this case the masses are on a collision course with passing angle θ equal to zero.



In figure A above, the $V_{//}$ and hence the $E_{//}$ of the entering mass M_2 is 1 at r=∞ directed toward the cg. along the radius of rotation of M_2. Thus, M_2 will procede toward the cg. Because of the resistance of the dust cloud, it's equilibrium distance will be reduced according to: $E_{//}= 1-Kc/r$ (See page .) Also because of the resistance and mass in the cloud, M_2 can be expected to accumulate mass from the cloud, just as M_1 near the center of the cloud has been shown to be doing. Thus, the two masses will accumulate mass from the cloud, and in the process, thin the cloud down. As M_2 increases in mass, it will start influencing the part of the cloud close to it's then radius of revolution, as it goes around. See fig. A.A below.

Fig. A A. This figure demonstrates how secondrary rotation is generated within the part of the dust cloud close to the orbit of M_2 by that orbiting body. This secondrarily rotating mass will eventually condense to form satellites of M_2 as described below.



Given enough time, smaller masses from outside the system, which happen to be travelling in the plane of induced secondrary rotation, with $V_{//}$ directed along the radius of rotation around their cg.s with M_2, will by chance enter the dust cloud at infinity. Because of the resistance of the cloud, these masses will start to contract on their cg.s with M_2 thus forming the embryos of planet-satellite systems such as that which we see around Jupiter.

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At some much later time, by which time, M_2's equilibrium distance has been reduced by friction with the cloud, to a long way from r= infinity and perhaps to some position such as that shown in fig.A A, a second stray mass (M_3), by chance enters the dust cloud from outside and travelling in it's plane of rotation with $V_{//}$ directed toward the CG. of M_3 and the cloud. As in the case of M_2, friction in the cloud induces contraction, and absorption of mass and the generation of secondrary rotation at the radius of the cloud from it'scg. with M_3, close to the then radius of rotation of M_3,

thus, setting up another embryo satellite system around M_3.
During the life of the dust cloud, several more stray mass from outside the cloud, M_4, M_5, M_6, etc. may at various times enter the cloud in the plane of it's rotation with $V_{\parallel}$ directed toward that mass's cg. with the dust cloud, thus as described above, forming a further series of primary-satellite systems orbiting the cg. of the cloud. These new masses will also absorb mass from the cloud until at some time all of the mass will effectively be absorbed from the cloud, leaving a series of primary-satellite systems **circularly orbiting** the cg. Because it has ceased to exist, the cloud will now have no mass nor a cg. with the masses left. So these masses, M_2, M_3, M_4, M_5 etc will circularly orbit their cg. with the new primary mass M_1, in stable equilibrium at various distance from that cg. as determined by the different times in which they first entered the cloud and it's varying resistance during their times in it, before it was absorbed.

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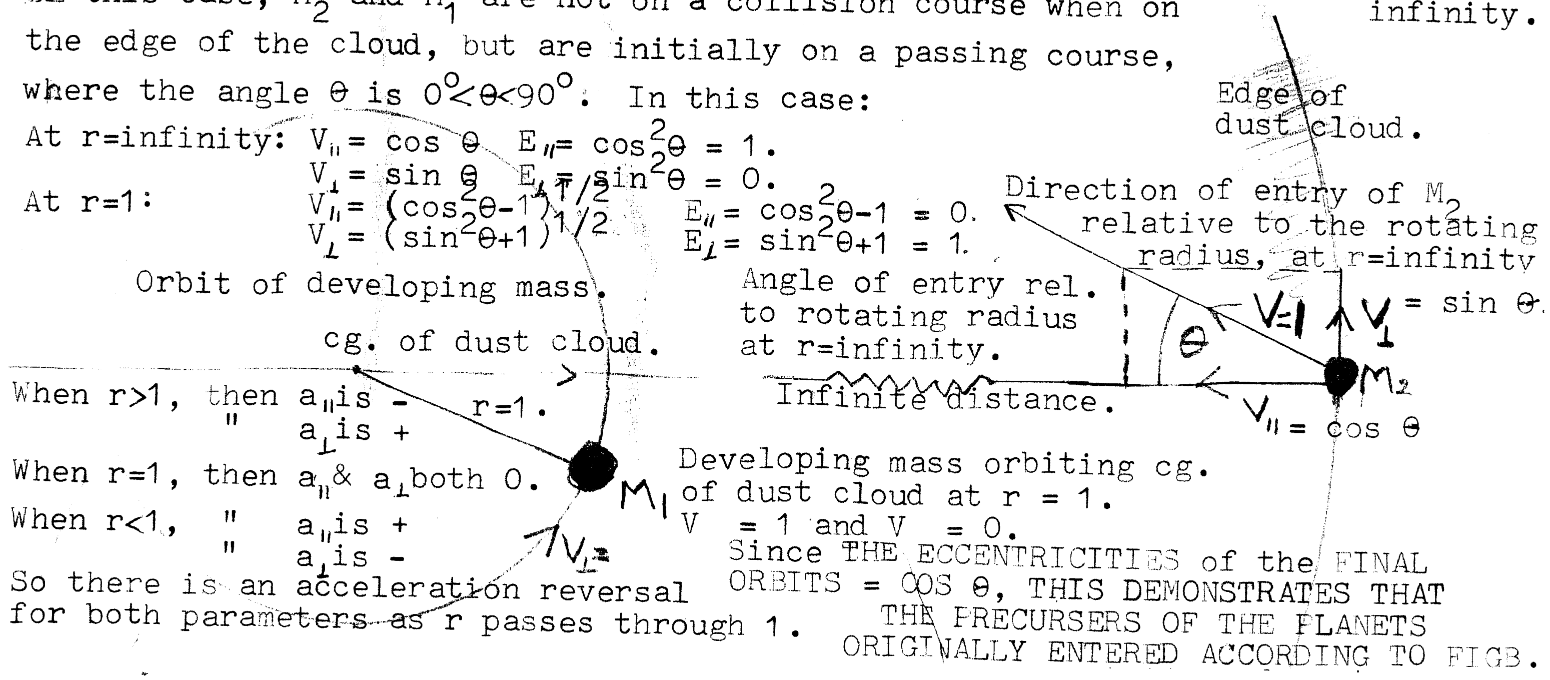
It is not difficult to imagine that the abovedescribed development might result in something resembling the solar system as we see it today, where M_1 represents the sun, while the other masses M_2, M_3, M_4, M_5, etc. become the **planets**, most of which have satellite systems around them; except for one obvious discrepancy. This is: the above discription would, as mentioned above, result in the formation of circular orbits for all of the masses, while in the solar system we see only elliptic orbits with $0<e<1$. To correct this problem we must look at fig. B below:

Fig. B. This diagram illustrates the case where a body from outside, (M_2), enters the outside edge of the dustcloud relative to the solar system, in the plane of rotation of that system, with total V=1, not as in case A, where $\theta=0^o$, but at an angle θ in the plane of rotation, to the line from M_2 to the cg, when r= infinity. In this case, M_2 and M_1 are not on a collision course when on the edge of the cloud, but are initially on a passing course, where the angle θ is $0^o<\theta<90^o$. In this case:



In the above case, friction in the dust cloud will cause contraction in the system, just as it did in the case of fig.A. However, at infinity in this case, $V_{\parallel}$ will be cos θ and not 1 as in case A, while $E_{\perp}$ will be sin θ, and not zero. Thus, in this case, $E_{\parallel} = \cos^2\theta$ and $E_{\perp} = \sin^2\theta$ at infinity. By the time that all of the massin the cloud has been absorbed by the developing masses and by which time the friction in the cloud has been eliminated, the total previous friction will have caused contraction to r=unity (equilibrium), where $E_{\parallel} = \cos^2\theta - 1 = -\sin^2\theta$ and $E_{\perp} = \sin^2\theta + 1$ and where an acceleration reversal is induced in both amplitude and eccentricity. See pages 29, 30, 31, 34, 36, and 37.

Thus at r=unity, there is a regime change between the mechanics of the two phases, first from:

1). a disequilibrium contraction/expansion, where energy is lost or gained to or from outside masses; (for example, the dust cloud) where 4th law rules,

to (2). an iso-energetic oscillation about r=unity, which distance is determined by the 3rd law, in which energy is passed between the two oscillating masses at all points in the cycle in equal amounts with no energy gained or lost, from or to, outside masses during this time.

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It was shown above that at r=unity in case B, $E_{\parallel} = -\sin^2\theta$ so that $V_{\parallel} = -\sin\theta$* and that the induced oscillation is iso-energetic, implying that it is also con-focal elliptic. It has been shown throughout the work, that: (1) both the displacement from equilibrium to perihelion and to aphelion is ±e, where e is the eccentricity of the oscillation.

