This page introduces the complete pdf of the poster entitled:-

"Close-in exoplanets, but none of ours. Guidance from Triton's orbit and the physics of gravitation"

Presented by **Miles Osmaston** in Session **PL2,**

'Exoplanets', convened by Peter Wheatley (Univ. Warwick, UK), Eamonn Kerins (Univ. Manchester, UK), Coel Hellier (Univ. Keele, UK)

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Close-in exoplanets,

Guidance from Triton’s orbit

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but none of ours:

and the physics of gravitation

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Abstract (incl. refs in full)

Some 23% of all orbitally-determined exoplanets orbit their star within $12_{\odot}$, with a clear concentration centred on 10 $R_{\odot}$. The proportion has changed little as numbers grew. Not a matter of detectability but of why they are there at all (Mercury is at 83).

Triton's retrograde orbit invites a reconsideration of the main mechanism of planetary construction. Its immersion in the (56 body) prograde satellite population of the Giant Planets implies [1] that tidal capture had been the mechanism of central body accretion until the arrival of their gas-ice envelopes liquefied their interiors, destroying their tidal attribute and halting Triton's inward motion. Efficient tidal capture required nebular gas-drag during planetary growth, confirmed by the preserved low eccentricities of all except Mercury (so it alone suffered a late giant impact).

The second problem of planetary construction, of long standing [2], is to equip their growth materials with their very high (orbitally prescribed) specific angular momenta relative to that of their rotating star/Sun. Nebular action is the only

conceivable agent for doing this. New insight on the physical mechanism of gravitation [3] leads to the expectation that the Newtonian field of any gravity-retained assemblage is inescapably accompanied by a radial Gravity-Electric (G-E) field, providing a potentially over-riding repulsive force on sufficiently charged nebular ions.

The tangential velocity pattern is then not Keplerian and we show that, in the solar system example, outward G-E field action yields an adequate a.m. growth mechanism within the frame of our new scenario for planetary system formation [3]. Its key feature is that solar/stellar passage through a second cloud gathers cold protoplanetary material whose high opacity permits protoplanetary nuclei to form very close to the star and then be pushed out successively in a G-E driven nebular disc wind, growing by tidal capture of passing objects.

Apparently we see close-in exoplanets soon after their star has left the high-opacity second cloud, exposing them to us and to their star. Now, with no disc wind to drive them outward, they accumulate in number until they vanish by evaporation.

[1] McCord TB (1968) The loss of retrograde satellites in the solar system. *JGR* **73**, 1497-1500.
Counselman CC, III. (1973) Outcomes of tidal evolution. *Ap.J.* **180**, 307-314
[2] Jeans JH (1919) *Problems of cosmogony and stellar dynamics*. Oxford, Clarendon Press. 293p.
[3] Osmaston MF. (2006) A new scenario for forming the Sun's planetary system (and others?): dynamics, cores and chemistry (pt 2). *Geochim Cosmochim Acta* **70**(18S), A465. Goldschmidt 2006, Melbourne, Australia.
— (2009a) A two-stage scenario for forming the Sun's planetary system, with good links to exoplanet findings, arising from new physical insight on the gravitational process. *European Planetary Science Congress, Potsdam, EPSC Abstr.* 4, EPSC-2009.264.
— (2009b) A new, mainly dynamical, two-stage scenario for forming the Sun's planetary system and its relation to exoplanet findings. *EGU Gen. Assy, Vienna. Geophys. Res. Abstr.* **11**, EGU2009-12204.
— (2010) Implementing Maxwell's aether illuminates the physics of gravitation, yielding galaxy dynamics without CDM, high-a.m. planetary systems, and how high-mass stars are built. Abstr # 174. In *JENAM 2010, Lisbon* (ed. A. Moitinho et al) *Abstract Book* (Version 2.0) p.159.
— *(submitted).* What can Triton's retrograde orbit tell us about the Giant Planet interiors and how they acquired their gas/ice envelopes? New implications for gravitation and planetary system construction. *Planetary & Space Science.*

