

OF COURSE THERE MUST BE EXTRASOLAR PLANETS
THAT HAVE RETROGRADE ORBITS.

By Frank Lee, geologist
102 Mill Street, Ballarat 3350, Victoria, Australia.
Tel: 03 53316938. www.franklee-geologist.com
26th. October, 2010.

Introduction. Having proved a few years ago, to my satisfaction if not to others, and after determining some forty planetary relationships over sixteen years, relationships which had to exist if the hypothesis was true in fact, that the Single Body Breakup Origin of our Solar System really did explain the formation of our Solar System, I concluded that to be true it must be applicable to extrasolar systems. So I began a study of the increasing data being published on that subject. But partly because the data was too sparse and too approximate, and partly because I did not then realise the variability that could ensue concerning the development of solar systems, I dropped the study and turned to other interests.

A casual mention in a letter from an astronomer in mid-2010, that attention had focused on a recent discovery of an extrasolar planet moving with retrograde orbit rotation to normal, brought me reluctantly back to that field of study. It was clear to me that this phenomenon could be used as another test of my Origin of Breakup. Two minutes of thought gave why such a phenomenon must, at least occasionally, occur. It has taken considerably longer to put the evidence down on paper. This is mainly due to boredom due to the simplicity of the problem and partly for the inevitable, unpleasant reaction to it by “experts”. The evidence follows.

Preamble. As readers, if any, of this paper will not have any knowledge of the Breakup theory it is necessary to give an outline of the step-by-step formation of our Solar System as given by Body Breakup.

The first two steps are hypothetical. A rotating mass of “dusty” gas began to form into a more compact body by inside-to-out collapse. Collapse was not radial as generally assumed for easy calculation but by inward spiralling of the material and thus retained its contained angular momentum. An ellipsoidal body gradually formed, with the greater density particles (the “dust”) slowly concentrating about a focal point. There is some evidence for the latter part of this statement.)

A stage was reached when the rotating gas reached escape velocity at the pericentre and the weakening at this point resulted in the ellipsoidal core moving forcefully outwards along the a-axis. The vastly greater mass of gas, due to the sudden change of its moment of inertia factor that this escape caused, catastrophically collapsed to give our Sun. The ejected “brown” body, which of course had an offset core, moved outwards to an orbit distance of 5.3AU from the Sun, where it went into orbit about that body. For how long this “brown” body orbited the Sun, its core continuing to differentiate, is not known but from this stage onwards to the Present the breakup can be fairly precisely given.

The rotating, orbiting, prolate-ellipsoidal “brown” body gradually lengthened until it reached what is known as the Jacobi Bifurcation Point shape. The body then broke into two, an inert largely coreless mass (Saturn) and a larger mass (protoJupiter) with a large, well-differentiated core. Determine the mass ratio for the two bodies and compare it to the Jacobi ideal gas separation ratio and note how near the two values are to one another: approximately 22:78.

The “brown” body/Sun force field was a closed field so we have the present-day formula $M_J/M_S = \text{orbit-distance}_S^2 / \text{orbit-distance}_J^2$ for Jupiter/Saturn. When the “brown” body split into two, because it was not pure gas (it had a core), its division resulted in a slightly different total

force than before splitting. Adjustment *had* to take place to correct for this difference, and adjustment could only be adequately done by the core in the body of protoJupiter. The adjustment was simple: it did this by breaking up its impure core into a “silicate” sphere and a “heavy gaseous” sphere touching each other at the centre of protoJupiter, the first to the forward part of the body and the second to the rear. This internal breakup had to obey Newton’s Third Law. The division resulted in the collapse of the outer gasses of protoJupiter, causing an impulse force at the centre of protoJupiter. The direction of impulse at the centre had to be along the line of least resistance, and that was along the line joining the inner spheres. In a series of impulses – division/collapse, division /collapse – the various lesser bodies of our now System formed and were ejected, beginning with the satellites and ending with Neptune/Venus-Mercury. (See elsewhere on my website for the step-by-step sequence with proofs.) The order of ejection was strictly mathematically controlled, and only ceased when force equality was obtained.