(2) at both perihelion and at aphelion $E_{\parallel}$ is 0.

Since, accordin; to the formula $E_1^2 - E_2^2 = 2.a.s$, then $-\sin^2\theta - 0 = 2.a.e/2.$

or $\pm \sin^2 0 = \mp a.e.$

This can only be valid if ± both a and e equal ∓sin θ.

Thus the eccentricity of the oscillation must be determined by the sign of the original passing angle of the masses back at r=infinity.

After all of the resistance from the dust cloud has ceased, the picture emerges of a resultant system closely resembling the present solar system in all of the major respects. These are:

1). The presence of a very large mass near the center of the system, (the su containing most of the mass in the original dust cloud.

2). This mass is individually orbiting with each of the captured masses, M_2, M_3, M_4, ... etc. (the planets), about their individual cg_s.

3). Each of the equilibrium distances, r_2, r_3, etc. is determined by their residual $E_{\perp} = W^2.r_n^2 = Kc/r_n$, after resistance from the dust cloud has ceased.

4). The eccentricities of each of the orbits are elliptical and not circular indicating that capture occured according to fig.B and not fig. A.

*I am having trouble with Argand again. Forget him, he knew nothing about vectors.

5). Six of the planets in the solar system have satellites in secondrary rotation about them. How this phenomenon might have developed was demonstrated according to fig. AA above and in the accompanying legend.

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It was shown in the hypothetical explanation of the origin of, and the development therefrom, of the different primary-secondrary systems seen in th solar system, how the above five observed features could have developed according to this hypothesis, thus indicating that the hypothesis might represent a likely explanation of how the solar system actually developed.

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There remains one matter to be cleared up before leaving this question. An obvious question regarding the above discussion is this: It has been shown throughout the above work, that for all isO-energetic oscillations, the equilibrium distance is always 1(sometimes written as unity), yet accordir to the 3rd law (and as measured), the equilibrium distances of the planets are all different and therefore cannot all be equal to 1. How can this be ?. A good question which I will try to answer as follows: For con-focal ellipses of eccentricity e, then $r=\pm(1-e^2+ex)$ and the equilibrium distance occurs at x= In this case $r_{equilibrium}= 1-e^2+e.e = 1$. This is a pure mathematical conclusion, valid only for the mathematical premise or formula: $r=\pm(1-e^2+ex)$. Note that if this formula is modified in some way, such as, say by multiplying it by 4, to $r=\pm4.(1-e^2+ex)$ then all values of r, including $r_{equilibrium}$ are X Now, this is the sort of thing that we are doing when we apply the physical and astronomical related 3rd law to the pure mathematical, con-focal elliptic situation outlined above to produce physical distances relating to specific planets in the solar ststem. Then, we are saying: $r=\pm(1-e^2+e.e).(Kc/W^2)^{1/3}$. Note that the first factor, $(1-e^2+e.e)$ is always = 1, and that while the second factor $(Kc/W^2)^{1/3}$ is always the same for a given planet, it is different for each of the planets, because the variable W changes from planet to planet. Thus, the equilibrium distances of the planets, under Kepler's 3rd law are all different and so they cannot all be equal to 1. When you multiply 2 factors together, one of which is 1, the value of the product is that of the other factor This explains why the equilibrium distances in the solar system are all different even though the equilibrium distances in part of the expression are

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The above explanation seems to me to afford a way of; by adjusting the unit values of the components of one of the parameters in a multi-parameter expression to 1 when the expression equals 1, we can simplify calculation of that expression. An example of this idea is given on the next page. Page 42. I think that a much more satisfactory calculation system could be established for use in the solar system by arranging: "unit" Kc = "unit" mass of the sun = "unit" radius of equilibrium rotation of the earth about the sun = 1. Then, since $W^2.r^3= Kc$, then W^2 X 1 = 1 so "unit" W would have to be 1. Equivalent values for all of the above parameters could then be expressed in termas of the above units, thus simplifying calculation as shown on p. 42. We need a "metric" system for astronomy.

KEPLER'S SECEND LAW IS INVALID.

Kepler's second law, restated in modern terms is: "The planets sweep out equal areas in equal intervals of time".
Therefore, they must sweep out equal areas in unit time.
But the area swept out in unit time is r.W. But r.W is angular velocity $V_\perp$.
Thus, a conclusion of the second law is that angular velocity is constant around the orbit.

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Now, if we look at fig. B on p. 39 and the accompanying legend on p. 40, we see that for a mass entering the dust cloud at r= infinity with a velocity V = 1, in the plane of rotation of the cloud, and at an angle θ with the line from the point of entry, through the cg. of the cloud, then $V_\perp = \sin\theta = e$ and $V_\parallel = \cos\theta$.
Furthermore, we see that, at the equilibrium distance where r=1, then $V_\perp = \sin\theta + 1$ and $V_\parallel = \cos\theta - 1$.
Obviously, since $a_\parallel$ is reversed at both perihelion and at aphelion, where r = e-1 and e+1 respectively, then $V_\parallel$ must be 0 and $V_\perp$ must be 1 at those points.
Thus $V_\perp$ must vary from sin θ +1 = e+1 at equilibrium (r=1), through (e+1)-1 = e = sin θ, to both perihelion (r=e-1) and aphelion (r=e+1).
Thus the angular velocity (r.W), that is $V_\perp$, cannot be constant around the orbit, but must vary through a range of sin θ = e.
Thus, the second law must be invalid.

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Kepler can hardly be blamed for his invalid conclusion, for the following reasons:
Tico had only three planets, Venus, Mars and Jupiter, on which to make measurements at the time and he is said to have made most of them on the most accible planet, Venus, which unfortunately has the lowest eccentricity of all of the planets, (.007), which is nearly circular.
While Tico's equipment and techniques were a great improvement on what went before, the GPE of his measurements is still said to have been about six minutes of arc.
If Venus' orbit had been circular (e=0) and not of eccentricity only .007, then the variation in r.W would have been zero and the 3rd law would have been correct.
Thus, the GPE of Tico's measurements masked the small range in eccentricity which he had to distinguish, to properly state the law.
He was a victim of the limited technology of his time.
What is amazing are his titanic achievements with such limited information.

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It was shown in fig. 1F8 that for con-focal iso-energetic (elliptic) oscillation, r must be 1-e.(e-x), so the equation of the above defined oscillation must be: $r = 1-e^2+ex$.

AN ILLUSTRATION OF THE WAY IN WHICH, BY ADJUSTING THE UNIT VALUES OF ALL OF THE RELATED PARAMETERS IN A FUNCTION, TO UNITY, CAN SIMPLIFY CALCULATION OF THAT FUNCTION.

Kepler's 3rd law tells us that $W^2.r^2 = Kc/r = E_\perp$ per unit mass at the equilibrium distance, for all of the planets and their satellites in the solar system. Thus, $E_\perp$ at equilibrium for any planet, say P1 = Kc(sun)/r(planet1), $E_\perp$ for plane = Kc(sun)/r(planet2), etc.

Thus, if we designate Kc(sun) nominally = 1 and r(planet1) = 1 then $E_\perp$ planet1 =
Note, that by establishing unit values for Kc of the sun (the primary) and of 1 for r for planet 1 we have automatically established a unit value for $E_\perp$ for planet1 under Kepler's 3rd law.

Consider now, another planet2 who's mass is M_2 compared to planet1's mass and who's equilibrium distance is r_2 compared to planet1's r = 1.
Then $E_\perp$ planet2 would = Kc(sun)/r(planet2) = $1/r_2$ in units of $E_\perp$(planet1), which
Similarly $E_\perp$ planet3 = Kc(sun)/r(planet3), $E_\perp$(planet4)=Kc(sun)/r(planet4), etc.
Thus, by establishing interelated unit values, for the parameters determining $E_\perp$ for any one of the planets (in this case planet1), we have established a units system for comparing $E_\perp$ for all of the planets in the solar system.
We have established in pages through that the Kc of any primary in the solar system is linearly proportional to it's mass, so Kc(sun)/Kc(planet) = M(sun)/M(planet) = 1/MPlanet. So when Kc(sun) = 1 then Kc(planet) = M(planet).
Then we can calculate the Kc for all of the planets in the solar system according to the formula: Kc(planet) = m(planet).Kc(sun)/M(sun) =m(planet).1/1
Having done this, we can then calculate $E_\perp$ for all of the planets and all of their satellites in the system according to the formula:

$E_\perp$(satellite1) of planet1 = M(planet1)/r(planet1).r(satellite1).
$E_\perp$(satellite2) ofplanet1 = M(planet1)/r(planet1).r(satellite2).
$E_\perp$ satellite3) of planet1 = M(planet1)/r(planet1).r(satellite3). etc.
$E_\perp$ satellite1) of planet2 = M(planet2)/r(planet2).r(satellite1) of planet2.
$E_\perp$(satellite2) of planet2 = M(planet2)/r(planet2)/r(satellite2) of planet2. E

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Knowing r for all of the satellites and after calculating their individual $E_\perp$ then, if those satellites had further satellites around them (which does not occur in the solar system), we could nevertheless calculate $E_\perp$ for them.
This observation is not as way out as it might seem. At this satge we cannot rule out rotary systems of higher order than 2, in the nucleus so the device may yet prove useful. Note, that we have established a units system for rotary systems of any degree, just by establishing related units for the mass of the highest primary and it's Kc together with a unit equilibrium radius of rotation for one of the highest order satellites, according to Kepler's 3rd law.
Note also, that we can do away with the Kepler constant, which has no fundamental significance in the mechanics of Mass Systems. It is merely a correction factor which introduces itself into the calculations if we do not set the correct relationships between the units of the parameters involved in the function involved, (in this case Kepler's 3rd law.)