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Introduction

My poster in Session ISM1 earlier this week* explored the consequences of asking a fundamental physical question which seems never to have been asked before; namely, What is the physical mechanism whereby mass-bearing fundamental particles and gravitational assemblages of them generate Newtonian fields around them? **(NOT identical to that now being asked at CERN)**

That was because I reject the 'intrinsic' view of the mass property, believing that physical inquiry demands more rigour. Reasoning set out on that poster led to the expectation that the generation of the Newtonian force must always produce also a positive-body-repelling radial electric field, the Gravity-Electric (G-E) field. That is because the Newtonian field and the Gravity-Electric field emerge as being but facets of a single physical mechanism.

Because of this direct relationship to the Newtonian field, G-E field strength at the surface of an object will depend directly upon the gravitational potential there, being highest (very high indeed) at neutron stars, with white dwarfs second. Earth ionospheric and other evidence extrapolates to about 10 V/m at the solar surface, but

uncertainty is still considerable.

My ISM1 poster inferred the G-E field to be a major mass-loss agent of ionized materials from high-mass stars, but that its relative absence during infall of high-opacity neutral material means it would not significantly impede their accretion in the first place - whereas radiation pressure would.

Here we pursue this result to show how, in a 2-stage new scenario, the actions of the G-E field can resolve serious dynamical problems of solar planetary system construction. These arise in the context of the traditional Kant-Laplace-based Single Contracting Solar Nebula (SCSN) scenario, particularly in its growth-by-random-impact implementation. This has discouraged recognition of observed dynamical features such as prograde spin direction and retained orbit circularity, as having any systematic significance. The problem of prograde spin, but rarely noted, is that vorticity is retrograde in a Keplerian disc.

Above all, SCSN has been powerless to explain the very high orbital specific angular momenta (a.m.) with which growing planets, including exoplanets, need to be equipped, to put them into their observed orbits. [The a.m. of Jovian materials is ~120,000 times solar.] Nebular action of some kind is the only conceivable agent for any resolution of this a.m. problem.

It carries the implication that planetary growth must be completed during the short time (<5 Ma?) that the nebula is present, so that it may also equip all the feedstock material with the requisite a.m. Failure to recognize this simple fact has led to the vast proliferation of solar system models (e.g. the ‘Nice model’) which invoke the continuation of impact accretion for many 10s of Ma. The near-circular orbits of all except Mercury is indeed consistent with completing their construction in the presence of nebular gas-drag.

We show here that, in our 2-stage new scenario, the G-E field offers adequate resolution of this a.m. problem. Progade protoplanetary nuclei form successively very close to the star and each is then pushed outward in a G-E-driven disc wind, proportionately increasing its orbital specific a.m. as the result. The close-in positions of so many exoplanets, referred to in this poster’s title, may thus be set in a unified frame.

* entitled - “How stars grow massive despite radiation pressure, triggering star-bursts; insights from gravitation”. I have its complete pdf available onsite for download into your laptop, if you ask. The same applies to this poster.

Satellites of the SS Giant Planets (GPs):
some important dynamical considerations

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- **Of the 56 which orbit their GP at less than 4 Mkm, all are prograde <u>except retrograde Triton</u>, at 0.35 Mkm.**
- **This betrays (McCord 1968, Counselman 1973) that they are the remaining half(?) of a tidal capture population, which leaves prograde captures in slowly receding orbit but makes retrograde ones spiral much more rapidly inward to coalescence and planetary growth, so are no longer seen.**
- **There is no sign that the GPs, with hot, low-viscosity deep interiors, now have an appreciable tidal attribute, so how did it arise, and when and how did they lose it?**
- **The arrest of Triton's inward spiral, having gathered up some of its brethren as it did so, must be a record of that moment.**
- **The conclusion has to be that <u>our</u> (but not all) GPs must be 'two-stage planets', first being built as 8-18? Earth-mass silicate bodies, with a tidal attribute, subsequently losing that when their massive gas/ice envelopes arrived, liquefying their deep interiors.**