When final force equality was reached the planets moved out to their mathematically required orbits – those that exist to-day. The whole ejection sequence, including tilts and rotations can be determined using simple physics and elementary mathematics. (Except for the tilt of Mercury and the rotations of Mercury and Venus , which two bodies collided while moving out from protoJupiter. None-the-less their rotations can be used to determine the rotation of Neptune.) The sequence also explains why the rotations and tilts of Jupiter and Saturn are mathematically related by formulae quite different to those for the ejected bodies.

At first glance it may appear that Uranus, Neptune, and Pluto, suffering a rearwards impulse, should orbit about the Sun in the opposite direction to that of the “silicate” bodies. However, their ejection speeds, being slower than that of protoJupiter, means that they still move about the Sun in the same direction as the “silicate” bodies. Only if the ejection speed of a rear-ejected body exceeds the orbit speed of protoJupiter about the Sun would it have so-called retrograde orbit.

If such a simple development of origin as given above did give our Solar System it can be safely presumed that most(?) extrasolar systems also formed in the same way. The development should be able to account for retrograde orbiting.

Planet	Mass (10x24 kg)	Radius (km)	Orbit Speed (km.sec ⁻¹)
Mercury	0.33	1429	47.9
Venus	4.87	6050	35.0
Earth	5.98	6378	29.8
Mars	0.64	3396	24.1
(protoJupiter)	2101.11	74007	12.9
Uranus	86.6	26150	6.8
Neptune	103	24750	5.4
Io	0.0892	1829	17.98
Moon	0.0375	1738	16.05
Europa	0.487	1560	14.10
Ganymede	0.149	2640	11.16
Titan	0.136	2560	9.88
Callisto	0.106	2400	8.41

The above table gives the planetary values used in this paper. They are those used in my earlier Solar System studies and may vary marginally from those now accepted in astronomical

circles. The differences do not materially affect the conclusions reached. Triton, Pluto, Charon, and “Asteroid” have been omitted. They hardly affect the results.

First Case.

It has been stated above that the ellipsoidal protoJupiter/Saturn “brown” body, when it turned into orbit about the Sun had its silicate/“icy” core at the forward focal point of the body. Though possibly rare, the core just may have been in the rear. In such a case, and assuming that protoJupiter broke up to give our present planets in the same order, then the planets would have taken up quite different speeds of orbit. These speeds and their orbit distances from the Sun must be determined.

In this case Jupiter would have suffered movement *away* from the Sun and Saturn a movement *towards* the Sun. Jupiter, as we have it now, moved 0.1 AU inwards after breakup (5.3 → 5.2 AU) so that we can say that in this first case Jupiter would have moved outwards to about 5.45 AU. Using the formula developed in an earlier paper,

$$\text{i.e., } M_j/M_s = AU_s^2/AU_j^2 \text{ we have } AU_s = (568.6/1899 \times 5.45^2)^{1/2} = \mathbf{2.98 \text{ AU}}$$

Using the approximate formula $v = (GM/d)^{1/2}$, where in our present Solar System for Jupiter $v = 13.1 \text{ km.sec}^{-1}$ and $d = 5.2 \text{ AU}$ we obtain for GM a value of $13.1^2 \times 5.2 = 892.37$. Assume this value for GM pertains to this first case. Then for Jupiter $v_j = (892.37/5.45)^{1/2} = 12.80 \text{ km.sec}^{-1}$ and for Saturn $v_s = 892.37/2.98)^{1/2} = 17.30 \text{ km.sec}^{-1}$.