A NEW THEORY CONCERNING THE OBSERVED PHENOMENON KNOWN AS "GRAVITATION".

It was shown in the introduction that the existing theory of gravitation fails to satisfactorily explain many existingly observed gravitational phenomena. In view of this fact a more satisfactory theory relating to these phenomena is clearly required and I believe that the contents of the work above and in the appended material affords the basis for such a theory.

An outline of this theory is presented below. The assertions made there being justified above. This outline will be worded for application to a two mass system but will be seen to be of universal application.

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AN OUTLINE OF THE NEW THEORY REGARDING GRAVITATIONAL PHENOMENA.

In my opinion the basic trouble involving the old theory of gravitation lies in the first law of motion.

Newton stated: " A body continues in a state of rest or of uniform motion in a straight line unless it is acted upon by some external impressed force to change that state".

He then went on to formulate the second law as: "The time rate of change in momentum is proportional to the impressed force and takes place in the direction in which that force acts".

In view of this formulation of the second law, in my opinion he could with more power and symmetry have stated the first law in some form such as:

"The momentum of a mass is conserved unless it is acted upon by some external impressed force to change that momentum".

He could then have rounded the laws off as: "For any change in momentum there is an equal and opposite change in momentum".

This would not only have been a more consistent statement of the laws; it would also have been an elegant statement of the law of conservation of momentum, which he obviously understood but never overtly articulated.

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There is no evidence to show that Newton ever formed the concept of rotational momentum but we know that his laws apply equally to both linear and rotational momentum.

I point out at this stage that there is no evidence, experimental or otherwise has ever been produced indicating that masses, when not under force, do move in straight lines. The idea is intuitive but has never been experimentally demonstrated. In fact, for the law of conservation of rotational momentum to hold it is necessary to conclude that no force is required to change the direction of a mass's motion, as set out below.

The law of conservation of rotational momentum implies that NO FORCE IS REQUIRED TO MAINTAIN ROTATIONAL MOMENTUM.

Since the direction of motion is constantly changeing during rotation, the inescapable conclusion is that NO FORCE IS REQUIRED TO CHANGE A MASS'S DIRECTION OF MOTION. THEREFORE A BODY DOES NOT HAVE TO MAINTAIN A UNIFORM MOTION IN A STRAIGHT LINE UNLESS IT IS ACTED UPON BY SOME EXTERNAL IMPRESSED FORCE.

Anybody who argues that force is required to change direction of motion will have trouble explaining where the energy is coming from to maintain uniform rotational motion.

Furthermore, for the laws of conservation of "linear" and "rotational" monentum to hold at the same time, "linear"momentum and hence "linear" velocity must mean the same thing as "instantaneous tangential" momentum and hence "instantaneous tangential" velocity.

The conclusion must follow that any mass, rotating in a two mass system, when unaffected by external force, does not follow a straight line but that it's direction must remain at right angles to the instantaneous radius of rotation about the other mass. Therefore it must be continually changeing.

Therefore, Newton's original statement of his First Law of Motion: "A body continues in a state of rest or of uniform motion in a straight line ...." is not a valid statement of the laws of nature as we see them.

A more accurate formulation would be: "The momentum of a mass is conserved unless it is acted on by some external impressed force to change that momentum".

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If this postulation is accepted it will be realised that no force is required to maintain uniform rotational motion and consequently no force, gravitational or otherwise is required to maintain the planets in their observed orbits around the sun;- their uniform orbits are simply the result of the application of the law of conservation of momentum/energy.

****

If M.V. is constant = C, then $V = C/M$ so $V^2 = C^2/M^2$.
Also $\frac{1}{2}.M.V^2 = \frac{1}{2}.M.C^2/M^2 = C^2/(2.M)$ = another constant = K.
Of course this means that if momentum remains constant, then energy must also remain constant, and thus any law implying conservation of momentum must also imply conservation of energy.
As about fifty years elapsed between Thomas Young's conception of energy and Meyer's and Helmholtz' independent enunciations of the law of conservation of energy, it is surprising how long it took for this fact to sink in.

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From the above, it is obvious that planetry motion is simply the result of the operation of the law of conservation of momentum/energy. No gravitational attraction being required to keep the planets in their orbits. Two masses in equilibrium, orbiting each other about their common center of gravity will simply move so as to keep their angular momentum/energy relative to each other constant. Their equilibrium distances from their common center of gravity will depend, as seen from Kepler's third law, upon their rotational kinetic energy per unit mass, and be in the inverse ratio of their respective masses, but will remain constant as long as their rotational momenta/KEs relative to each other do not change. In this case $r_1/r_2 = C.M_2/M_1$
This is born out by observation; all of the planets maintain constant average distances from the CG. with their primary while at the same time maintaining constant angular momenta/energies relative to that primary.

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So far we are not yet looking at the entire picture regarding planetry motion since we have only dealt with rotational motion. That is motion at right angles to the instantaneous direction from the common CG. to the masses as they rotate.
We know from vector mechanics that any instantaneous vector in the plane of a rotation can be resolved into two instantaneous vector components; one along the instantaneous radius of rotation called the radius vector or the central vector and designated $V_{//}(t)$, and one at right angles to the radius

vector and in the plane of the rotation called the rotational vector and designated $V_\perp$ (t).

The angular momentum comes entirely from the component of velocity that is perpendicular to the radius vector; the component parallel to the radius vector contributes nothing to the angular momentum.

The component parallel to the radius vector entirely determines the linear momentum along the radius vector while the component perpendicular to the radius vector contributes nothing to the linear momentum.

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We must now deal with the component of planetry velocity parallel with the radius vector and the motion which it induces.

This velocity $V_{//}$ is at it's maximum at the equilibrium distance. See app. /

The value of this distance is entirely determined by $V_\perp$. (Kepler's third law.)

A simple harmonic oscillation is induced along the radius vector of magnitude $e = V_{//}/V. = \cos\theta$ and of period 1/W. See app. /

Consequently, if we examine the actions of $V_{//}$ and $V_\perp$ at the same time we see that $V_\perp$ is inducing rotational motion about the common cg. of the masses of average radii r_1 and r_2 where $r_1/r_2 = M_2/M_1$, while $V_{//}$ is inducing simple harmonic motions of the masses about their equilibrium distances of magnitudes $e.r_1$ and $e.r_2$ where $e = V_{//}/V = \cos\theta$.

From above it can be seen that the combination of these two motions results in the formation of two con-focal ellipses of average radii r_1 and r_2 where $r_1/r_2 = M_2/M_1$ and with each ellipse being of eccentricity $e = \cos\theta$.

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The above result agrees exactly with what we see in the solar system and elsewhere.

Kepler's First Law of planetry motion, formulated entirely from observational data, states: "The paths of the planets are ellipses with the sun at one focus". Allowing for the observational inaccuracies in his data, it agrees exactly with the above theory.

His second law states: "The planets sweep out equal areas in equal intervals of time". This implies that their instantaneous tangential velocities ($V_\perp$) and consequently their angular momenta are conserved, again as required by

the above theory.
Nowhere can the above theory be demonstrated to be at variance with observation while numerous anomalies have been demonstrated for the current theory of gravitation.