Protoplanetary nebula; dynamical demands for its presence throughout planetary growth

Mean specific orbital angular momentum (a.m.) of SS planetary materials is **>10^5 times** that of solar material (Jeans 1919, Spencer-Jones 1956). As noted in my Introduction, this means that **planetary growth must be essentially completed during the short time (<5Ma?) that nebula is present.**

Nebular gas-drag has two important functions if its density is high enough, both of them due to its **discrimination against higher speed through it:-**

(a) its presence during the first pass around a protoplanet is **necessary** for **systematic tidal capture** such as the GPs display**.** This, in turn, offers a much bigger capture cross-section and **speedier growth** than by impact, favouring **planetary completion within the nebular timescale.**

(b) Near-circular and coplanar orbits preserved by all the planets (bar Mercury) is consistent with their construction in the presence of nebular **gas-drag**. So **only Mercury** (tilted and eccentric orbit, 2/3rds of mantle missing) underwent an out-of-plane post-nebula giant impact (Cameron & Benz 1987, LPSci XVIII). It appears dynamically possible and adequate that <3mass% of those ejecta were prograde-captured by Earth and self-reassembled in orbit as the Moon (Osmaston 2009, EPSC)

Significance of planetary spins

Prograde spins. The 97º tilting of the Uranian axis must have occurred well before nebular departure, giving time for gas-drag to restore its now-circular orbit. If you restore that tilting so that its satellite population behaviour is like the other GPs, you find that **SS planetary spins are systematically prograde** (bar Venus, very slow retrograde - possibly reversed by lots of Mercury impact debris). This speaks of **gravitational nucleation** of the planets, rather than random impact; and of subsequent **growth by tidal capture**, which **preserves the spin direction** if the capture population is a dynamically balanced one.

So my firm conclusion, guided by this well-observed GP evidence, is that, in the Solar System, primary **planetary construction was by prograde gravitational nucleation, with subsequent growth by tidal capture, all during presence of the nebular protoplanetary disc.**

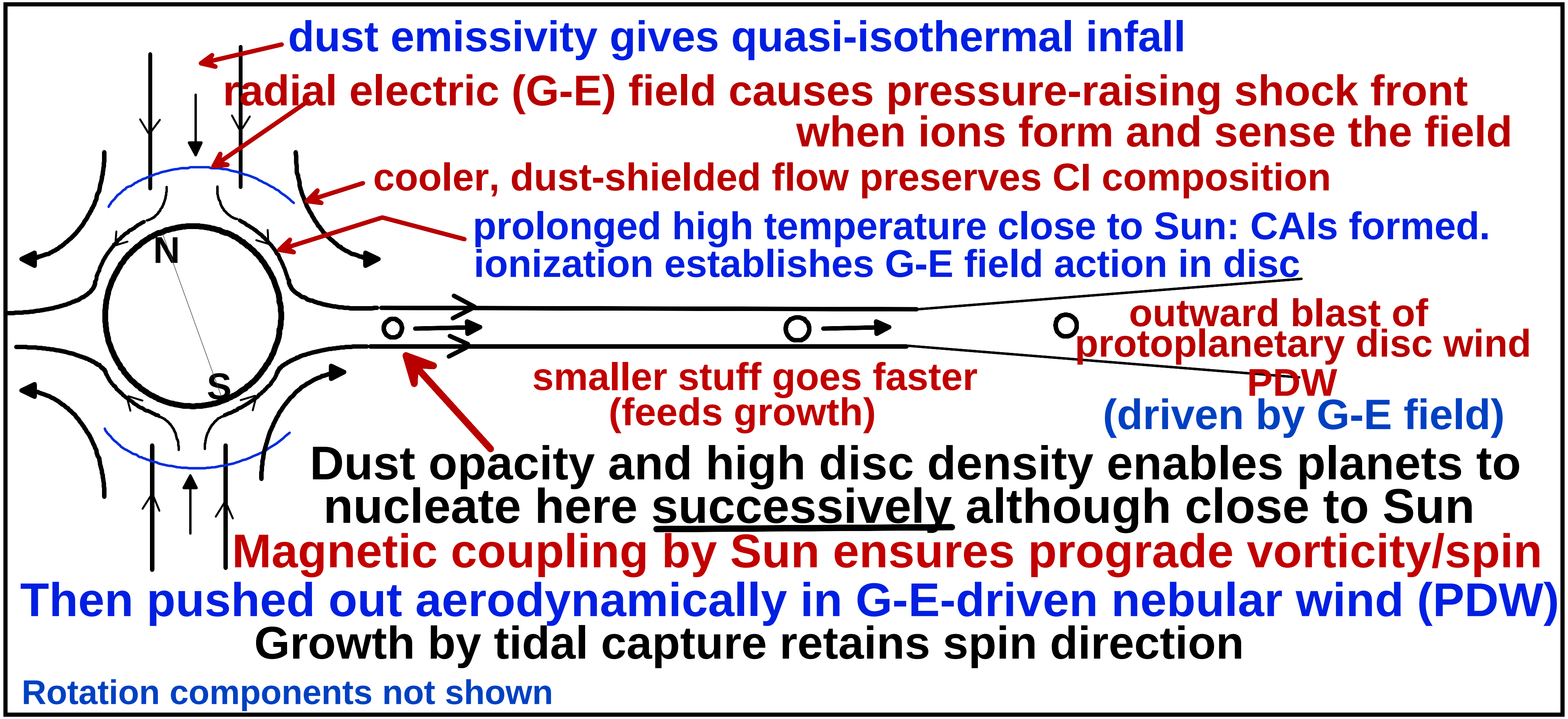
But the **big snag**, noted above, is that in a Keplerian disc, the **vorticity is RETROGRADE**.