Remembering that breakup of protoJupiter in our normal case at 5.3 AU ($v = 12.9 \text{ km.sec}^{-1}$), then for the lesser planets:

<u>Planet</u>	<u>Present orbit speed (p.o.s)</u> km.sec ⁻¹	<u>Ejection speed</u> (12.8 - p.o.s)	<u>Reversed orbit speed case</u> (ejection speed – 12.8)
Neptune	← 5.4	← 7.4	20.2 ←
Uranus	← 6.8	← 6.0	18.8 ←
		(p.o.s – 12.8)	
Mars	← 24.1	← 11.3	1.5 ←
Earth	← 29.8	→ 17.0	4.2 →
Venus	← 35.0	→ 22.2	9.4 →
Mercury	← 47.9	→ 35.1	22.3 →

Using the present convention of anticlockwise orbit rotation being normal, then Neptune, Uranus, and Mars have normal direction. And as the speeds of Neptune and Uranus are greater than that of Jupiter then they would move inwards towards the Sun. Mercury, Venus, and Earth have clockwise orbit rotation, i.e., have reverse direction, and in the case of Mercury it, also, would move in towards the Sun. Venus and Earth, however, would move outwards, away from the Sun. This case therefore supports the contention that orbits of planets may be either anticlockwise or clockwise. However the following should be pointed out. Remembering that Jupiter’s speed is 12.8 km.sec^{-1} and Saturn’s is 17.3 km.sec^{-1} , it is probable that Uranus would collide with or be captured by Saturn; while Venus could suffer from its nearness of orbit to Jupiter and become a satellite of it or be thrown out into space. As for Earth, its speed is 4.2 km.sec^{-1} clockwise and of Mars 1.5 km.sec^{-1} anticlockwise and these slow speeds and opposition would result in collision within protoJupiter, resulting perhaps in a larger, slower-moving body or a fragmented (as yet not solid) Mars. If the former, a slightly larger Earth, having orbit movement in opposition to normal, would orbit about the Sun almost as distant from the Sun as is present Pluto.

So it would appear that a reverse orbit should sometimes be expected. But as I stated at the

beginning of this first case, I believe it to be a rare, if at all, event.

Second Case.

In this case we take the breakup as for our “normal” case but consider the effect that an impulse force 2X that which actually occurred would have on the planets’ final orbit speeds. The number 2 is probably unlikely but is used to exaggerate the final values in order to give emphasis to the changes that can occur to the movements of the various bodies. The changes are determined as follows:

<u>Planet</u>	<u>Present Orbit Speed</u> km.sec ⁻¹	<u>Ejection Speed</u> {(Orbit speed -12.9)x2 + 12.9}
Mercury 82.9 ←	← 47.9	{(47.9 – 12.9)x2 + 12.9} =
Venus 56.1 ←	← 35.0	{(35.0 – 12.9)x2 + 12.9} =
Earth 46.7 ←	←29.8	{(29.8 - 12.9)x2 + 12.9} =
Mars 35.3 ←	← 24.1	{(24.1 – 12.9)x2 + 12.9} =
12.9}		{(12.9 – Orbit speed)x2 –
Uranus ←	← 6.8	{(12.9-6.8)x2 - 12.9} = 0.7
Neptune →	← 5.4	{(12.9-5.4)x2 - 12.9} = -2.1

It is clear from the calculated figures that in this case Mars would occupy the orbit of present Venus, Earth of Mercury, and Venus nearer to the Sun than Mercury. Mercury almost certainly would be drawn into the Sun; and probably Venus also. Of the gaseous bodies Uranus, while having an anticlockwise orbit speed, the speed value is so low that the body would pass into the outer reaches of the Sun’s influence. Neptune though, while it would orbit well beyond that of present Pluto, if its orbit was stable it would have clockwise rotation, i.e., would orbit in opposition to the other bodies.

Third Case.

Adding the “silicate” planets and satellites Mercury/Venus/Earth/Mars/IO/Moon/Europa to form one sphere gives a mass of 12.031×10^{24} kg and a radius of 8133.91km. Adding the gaseous/“icy” bodies Neptune/Uranus/Ganymede/Titan/Callisto gives a mass of 189.99×10^{24} kg and a radius of 32105 .08 km. (Note the ratios $Mass_G / Mass_s = 15.79$ and $Radius_G / Radius_s = 3.95$. We therefore have the $15.79/3.95^2 = 1.014$, i.e., within 1.36% of what Newton’s Third Law requires.)