****

It may be argued that while the new theory agrees with astronomical observation it has not yet been demonstrated why the apple falls to the ground when detatched from it's tree. If it is not gravitational attraction pulling the apple to the ground, what is causing it to fall ?.
Fortunately, in this day of artificial satellites it is easier to see what is actually happening in this case than it would have been three hundred years ago, when the current theory of gravitation was formulated.
The apple is falling because it's current angular velocity (1 revolution/day) around the earth at it's current distance (6,400 km) is less than the 16 revolutions/day required to establish equilibrium at that distance. (See sheet M over). An artificial satellite sitting on it's launch pad has the same rotational momentum/unit mass relative to the earth as does the apple lying on the ground (namely 6,400 km.revolutions/day) and if the surface of the earth were not in the way, both would be accelerated toward their equilibrium distances at that rotational momentum/unit mass, namely 1,849 km.
Extra NEGATIVE rotational momentum/unit mass must be imparted to the satellite by it's rocket motors before it is in rotational equilibrium with the earth at 6,400 kms and before it will orbit at that distance.
It should be noted that as both the apple and the satellite (having angular momenta of 6,400 km.revolutions/day) are being accelerated toward their equilibrium distances (without alteration of rotational momenta), r.W must remain constant. Thus, as r is being reduced, W must be correspondingly increased until $r^3.W^2$ equals the Kepler Constant (about 75,000) for the Earth-satellite system in the units used on sheet M , when they would orbit in equilibrium at a distance from their cg.s with the Earth of about 1,800 km and with an angular velocity of about 3.5 revolutions/day.
From these considerations it is no mystery why the apple falls toward the Earth when detatched from it's tree.

If the above is true, why did Newton get his law so wrong ?.

In attempting to explain this, I will hypothesise that in his investigation Newton differentiated the 3rd law equation with respect to r, as I have above: Viz. $W^2.r^2 = C.r^{-1}$ so $d/dr(W^2.r^2) = d/dr(C.r^{-1})$ so $2.W^2.r = -C.r^{-2}$.

He would have recognised $W^2.r$ and $-C.r^{-2}$ as forces although he would not have understood the energy parameters from which they were derived.

Knowing nothing about energy and very little about rotational mechanics he would have recognised $W^2.r$ as a centrifugal force acting parallel, which he coul confirm by, (say) simply swinging a bucket of water on the end of a rope, and -C/r as a centripetal force, also acting parallel and in the opposite direction to the centrifugal force. To establish an equilibrium distance these forces would have to be equal in magnitude and opposite in direction, at that distance, so th centripetal force, $-C/r^2$ must also be acting parallel.

Following correspondence with Robert Hooke*, and according to legend, observing the fall of the apple, he identified this force as that of attraction between the earth and objects above it's surface, which force unquestionable acted paralle Thus his inverse square law of gravitational attraction may have been born.

Because he was dealing with the equality of forces, he assumed that these forces would have to be continually in existance to maintain the equilibrium.

Had he understood the parameters from which these forces were derived, namely, the energies $M.W^2.r^2$ and $M.C/r$ he might have seen that these energies could maintain their values long after the forces determining them have ceased to appl He may then have realised that $-M.C/r$ could represent some force which applied in the past and was no longer in operation, and so did not involve the apparent gravitational attraction, which had to be a continually acting force.

It seems that Newton did not get the magnitude of his force involving an inverse square law wrong but he misinterpreted it's nature and it's direction and did this so convincingly that he set theoretical physics back about 300 years.

* See future work.

It is interesting to speculate that if only a small fraction (F) of this force, (say $F.Kc/r^2$), began acting again today and acted over just one cycle of the oscillation, the work done by this force would be F.Kc/r. Now, the only place from which this energy could come is the potential energy of displacement from infinity, that is F.Kc/r. Thus the residual energy of displacement must be: (1-F).Kc/r. Remember, F is a very small fraction, much Thus insufficient energy of displacement from infinity would be left avaliabl to return the oscillation to it's original equilibrium position before the force operated. Thus a new equilibrium radius of rotation would be establish so that: $r_{2(equilibrium)} = (1-F).(Kc/r)\text{times } r_{1(equilibrium)} = (1-F).r_{1(equibi}$

If this force acted over n cycles, the equilibrium r would be reduced accordingly on every cycle and even if the factor (F) was very small on any given cycle, the accumulated reduction in the equilibrium radius of rotation could be very great if sufficient cycles (perhaps something even approaching infinity) were involved over time.

Of course, this is only speculation, but I think that this senario possibly accounts for the general configuration of the solar and other systems that we see today. The next section will be devoted to trying to refine this speculation. Since space is not a perfect vacuum;- we see various objects and other particulate matter out there, this process might not have yet totally ceased and it might be going on to an unmeasurable extent even today. Summing up the above speculation so far;- Note that the above force equality formula: $W^2.r = -Kc/r^2$ was derived by differentiating the above energy equality formula: $W^2.r^r = Kc/r$, with respect to r, over the range from ∞ to r. At first sight, this result seems to imply that a force of $-Kc/r^2$ is required to induce an energy of displacement of Kc/r OVER ONE CYCLE OF OPERATION. However, since energy in general is cumulative over more than one cycle, it is equally valid to conclude that a force of $(1/n).Kc/r^2$ maintained over n cycles would result in the same cumulative energy change of Kc/r.

....

What could this hypothetical force have been ?.

Well, since all of the galactic systems are assumed to have condensed from a "dust" cloud, the friction from the cloud itself could have been the culprit After the dust cloud was absorbed, the force ceased.

WHY DOES THE APPLE FALL TO THE GROUND WHEN DETACHED FROM IT'S TREE ?.

Attached sheet M shows the observed values of: (1) the equilibrium radius of rotation, (2) the period of rotation, and (3) the associated angular velocity, of the moon and some of the artificial satellites launched and observed in the past. The purpose of this exercise was to determine from these observations, the Kepler Constant (in terms of the units used in the measurements), applicable for Earth satellites. As seen from column 7, the Kepler Constant found was 75,369 X 10^9 in terms of the units used.

Although the apple is not at it's equilibrium distance as listed in row 7, this distance can be used to determine r.W = 6,400 X 1 and the angular Ke = $r^2.W^2$ = 40.96 X 10^6 . We can then use this angular Ke to determine the equilibrium distance for this angular Ke per unit mass as follows:

The Kepler constant, as determined for earth satellites = $W^2.r^3$= 75,369 X 10^9 = $W^2.r^2$ X r. = 40.96 X r, from which r = 75,369 X 10^9/ 40.96 X 10^6 = 1.849 X 10^3 Km = 1.849 km.

Since the apple is rotating at 1 revolution per day at it's present distance of 6,400 Km and r_1W_1 must equal r_2W_2 so 6,400 X 1 must equal 1,849 X W_2 so W_2= 6,400/1,489 = 3.46.

Thus, an apple growing on it's tree experiences a force of acceleration tending to move it towatd it's equilibrium distance of 1,893 Km from it's cg. with the earth. However, while it is still growing and ripenimg it is restrained from responding to that force by an equal and opposite force,raised in the stem which is holding it to the tree. After the apple has fully ripened, the stem withers and releases the apple to be accelerated toward it's cg. with the earth and toward it's equilibrium distance at it's current angular Ke, until it's progress is interrupted by the surface of the earth and so is brought to a satadstill again.

Note, that if the body of the earth were not in the way, the apple would have been moved right down to it's equilibrium distance (1,849 km.) where the acceleration (a (force$_{ll}$) would become zero. Note also, that this force is not zero at the CG, but becomes zero at the equilibrium distance, and like all forces of displacement, is developed linearly from it's zero point. Thus, a_{ll}= C X the displacement from the equilibrium distance, where C is the constant of displacement.

I claim that the abovedescribed force is that causing all masses, when released from above the earth's surface, to fall to the ground; no force of attraction between masses, as described by Newton, nor any other force, being required to account for this phenomenon. The cause of the above force is fully described above, while Newton, despite being constantly asked, was never able to describe why masses attracted each other and indeed was never able to devise a laboratory experiment to demonstrate masses actually attracting each other and he made no attempt to correct these deficiencies in the Principia.

On the other hand, the present author has devised a repeatable experiment capable of donvincingly demonstrating that masses, even when in very close proximity, fail to attract each other.

SHEET M

The following data on Earth-satellite orbits has been accumulated from various sourced. The low-Earth orbit data is obviously less accurate than the rest and so has been deleted from the derived average of K but it still generally confirms the average result.

ORBIT TYPE.	Average radius of rotation. r.	Period of rotation.	W in rotations per day.	r^3	W^2	$r^3.W^2$ = K= The Kepler constant for the Earth-satellite system in the units used at left.	
Lunar	385,728 Km.	27.32 side-rial days.	1/27.32 revs./day	57,391.82 X 10^{12}	$\frac{1.3397}{10^3}$	76,886 X 10^9 in the units used at left.	
Synchronous	42,158 Km.	1 revolution per day.	1 rev./day.	74,927 X 10^9	1	74,927 X 10^9	
Semi. synchronous.	26,610 Km	12 hrs.	2 revs./day	18,842 X 10^9	4	75,369 X 10^9	Average value of K for the above three readings is 75,727 X 10^9
Low Earth orbit.	About 6,700 Km.	About 1.5 Hrs.	About 16 revs/day.	About 300.76 X 10^9	256	76,994 X 10^9	The data here is less accurate so deleted from avge
Apple	About 6,400 Km	1 day.	1 rev/day.	About 262.14 X 10^9	1	Postulated value of K for apple's equilibrium orbit is the average of above = 75,727 X 10^9 or near value.	