So where were they nucleated and acquire their prograde spins? And were the dynamics of the SS protoplanetary disc actually Keplerian?

Osmaston

The 2-stage scenario for building the planets that also achieves their high individual (orbital) angular momenta

The proto-Sun formed (Stage 1) in one dust cloud, and became an already-dense H-burning star. Later (Stage 2) it flew into and through another cloud, with high dust-opacity, from which the planets were formed *and* the outer 2.5% of the Sun's mass (above the tachocline) was added to and not mixed in, so its composition appears to match. The second cloud's initial temperature ~10K or even lower.



Explanation

The primary element in this scenario is the Gravity-Electric (G-E) Field. As noted earlier, it is a positive-repelling radial electric field, inevitably and proportionately associated with generating the Newtonian fields of bodies.

Here, its essential action is discriminatory. Neutral dust infall is unaffected. The critical imbalance causing the pole-to-equator direction of through-put flow is because at low latitude the ionization attained couples the plasma to (centrifugal) torque by the solar magnetic field.

This ionization also makes it responsive to the G-E field, in that, if high enough, the G-E force upon ions will become bigger than the Newtonian one, so nebular particles are radially driven outward as the protoplanetary disc. This transforms the dynamics and velocity pattern in the disc. It is no longer Keplerian! Radial distance grows, without change of tangential velocity, so a.m. grows likewise. If such a dense outward flow is sufficiently ionized, it can aerodynamically entrain neutral and assembled materials, thus constituting the powerful Protoplanetary Disc Wind (PDW).

Gravitational nucleation in the steep gravity field close to the Sun is made possible, despite the Roche constraint, because the G-E force gradient acts in the other direction. The G-E force will also prevent nebular

gas-drag causing rapid inward migration of the nucleation. The radius at which nucleation occurs in the flow will partly be determined by the heat-protection furnished by any remaining or re-formed nebular opacity.

The Sun is a 6-fold slow rotator for its class (Choi & Herbst 1996). If allowance is made for this slowing, attributable to the magnetic coupling to the plasmoid root of the disc, the full relative a.m. values of the individual planets are obtained.