The sums of the impulses on the two sets of planets are approximately: “Silicate”, $[(0.33x(47.9-12.9) + 4.87x(35.0-12.9) + 5.98x(29.8-12.9) + 0.64x(24.1-12.9) + 0.0892x17.98 + 0.735x16.05 + 0.0487x14.10)]x10^{24} = 230.877x10^{24}$ kg.km.sec⁻¹. “Gaseous”, $[86.6x(12.9-6.8) + 103x(12.9-5.4) + 0.149x11.16 + 0.136x9.88 + 0.106x8.41]x10^{24} = 1304.66x10^{24}$ kg.km.sec⁻¹.

The velocity of ejection for the “silicate” sphere would then have been approximately $230.877/12.031 = 19.19$ km.sec⁻¹ and for the “gaseous/“icy” sphere approximately

1304.66/189.991 = 6.87 km.sec⁻¹.

And, if again, we consider an impulse force 2x that which acted on the gaseous/"icy" body we have $12.9 - 2 \times 6.87 = -0.84$ km.sec⁻¹. Thus the "gaseous" body would orbit slowly clockwise, i.e., have retrograde motion. Would it remain in orbit about the Sun or drift away: what effect would Saturn have on such a slow-moving body passing by?

This case can only be suggestive of a possible opposite rotation occurring in some cases.

Fourth Case.

As given in the preamble of this paper a rotating "dusty" volume of gas began to spirally collapse, inside to out, to form a rotating ellipsoidal body of dominantly gas with an increasing concentration of "dust" (heavy gases to mineral grains) at one of its focal points. A stage was reached when structural instability of this body resulted in the core mass – termed by me the "brown" body – leaving the gas mass. That is to say, it acquired linear velocity. This led to the collapse of the enormously larger mass of gas (due to an abrupt change of its moment of inertia factor) to form the Sun. The "brown" body moved outwards from the Sun to the orbit distance at which its speed about the Sun, i.e., its angular velocity, equalled its velocity of ejection. The system at this stage consisted of our Sun plus one planet. This planet ultimately broke first into two parts; with the larger part internally differentiating and the internal bodies forming in it being ejected.

Note the words rotating (angular momentum), volume (with its implied mass), velocity; all are variables. Thus there must be many end-products in the formation of a solar system. Perhaps only one sun with a planet (I ignore binaries), perhaps with two planets, perhaps only gaseous planets, etc. I shall consider only one of the variables here, viz. the ejection velocity of the "brown" body. Say that it was ejected, not at 12.9 km.sec⁻¹ as in our Solar System but at 17.88 km.sec⁻¹, i.e., at the speed of Ceres. Its orbit distance would have been 2.77 AU and therefore, calculating as in Cases 1 and 3, the orbit distance of Saturn would have been $d_s = (M_j/M_s \times d_j^2)^{1/2} = (1899/568.6 \times 2.77^2)^{1/2} = 5.06$ AU.

Using the approximate formula $v = (GM/d)^{1/2}$, d being for our Solar System 5.2 AU and $v = 13.1$ km.sec⁻¹, then $GM = v^2 \times d = 892.4$ units. Thus for Saturn at 5.06 AU, $v = (892.4/5.06)^{1/2} = 13.28$ km.sec⁻¹.

In our Solar System a formula for orbit speeds of the planets was determined to be closely the speed of Jupiter (actually protoJupiter) $\times 1.23^n$ for powers of +6, +5, +4, +3, +1.5, 0, -1.5, -3, -4, -5; from Mercury out to Pluto. Use in this system's case $v = 17.88 \times 1.23^n$, from +6 to -4, to give the speeds of the planets from Mercury to Neptune, viz., 61.9, 50.3, 40.9, 33.3, 24.4, 17.9 (Jupiter), 13.1 (Saturn), 9.6, 7.8. The ejection velocities of the lesser planets would have been approximately $(X - 17.9)$, X being their individual orbit speeds, i.e., 44.0, 32.4, 23.0, 15.4, and $(17.9 - X)$, 8.3, 10.1 respectively. All have positive, i.e., anticlockwise, orbit directions.