If r.W for the apple is taken as 6.4 X 10^3 then $r^2.W^2$ must be 40.96 X 10^6.
But $r^3.W^2$ must equal 75,727 X 10^9 so r = 75,727 X 10^9/(40.96 X 10^6)
= 1.849 X 10^3 Km = 1,849 Km.

As equilibrium is established without change in energy r.W is constant = 6,400
so W at the equilibrium distance of 1,849 Km is 6400/1849 = 3.46 revolutions/day

THE KEPLER CONSTANT VARIES LINEARLY WITH THE MASS OF THE PRIMARY.

In the following investigation the mass of the Earth is taken as unity while the masses of the other primaries are taken as multiples of this mass. The attached sheets 111, 112, 113 and 114 give the distances, periods and derived Kepler Constants for the satellites of the sun, the Earth, Mars, Jupiter, Saturn, Uranus, Neptune and for the Earth launched Geostationary satellite. These figures show that for:

The Sun: Kepler constant/mass			= 6/332,000	=.000018
The Earth	"	"	= .000018/1	=.000018
Mars	"	"	=.0000015/.11	=.000014
Jupiter	"	"	= .0057/316	=.000018
Saturn	"	"	= .0017/94.9	=.000018
Uranus	"	"	= .00026/14.7	=.000018
Neptune	"	"	= .00032/17.2	=.000018
Geostationary Earth satellite.	"	"	= .000018/1	=.000018

Only the two satellites of Mars do not totally agree with all of the other above results, however these two satellites are very small and difficult to observe while my data on them is over sixty years old. Thus it is almost certain that the discrepancy here is due to innaccuracy in my data.

I consider that the above figures clearly demonstrate that the Kepler constant is linearly proportional to the mass of the throughout the solar system. This even applies the Titan which is retrograde.

d in millions of miles. P in days. M in Earth masses. 111

The SUN.

	d	d^2	d^3	P	P^2	$\frac{d^2}{P^2} = d^2\omega^2$	$\frac{d^3}{P^2} = d^3\omega^2$
M	35.96	1293.12	46,500.7	87.969	7738.35	0.167	6.009
V	67.20	4515.84	303,464.4	224.7	50,490.1	0.08944	6.01037
E	92.96	8630.41	801,765.1	365.256	133,411.94	0.06469	6.009
M	141.6	20050.56	2,839,159.2	686.98	471,941.52	0.04249	6.016
J	483.3	233,578.9	112,889,240	4329	18739377	0.01246	6.024
S	886.2	785,350.4	695,77558M	10,727	[illegible]	0.006593	6.020
U	1783 M	3.179809M²	5.668 M⁴	30,245	915 M	0.003473	6.19
N	2794 M	7.784 M⁴	21.7488 M⁶	60,147	3624 M	0.00214	6.08
Ceres	257.1	66,100	16894415	1681.6	2827815.5	0.02334	6.009
The Earth	EARTH						The mass of the Earth is 1.
M	.23886	.057054	.013628	27.32	746.38	.0000764	.000018
Mars.	MARS						The mass of Mars is .11
P	.0058	.000036	.0000001	.318	.101336	.000355	.000001
D	.0146	.000213	.000003	1.2625	1.5939	.000133	.0000015

This is the SUN's Kepler constant.

The SUN's mass is 331,950 times the mass of the Earth so if we divide the SUN's Kepler constant by the mass of the sun we get:

6.01/331,950
= .000018
which is the Earth's Kepler constant.

This is the Earth's Kepler constant.
= .000018/1
= .000018.

This is approximately MARS' Kepler constant.
= .0000015/.11
= .000014

d in millions of miles
P in DAYS. M in Earth masses.

MASS OF PRIMARY = 316

	d	JUPITER d^2	d^3	P	P^2	$\frac{d^2}{P^2} = d^2\omega^2$	$\frac{d^3}{P^2} = d^3\omega^2$	
F	·1126	·0127	·00143	·496	·2460	·0516	·0058	Mass of JUPITER=316.
I	·2618	·0686	·0178	1·77	3·133	·0219	·0057	
E	·4166	·1736	·0723	3·552	12·62	·0138	·0057	← This is the Kepler Constant for Jupiter in the units used.
G	·6642	·4411	·2930	7·1554	51·2	·0086	·0057	
C	1·169	1·367	1·598	16·688	278·5	·0049	·0057	
S_i	7·114	50·61	360·03	250·66	62,830·4	·0008	·0057	Kepler constant for JUPITER divided by the mass of JUPITER =
S_{ii}	7·292	53·173	387·74	260·04	67,621·8	·00079	·0057	.0058/316=
T	7·34	53·87	395·45	264	69,696	·00077	·0057	.000018 in the units used. This is the Kepler constant for the EARTH
E_2	14·0	196	27·44	692	478,864	·00041	·0057	
E_1	14·6	213·16	3112·1	739	546,121	·00039	·0057	
N	14·9	222·01	3308	758	574,564	·00039	·0057	
	URANUS.			Mass of URANUS 14.7				This is the Kepler constant for Uranus.
M	·081	·00656	·00053	1·42	2·02	·0032	·00026 ←	The Kepler constant for
A	·119	·014	·0017	2·52	6·35	·0022	·00026	URANUS divided by the mass
U	·166	·0275	·0046	4·15	17·2	·0016	·00026	of URANUS = .00026/14.7
T	·272	·074	·020	8·71	75·86	·0010	·00026	= .000018.
O	·364	·132	·048	13·46	181·17	·0007	·00026	Again we have derived the KEPLER constant for for the

d in millions of miles. P in days. M in Earth masses.

SATURN. Mass of Saturn 94.9

	d	d^2	d^3	P	P^2	$\frac{d^2}{P^2} = d^2\omega^2$	$\frac{d^3}{P^2} = d^3\omega^2$	
M	.115	.013	.00175	.941	.886	.015	.0017	This is the Kepler constant for Saturn in the units used.
E	.148	.022	.0032417	1.371	1.88	.0117	.0017	
Te	.183	.0335	.00613	1.8875	3.56	.0094	.0017	The Kepler constant for Saturn divided by the mass of Saturn = .0017/94.9 = .000018 in the units used.
D	.234	.055	.013	2.723	7.415	.0074	.0017	
R	.327	.107	.035	4.517	20.40	.0052	.0017	
Ti	.759	.576	.437	15.946	254.3	.0022	.0017	This again is the Kepler constant for the Earth.
H	.920	.846	.778	21.275	452.63	.0019	.0017	
I	2.210	4.884	10.794	79.330	6293.3	.00078	.0017	
P	8.034	64.54	518.56	550.0	302,500	.00021	.0017	

Neptune.

	d	d^2	d^3	P	P^2	$\frac{d^2}{P^2}$	$\frac{d^3}{P^2}$	
N	3.446	11.8749	40.92	360	129600	.000092	.00032	This is the Kepler constant for Neptune.
T	.22125	.04895	.011	5.88	34.57	.001416	.00032	Mass of Neptune is 17.2 so .00032/17.2 = .000018 as above.

I find it a bit unexpected that the only retrograde satellite in the solar system also obeys the 3rd law and the primary-mass relationship.

Artificial Geostationary Earth Satellite.

.0263	.00069	.000018	1	1	.00069	.000018	This is an Earth satellite and as required has the same Kepler constant as the moon.

All of the other artificial satellites for which I have data also obey the third law but there is not enough room to include them here.

AN EXAMINATION OF THE FORCES REQUIRED TO KEEP AN ISOLATED SINGLE MASS IN THE SAME ELLIPTIC ORBIT AS THE ORBITS OF THE INDIVIDUAL MASSES IN A TWO MASS SYSTEM.

As a starting point, I observe that since the orbits have to be idintical, the tangents to the curves have to be in the same direction at the same points in both cases.

Refering to Fig. Q:

The angle of rotation at C was found as $\tan\theta = (1-e^2)^{\frac{1}{2}}.(1-(x-e)^2)^{\frac{1}{2}}/x$.

$\tan\alpha = d/dx.(1-e^2)^{\frac{1}{2}}.(1-(x-e^2)^{\frac{1}{2}} = -(1-e^2)^{\frac{1}{2}}.(x-e)/(1-(x-e^2))^{\frac{1}{2}}$.

The angle of the tangent is alpha.