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Exoplanet dynamical features that differ from ours

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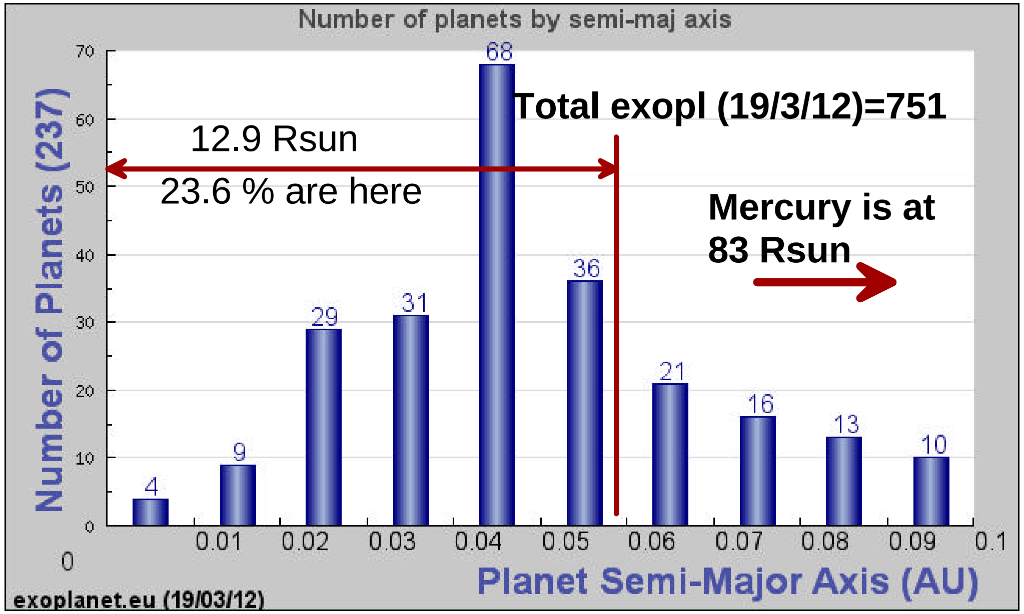
Can they fit our new scenario?

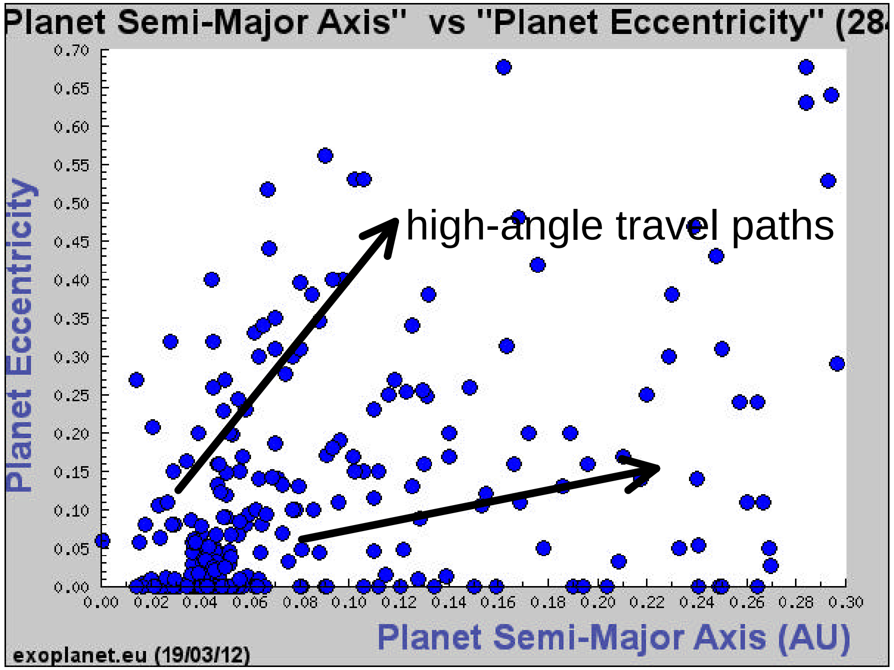
Close-in concentration



Evidently we see exoplanets only after their emergence from the high-opacity protoplanetary source cloud. So in our new scenario the outward G-E-field-driven protoplanetary disc wind (PDW) has ceased, and those close-in at that moment, now exposed to their star, are stuck there, and destined eventually to vanish by evaporation.