But if the ejection speeds had been 2x these, as in Case 2 then the values would have been 88.0, 64.8, 46.0, 30.8, - 16.6, and 20.2 respectively. Consider only the velocities of Uranus and Neptune. The orbit speeds of these two bodies relative to the sun would have been: for Uranus $17.9 - 16.6 = +1.3$ km.sec⁻¹; for Neptune $17.9 - 20.2 = -2.3$ km.sec⁻¹. That is to say, Neptune would have orbited about the sun in opposition to the other bodies.

Fifth Case. I shall give, here, a final example; one slightly more complex.

Take the case of a collapsing, rotating cloud having the same volume but only half of the "dusty" (non-hydrogen/helium) component as the precursor of our Solar System. Assume its "brown" body core developed in all respects as ours did, but with only half the density, and that

it was ejected to 5.3 AU. Further, this “brown” body broke up into the same number of planets in the same way as for our Solar System, having the same volumes but each having half the density of the comparable bodies, and lastly that the impulsive forces suffered by those planets for ejection was $1\frac{1}{2}$ x that of those that acted on our planets.

It is a simple matter to develop an equation relating the orbit speeds of the equivalent planets of our Solar System to that of the system hypothesised. It is:

For the “silicate” planets: $v_x = 3 \times (v_x - 12.9) - 12.9$;

and for the “gaseous” planets: $v_x = (12.9 - 3 \times (12.9 - v_x))$;

where $v = \text{km}\cdot\text{sec}^{-1}$, $x =$ hypothesised planet, $X =$ the equivalent Solar System planet.

The orbit speeds are then (for the equivalents to our Solar System):

“mercury” = $3 \times (47.9 - 12.9) - 12.9 = +92.1 \text{ km}\cdot\text{sec}^{-1}$

“venus” = $3 \times (35.0 - 12.9) - 12.9 = +53.4$ “

“earth” = $3 \times (29.8 - 12.9) - 12.9 = +37.8$ “

“mars” = $3 \times (24.1 - 12.9) - 12.9 = +20.7$ “

“uranus” = $12.9 - 3 \times (12.9 - 6.8) = -5.4$ “

“neptune” = $12.9 - 3 \times (12.9 - 5.4) = -9.6$ “

The negative values of “uranus” and “neptune” indicate that the two “planets” orbit in opposition to the “normal” (anticlockwise) movement of planets about their suns. The system would therefore have two planets having reverse orbit speeds relative to what has been described in the past as “normal”.

Conclusions. Retrograde orbiting of a planet about a sun can therefore be explained by the Single Body Breakup theory. True, in the examples given above (excluding the Fifth Case) the orbit speeds would appear to be trivial. However, each example uses only one variation of a property that led to the development of our Solar System and there are quite a number of possible variations. For example: gas cloud size, gas cloud angular momentum, the amount of “dust” contamination of the gas cloud, amount of differentiation within the “brown” body, the speed of ejection of the “brown” body from the gas cloud, the differentiation within the “brown” body when its shape reaches the Jacobi bifurcation shape, the impulse force created at the centre of the body by collapsing of the Jupiter/Saturn envelope when the two inner touching bodies are created, and so on.

Of course the total of all the variations that are possible in a developing solar system will not necessarily result in a retrograde orbit appearing. Quite probably most won’t (I haven’t gone into this). However, the study is not to show that “normal” orbiting must exist. It is to show that *retrograde* orbiting not only could exist but that *it will at least appear from time to time throughout the Universe*. And thus it can be said, “Of Course There Must Be Extrasolar Planets That Have Retrograde Orbits”.

(Typing completed on 24th January, 2011.)