$\tan(\theta-\alpha) = \dfrac{\tan\theta - \tan\alpha}{1+\tan\theta.\tan\alpha}$. was found according to calculation sheet Q.1 as $\tan(\theta-\alpha) = \dfrac{(1-e^2)^{\frac{1}{2}}((1-(x-e)^2)^{\frac{1}{2}} - x^2+ex}{x(1-(x-e)^2)^{\frac{1}{2}} - (1-e^2)^{\frac{1}{2}}((1-(x-e)^2)^{\frac{1}{2}}(x-e)} = \dfrac{V_\perp}{V_\parallel}$.

It will be observed that $V_\perp$ which is represented by the numerator in the above expression involves three different powers of the variable x, so it cannot be constant around the orbit as is the case with the two mass system where $V_\perp = (1-e^2)^{\frac{1}{2}}$ and so is constant.

Similarly, $V_\parallel$ which is represented by the denomenator in the above expression, is vastly different from $V_\parallel = e.(1-e).(1+\cos\theta)/(1-e\cos\theta)$ in the two mass system

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The above result clearly indicates that a totally different velocity regime, and consequently a totally different force regime is required to keep an isolated single mass in elliptic orbit than is required to keep the masses in a two mass system in the same orbits.

The only force required to maintain the masses in a two mass system in stable orbit is that maintaining the simple harmonic oscillation about the equilibrium distance, which distance is constant because of the constant rotational KE relationship between the two orbiting masses. Note that this force is internally generated and then dissipated over the rotational cycle of the masses. An isolated single mass obviously has no rotational partner and thus no rotational KE relative to one and so has no equilibrium distance relative to one.

Note too, that since no mass system exists to generate internal forces, any force applied to the mass must be EXTERNALLY applied.

The forces maintaining the orbit of an isolated single mass would have to be externall impressed according to Newton's laws.

FIG Q.

THIS FIGURE SHOWS THE FORCE REGIME REQUIRED TO KEEP A SINGLE ISOLATED MASS IN THE SAME ELLIPTIC ORBIT AS THE ORBITS OF THE MASSES IN A TWO MASS SYSTEM.

θ is the angle of rotation at C. Alpha is the angle of the tangent at C.

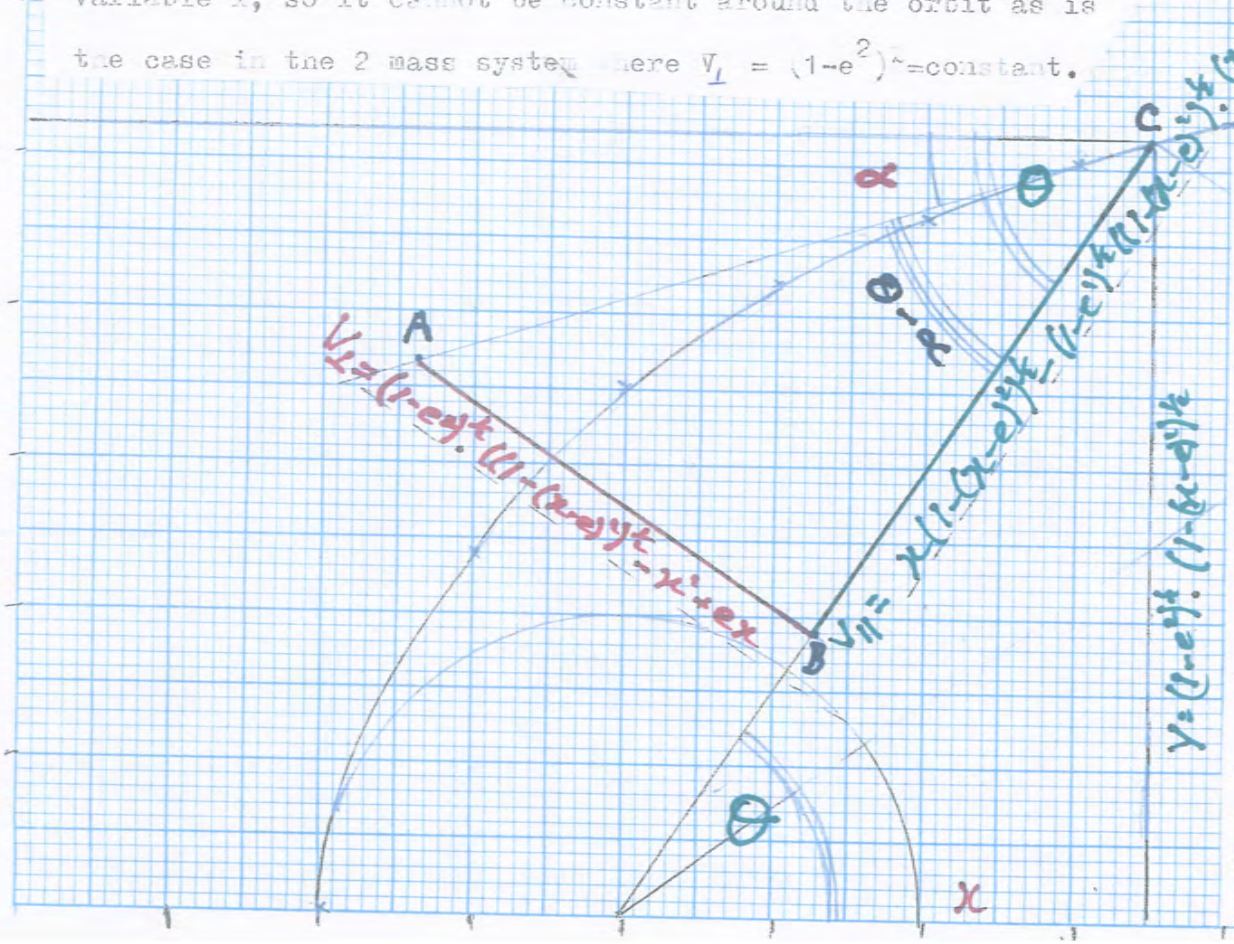
$\tan\theta = (1-e^2)^{\frac{1}{2}}.(1-(x-e)^2)^{\frac{1}{2}}/x.$ $\tan\alpha = d/dx.(1-e^2)^{\frac{1}{2}}.(1-(x-e)^2)^{\frac{1}{2}}.$

$\tan(\theta-\alpha) = \frac{\tan\theta - \tan\alpha}{1+\tan\theta.\tan\alpha}.$ $\tan\alpha = -(1-e^2)^{\frac{1}{2}}.(x-e)/(1-(x-e)^2)^{\frac{1}{2}}.$

$$\tan(\theta-\alpha) = \frac{(1-e^2)^{\frac{1}{2}}.(1-(x-e)^2)^{\frac{1}{2}} - x^2 + ex}{x(1-(x-e)^2)^{\frac{1}{2}} - (1-e^2)^{\frac{1}{2}}.(1-(x-e)^2)^{\frac{1}{2}}.(x-e)} = \frac{V_\perp}{V_\parallel}.$$

It will be seen that $V_\perp$ involves three different powers of the variable x, so it cannot be constant around the orbit as is the case in the 2 mass system where $V_\perp = (1-e^2)^{\frac{1}{2}}$=constant.

SINCE THE ORBITS HAVE TO BE THE SAME IN BOTH CASES THE TANGENTS TO THE CURVES HAVE TO BE IN THE SAME DIRECTIONS IN BOTH CASES AT THE SAME POINTS ON THE CURVES ALTHOUGH THE FORCES AT THESE POINTS MIGHT BE DIFFERENT.



At left it will be seen that a totally different velocity, and hence a totally different force regime is required to keep an isolated single mass in elliptic orbit than would be required to keep the masses in a two mass system in the same orbits. This is because a single mass has no rotating partner with which to maintain an equilibrium distance, consequently an extra externally impressed force must be applied to do this job. This force in turn alters the values of $V_\parallel$ required to maintain the orbit. I think that these facts have great significance regarding the dynamics of multi-mass systems.

1mm Squares

Calculation sheet for fig. q.

The angle of rotation at any point C is θ. $\tan\theta = (1-e^2)^{\frac{1}{2}}.(1-(x-e)^2)^{\frac{1}{2}}/x$.

The angle of the tangent at C is α. $\tan\alpha = d.(1-e^2)^{\frac{1}{2}}.(1-(x-e)^2)^{\frac{1}{2}}.dx$.