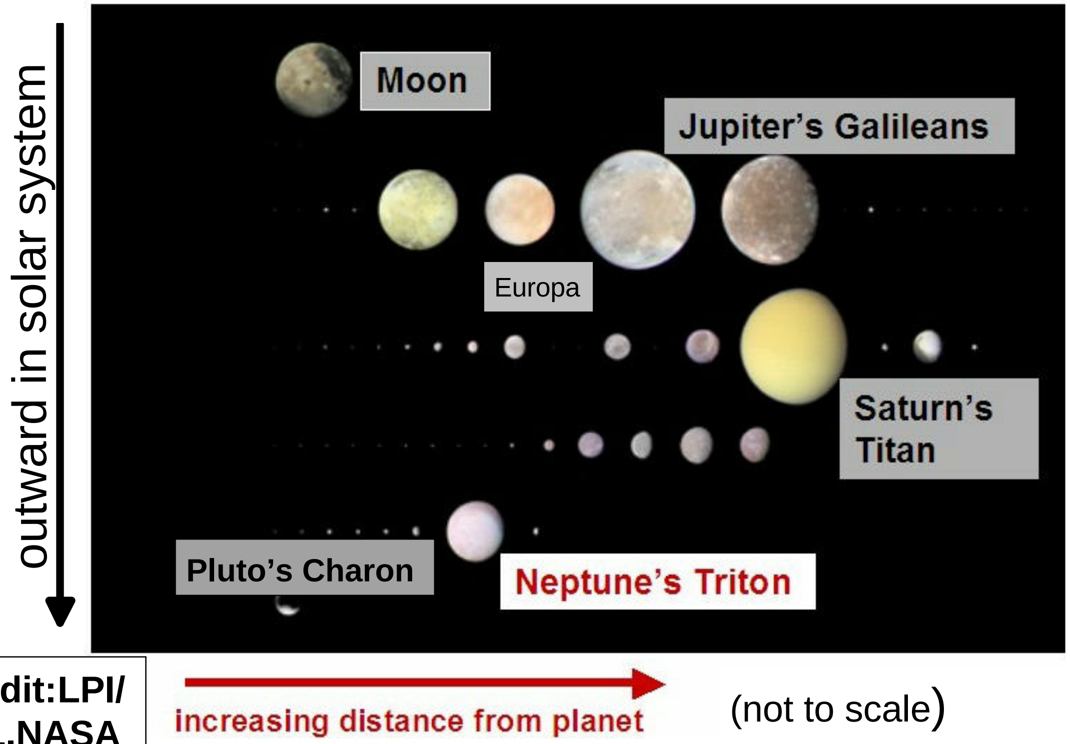
These snapshots of planetary system formation are consistent with nucleation systematically starting in a close-in position, as inferred in our scenario.

Eccentricity growth vs. orbit size



The drawing of our new scenario shows the star axis only slightly tilted relative to the direction of the infall column. If the axis of the star is <u>grossly tilted</u> w.r.t. the direction of travel, infall will be far from polar, the flow path to the near-equatorial disc will be much shorter on one side than the other, and the PDW strength correspondingly asymmetrical, 'puffing' orbiting objects to increasing eccentricity every time around.

High-density materials reached the outer SS



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Credit:LPI/ JPL.NASA (modified)

(not to scale)

This is not expected in the SCSN standard paradigm. But, as recognized here, tidal capture was the means of GP growth, before their massive gas/ice envelopes arrived. So the composition of the remaining prograde population of captures/ satellites is representative of those retrogrades that built up the central bodies. I illustrate that with the well-determined densities of the Solar System's largest satellites.