$y = (1-e^2)^{\frac{1}{2}}.(1-(x-e)^2)^{\frac{1}{2}}$ LET $w = (x-e)$ $dw/dx = 1$

$y = (1-e^2)^{\frac{1}{2}}(1-w^2)^{\frac{1}{2}}$ LET $Z = (1-w^2)$ $dz/dw = -2w = -2(x-e)$

$y = (1-e^2)^{\frac{1}{2}}(Z)^{\frac{1}{2}}$ LET $y = (1-e^2)^{\frac{1}{2}}Z^{\frac{1}{2}}$ $dy/dz = \frac{(1-e^2)^{\frac{1}{2}}}{2Z^{\frac{1}{2}}}$

$dy/dx = dy/dz \cdot dz/dw \cdot dw/dx = \frac{-2(x-e)(1-e^2)^{\frac{1}{2}}}{2(1-w^2)^{\frac{1}{2}}} = -\frac{(1-e^2)^{\frac{1}{2}}(x-e)}{(1-(x-e)^2)^{\frac{1}{2}}} = \tan\alpha$

$$\tan(\theta-\alpha) = \frac{\tan\theta - \tan\alpha}{1+\tan\theta.\tan\alpha}$$

$$= \frac{\dfrac{(1-e^2)^{\frac{1}{2}}(1-(x-e)^2)^{\frac{1}{2}}}{x} + \dfrac{(1-e^2)^{\frac{1}{2}}.(x-e)}{(1-(x-e)^2)^{\frac{1}{2}}}}{1 - \dfrac{(1-e^2)^{\frac{1}{2}}(1-(x-e)^2)^{\frac{1}{2}}.(1-e^2)^{\frac{1}{2}}(x-e)}{x.(1-(x-e)^2)^{\frac{1}{2}}}}$$

$$= \frac{\dfrac{(1-e^2)^{\frac{1}{2}}\{(1-(x-e)^2) + x(x-e)\}}{x(1-(x-e)^2)^{\frac{1}{2}}}}{1 - \dfrac{(1-e^2)^{\frac{1}{2}}(1-(x-e)^2) + x^2 - ex}{x(1-(x-e)^2)^{\frac{1}{2}}}}$$

$$= \frac{(1-e^2)^{\frac{1}{2}}\{(1-(x-e)^2) + x(x-e)\}}{x(1-(x-e)^2)^{\frac{1}{2}} - (1-e^2)^{\frac{1}{2}}(1-(x-e)^2).x.(x-e)}$$

AN HIPOTHESIS ON THE INFINITELY PERIODIC MOTION OF THE SUN, INDUCED BY IT'S PLANETS.

I have long suspected that the sun and it's planets are reacting with each other through their common centers of gravity, to adjust their distances and hence their respective angular velocities in order to establish and/or tomaintain, some kind of dynamic equilibrium within the solar system. Bode's Law gives a clue to this hypothesis which I will now try to further develop. 55

I point out several pertinent facts bearing on this hypothesis, these are:

1). The sun is in rotational motion along with it's nine planets which are rotating with different periods and at different distances, so it is receiving through it's common centers of gravity with those planets, nine different rotational inputs of various magnitudes and frequencies, from them.

2). THE SUN CAN ONLY BE IN ONE PLACE AT ANY GIVEN TIME WHILE THE DIFFERENT INPUTS ARE REQUIRING IT TO BE IN NINE SLIGHTLY DIFFEREN PLACES AT THE ONE TIME.

3). A logical consequence of condition 2., that is: the source of a moveable force acting on an immoveable object, is the forced movement of the moveable sourse.

4). Thus, if the nine separate periodic inputs from the planets were incompatible with some infinitely periodic motion of the sun under condition 2, it might be possible under condition 3, for the sun, acting through it's common centers of gravity with the individual planets, to adjust their rotational distances (principle of moments) and consequently their angular velocities, in order to establish an iinput regime comensurate with an infinitely periodic motion of the sun, thus stabilising the situation.

5). The condition for the establishment of an infinitely stable regime is that all of the input frequencies must be INTEGRAL MULTIPLES of some basic frequency.

....

While the figures on the following two pages do not establish with 100% certainty this hypothesis, they indicate with a very very high probability that this is what has actually happened. Since all of the planets' common CG_s with the sun are not coincident, the siderial planetry frequencies as measued from the sun would be different from those as measured from the earth. As those as measured from the sun are required to validate the series below and these are not available, I had to use those as measured from the earth. This fact could account for the fact that the frequencies listed below are not EXACT multiples of the basic frequency as would be required to definitely establish the validity of the hypothesis.

55B

TABLE 6

	PERIOD (yrs.) = P	W = I/P	W/W(Jupiter)	W / .0842985 X 42.	Departure from whole number.
P	253.9826	.0039372	.046707	2.0162	.0162
N	164.7913	.00607	.072006	3.0243	.0243
U	84.0169	.011902	.141931	5.9300	.0700
S	29.4477	.03396	.402854	16.9204	.0794
J	11.8626	.0842985	1.0000	42.0000	.0000
C				708.21	
M	1.8809	.53166	6.3069	264.90	.1000
E	1.0000	1.0000	11.862	498.12	.1200
V	.6152	1.6255	19.28	809.81	.1400
M	.2408	4.1528	49.24	2069.06	.0600

The gas giants account for 99.5% of the total mass of the planets

Jupiter alone accounts for over 71% of the total mass so it largely determines what the sun is doing. If it were the only planet the sun's motion would be easy to calculate.

The probability that the ~~six~~ five deviations at left are due to chance is somewhere near 1 in 500,000.

Average deviation from unity = .07

Jupiter's period was used as a starting point in determining the relative angular velocities of the other planets.

Average deviation from unity of the 4 inner planets = .105 which is more than for the giants. This is difficult to explain but may be due to their iron cores which may be being effected by magnetic affects seen on the surface of the sun.

These planets account for less than .5% of the total planetary mass so they play a relatively small part in determining the motion of the sun.

At this stage I believe that the Fourier Series set out below very closely approximates the infinite periodic motion of the sun around it's common CGs with the planets. This motion is the result of the combined motions of those planets according to the principle of moments AND as required by Kepler's laws. My reason for this belief is the proximity of the frequencies of all of the planets to whole numbers, as set out in column 4 of table 6. Only if these relative frequencies were whole numbers could the series depicted be infinitely periodic. I point out that under the conditions prevailing in the solar system this series cannot exactly represent the solar motion because all of the common CGs are not coincident. However, since the sun is so much more massive than the planets, the distances from the sun to the common CGs are greatly less than the distances from the planets to their corresponding CGs so this condition cannot have a great effect, so that the series very probably represents a close approximation to the sun's motion. It may even be that this condition accounts for the small variations from whole numbers of the frequencies seen in column 4 of table 6.

$$f_{SUN}(t) = .002\cos 2\omega t + 17.2\cos 3\omega t + 14.7\cos 6\omega t + 94.9\cos 17\omega t + 316.94\cos 42\omega t + .11\cos 265\omega t +$$

(Pluto's contribution; Neptune's contribution; Uranus' contribution; Saturn's contribution; Jupiter's contribution; Mars' contribution)

$$+ 1\cos 498\omega t + .81\cos 810\omega t + .04\cos 2069\omega t +$$

(Earth's contribution; Venus' contribution; Mercury's contribution)

$$.002\sin 2\omega t + 17.2\sin 3\omega t + 14.7\sin 6\omega t + 94.9\sin 17\omega t + 316\sin 42\omega t +$$

(Neptune'; Uranus'; Saturn's)

$$+ .11\sin 265\omega t + 1\sin 498\omega t + .81\sin 810\omega t + .04\sin 2069\omega t$$

(Mars'; Earth's; Venus'; Mercury')

The coeficients in the above series represent the relative masses of the various planets and hence the relative magnitudes of their contributing oscillations.

Since Jupiter is over 70% of the total mass of the planets it is the major contributor to the above series and since Jupiter's frequency is close to 21 times that of Pluto the frequencies in column 3 of table 15 have all been multiplied by 42 in order to get rid of the frequencies shown as less than 1 in column 3. This constant multiplier does not alter the relative ratios of the frequencies listed. ω in this case = the frequency of Jupiter/42 while the unit of time (t) = the period of Jupiter (11.8626 yrs) times 42= 498.2292 years.

AN ATTEMPT TO REMEDY SOME OF THE DEFICIENCIES IN KEPLER'S LAWS.

Kepler's laws are of no help in determining the motions of isolated single masses when subject to externally impressed forces but do have at least limited validity in relation to the solar system (which is of course a mass system) where only internally generated cyclic forces are involved. While they do accurately describe some aspects of planetary motion, they do not, for example include the cyclic oscillations seen about the equilibrium distances in all masses in the system. These motions had not been identified in Kepler's time. In view of this, I consider that a closer look at Kepler's laws (after 400 years), with a view to amendment and extension thereto may be appropriate. The following should be regarded as a halting first attempt to update the laws so that they agree more closely with observation.

****

In attempting to produce a more satisfactory group of statements to overcome the abovementioned problem I will begin by listing a group of short and simple statements which together more closely describe what we see happening in the solar system. These are:

1). Each planet is rotating with constant angular momentum about it's common center of gravity with the sun which is also rotating with the same equal angular momentum about the same center of gravity.