All those named here have densities >1.6 g/cm^3; Triton is 2.05 g/cm^3. This emphasizes that silicate was not restricted to the inner SS, as also demonstrated by the CAI and chondrule fragments brought back from the Wild-2 comet by the STARDUST mission.

Evidently, the G-E field-driven PDW in our new scenario had ample ability to drive dense materials out to the remoter parts of the SS.

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The final chapter: Solar exit from the second cloud

G-E field-driven radial clear-out of the disc: envelopes for the GPs

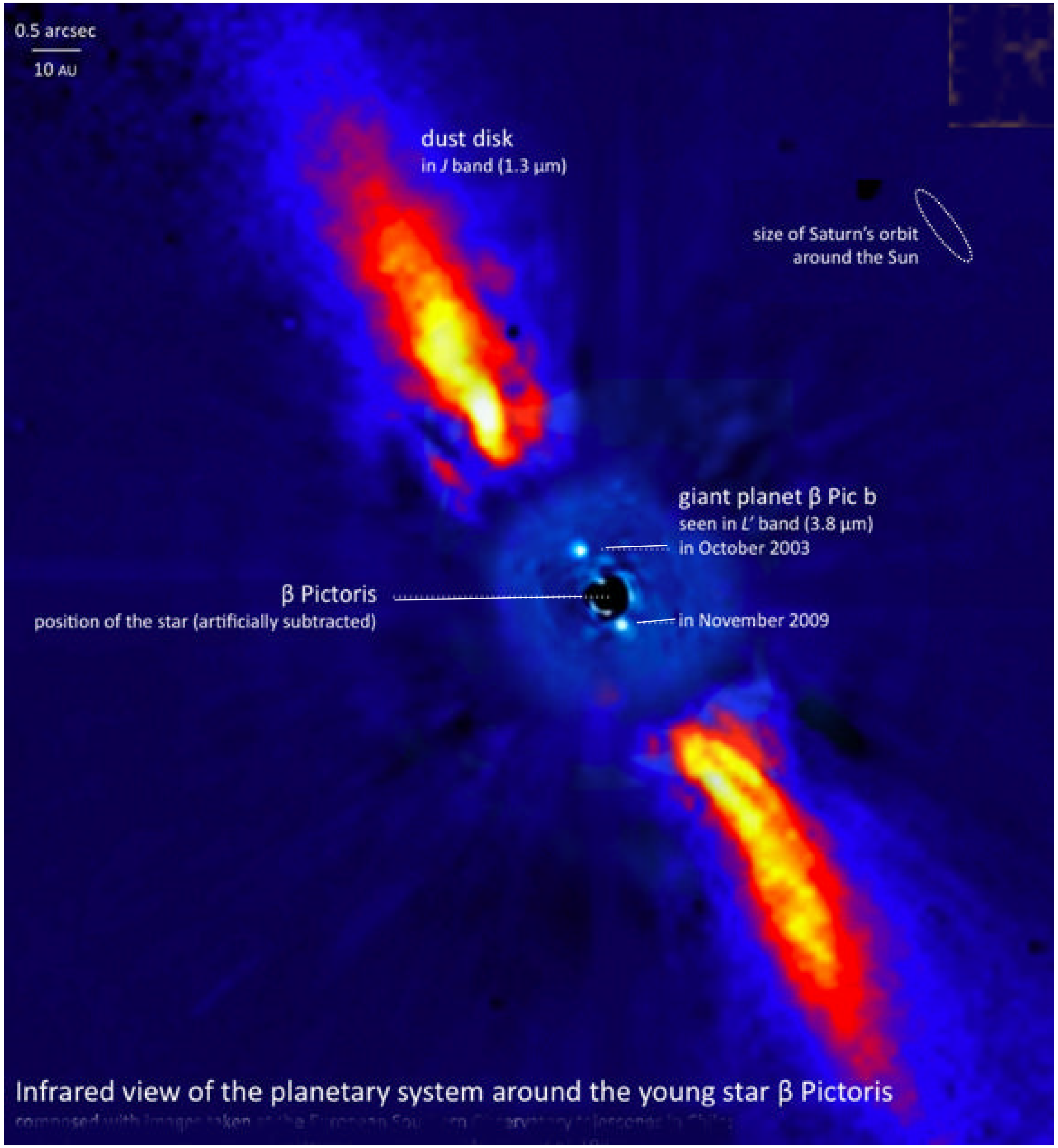
At solar exit from the second cloud, polar infall ceased. This caused progressive outward stripping of the protoplanetary disc by the G-E field. Radial decrease of the field enabled the 8-18? M_{Earth} GP 'cores' (and their satellites) to act as a gravitational ring-fence, capturing their gas/ice envelopes from it as the PDW fell.