2). While rotating each planet is also oscillating along the rotating diameter connecting it with the sun, about an equilibrium distance from their common center of gravity, while the sun is also performing a similar oscillation.

3). The equilibrium distances of each of the planets are inversely proportional to their rotational KEs per unit mass relative to the sun.

4). The periods of the above oscillations are equal to each planet's period of rotation.

5). The amplitude of the oscillation of each planet relative to it's equilibrium distance, (known as the oscillation factor), is determined by the ratio of it's linear momentum ($V_{\parallel}$) at the equilibrium distance, to it's total momentum ($V_{\parallel} + V_{\perp}$), at that distance.

6). The combined motions of each of the planets result in it's path being that of an ellipse of average radius from one focus of that ellipse being the equilibrium distance as defined above and of eccentricity equal to the above defined oscillation factor.

In the solar system, all of the satellites of the sun are seen to be rotating about an axis which is approximately parallel with the axis of rotation of the sun while at the same time they are orbiting at close to the plane of the ecliptic. In view of this fact I believe that two more hypothetical "laws"should be provisionally attached to the above list. These"laws" were previously detailed during the investigation. These are:

1). "Barnett's Law". When masses have second or higher order of rotation relative to a mass with first order rotation about some axis, the axes of rotation of the masses with higher order rotation will rotate so that they align themselves with the axis of first order rotation and so that the sense of the rotation is the same in all cases, about that axis.

2). A second law of higher order rotation might be stated as follows: When masses have higher order of rotation relative to a mass with first order rotation about some axis, and after the axes of rotation of these masses with higher order of rotation have aligned themselves with the primary axis of rotation according to "Barnett's Law", the PLANES OF ROTATION of these masses with higher order rotation will also align themselves with the plane of rotation of the primary mass.

****

I make no claim that the above list in any way constitutes a definitive set of statements defining the actions of internally generated forces on multimass systems. They are only listed as a first step in trying to understand this daunting subject.

********** *

While, as pointed out above, Kepler's laws are of no help whem dealing with the actions of externally impressed forces on isolated masses, Newton's laws have, to date, been of limited use when dealing with the effects of internally induced forces in multimass systems. For example, they are not able to explain or to give a derivation for the two hypothetical "laws" listed above on this page. It might be that a different dynamic approach to the understanding of multimass problems could profitably be considered.

ON THE POSSIBLE NEED FOR A NEW APPROACH IN THE APPLICATION OF DYNAMICS TO MASS SYSTEM

It was seen on page 39 that a totally different force regime is required to keep a single isolated mass in elliptic orbit than that which is required to keep the masses in a two mass system in the same orbits.

Furthermore, it was seen that the only force required to keep the two masses in a two mass system in stable orbit was internally generated and then dissipated over the system cycle while the forces needed to maintain an anattached mass in the same orbit as seen in the two mass system, have to be externally impressed.

In view of these observations it might be concluded that mass systems in which internally generated stabilising forces operate during an overall stable cycle as seen in fig. (1.K), etc. may require a different analytical approach to that in those cases where single isolated masses are subject to externally impressed forces, and which are accurately dealt with according to Newton' Laws.

It may be that the realm of dynamics could be profitably divided into two sections the first one dealing with the actions of externally impressed forces on single masses according to Newton's laws, and with application in macro-technology, etc. while the second section deals with cases where internally generated forces operate on multimass systems, and with application to the investigation of those systems.

The second section may take the form of a much expanded list of working hypotheses derived through experiment and testing, augmenting the list on pages 39 AND 40.

I suspect that this, much expanded list will become necessary before significant progress can be achieved in the dynamic and structural understanding of such mass systems as atoms, mollecules, galaxies etc.

Why cannot laboratory scale mass systems be generated and tested in space ?.

THE RANGE OF REALITIES AND HENCE THE DOMAINS OF CONICS FOR VARIOUS VALUES OF e.

Con-focal equidimensional conics can be expressed in rectangular coordinates as follows: Whichever is real.

$$y = (\pm(1-e^2)^{\frac{1}{2}} . (\pm(1-(x-e)^2)^{\frac{1}{2}}.$$

Consider first the case where e = 0. $y^2 = 1.(1-x)^2 = \pm(1-x^2)$.

Thus the locii are confocal circles centered on the origin and of unit radii.

The domaine of this function is from -1 to +1.

****

In the case where $0 < e < 1$, then $+(1-e^2)^{\frac{1}{2}}$ is ALWAYS real, while $+(1-(x-e)^2)^{\frac{1}{2}}$ is real in the range: $x=(e-1)$ to $x=(e+1)$ and from $x = -(e-1)$ to $x = -(e+1)$.

Since both factors must be real to produce a real product, the ellipse is real only within these ranges in x.

****

When $e > 1$, only $-(1-e^2)^{\frac{1}{2}}$ is real, while only $-(1-(x-e)^2)^{\frac{1}{2}}$ is real when x is in the range between $-(e-1)$ and - infinity and between $+(e-1)$ and + infinity.

Thus the hyperbola is real only within the ranges $x = \mp(e-1)$ to $\mp$ infinity.

****

That is, the domaine of the ellipse is from $\pm(e-1)$ to $\pm(e+1)$ while that of the corresponding hyperbola is from $\mp(e-1)$ to $\mp$ infinity.

This indicates that, not only do the forms of the functions change as e passes through 1 but also that the signs of the domains change also. That is, the domaine of say the mainly right hand side ellipse in fig 1e would become the mainly left hand side hyperbola and vice versa, if the value of e passed through 1. This observation will be seen to be of significance later in the discussion.

****

In polar coordinates $r = \pm(1-e^2+ex) = \pm(1-e^2)/(\pm(1-e\cos\theta))$. See fig. 1e.

We come now to the case where e = 1.

In this case $(1-e^2)$ must be zero unless $(1-e\cos\theta)$ is infinity, because $\cos\theta$ cannot be greater than 1. Thus r must be zero for all values of θ.

Thus the domains of confocal conics when e = 1 must be circles of zero radius about the origin so they must be coincident points at the origin, of no dimension.

****

Later in the discussion it is shown that the angle of the assymptotes in the hyperbola is given by: $\theta = \sec^{-1} e$. Thus when e = infinity, $\theta = \cos^{-1}(1/e)$ $= \cos^{-1}(1/\text{infinity}) = \cos^{-1}0^\circ$ so $\theta = 90^\circ$.

Since the distance from the origin to the intersection of the hyperbola with the x-axis is $\pm(e-1)$, the locii of the conics when e = infinity are straight lines parallel to the y-axis and at distances of (infinity - 1) on either side of the origin. *********

The above conclusions indicate that the transitional form between the ellipse and the hyperbola, (that is, when e=1), is a dimensionless dot at the origin. If this is true, where does that conclusion leave the tradionally accepted transition form;- the parabola ?. This question will be examined now.

****

THE TRANSITIONAL FORM BETWEEN THE ELLIPSE AND THE HYPERBOLA.

(The parabola versus the dot at the origin.)

First of all it should be noted that all parabolas represent quadratics of the form: $y = A.x^2 + B.x + C$ which by axial transformation can be converted to $y^2 = 4.d.x$.

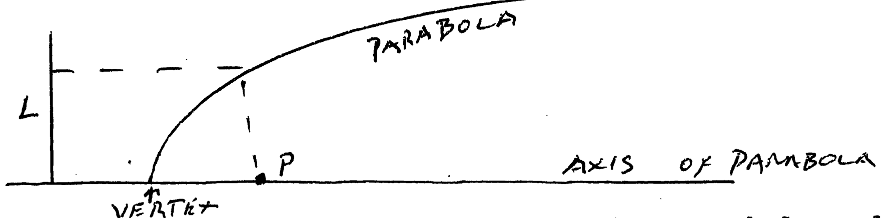
On the other hand as seen above, all conics can be represented by the equation:

$y = (\pm(1-e^2)^{\frac{1}{2}}.(\pm(1-(x-e)^2)^{\frac{1}{2}}.$ This form is certainly not a quadratic.

Why does the parabola seem to be the transitional form ?.

To see this, let us look at the way parabolas are defined and developed.

The figure below shows a line L and a point NOT ON THIS LINE.



The point P is called the focus of the parabola and the line L is known as the diectrix of the curve.

The locus of points equidistant from P and L is known as a Parabola.

The line through P and perpendicular to L is known as the axis of the parabola.

The point at which the axis intersects the curve is called the vertex.

If we place the origin at the vertex and the focus at some non zero coordinate d we can derive the formula $y^2 = 4.d.x$ and every parabola of the form $y = A.x^2 + B.x + C$ can be converted by transformation to the form $y^2=4dx$.

For all this to be validly deducible P must not be on L or the square on the hypotenuse of a right angled triangle would have to be equal to the square on ONE of it's sides.