This acquisition (prograde vorticity, being G-E field driven) speeded up Jupiter's spin the most and heated and liquefied their interiors, removing their tidal attribute and halting Triton's inward motion. So their later small-satellite captures, both prograde and retrograde, were likely due to the gas-drag of those envelopes, not tidal action.

The asteroids are not a 'failed planet' but are members of the outward-moving feedstock population that happened to be just there when the PDW ceased. The planetary gap they occupy likely marks solar passage through a low-density part of the second cloud.

With no effective G-E force, the planetary dynamics relaxed to the Newton/Keplerian prevailing ever since. This involved their inward motion at constant a.m. to speed up to Keplerian orbital velocities.

And here's the b Pic system doing just that



Seen nearly edge-on, I interpret this as soon after emerging from the 'second cloud' from which b Pic had acquired the nebular disc within which the ~9Mj planet b Pic b was formed - final orbit size similar to Saturn.

With a very obvious G-E field-driven outward flow pattern of the still-warm former disc materials, leaving the planet(s?) behind. Inner edge of clear-out is ~50AU.

In our new scenario this disc expulsion is typical of expectation where a close-in (and therefore young) exoplanet is seen. We cannot tell whether b Pic b (not so close-in) is a 'two-stage' GP like ours.

APOD 2010 July 3 (modified). Credit: A.-M. Lagrange, D. Ehrenreich (LAOG), et al., ESO

Discussion

The long-embraced Single Contracting Nebula scenario for planetary system construction fails in respect of major dynamical features of the solar planetary system - huge orbital a.m., predominantly prograde spins, systematically prograde satellites - so neither is it a suitable basis for study of exoplanets.

In the 2-stage new scenario for this job, outlined here, the presence of my independently inferred radial Gravity-Electric field, appears to play multiple and highly relevant parts, in which the ‘Newtonian field and the Gravity-Electric (G-E) field are but facets of a single physical mechanism’.

An outstanding finding, consistent with SS observations, is that individual planet nucleation and growth is conducted within an outwards-moving (G-E field driven) nebular disc-flow, with a close-to-star starting point. This both resolves the a.m. problem and explains the high proportion of exoplanets seen in close-in positions.

Poster-space limits have prevented attention to 2 other matters.

(a) The resulting planet’s mass is a matter of nebular supply to the

disc, which will depend on 3 factors:- (variable) density of the second cloud through which the star is passing; speed of passage through the cloud; gathering mass of the star.

(b) Origin of SS (and exoplanet?) water. In our new scenario, iron core formation in the terrestrial planets cannot, for 2 reasons, be by the long-favoured hot-nebula percolation of molten Fe: (i) the nebular disc is far too cool (<600K?); (ii) many studies have shown that it can't be done in less than 30Ma, which is far too long to satisfy the a.m. requirement that planetary growth must be completed within the short period of nebular presence. This dictates that iron cores were made by the nebula-present Ringwood process, in which volcanically erupting FeO is reduced by the nebula to Fe and vast volumes of water (~1000 Earth-ocean volumes for the SS terrestrial planet cores)(Osmaston 2010, 2011a,b). In our new scenario the excess water finally gets cleared out to the cometary belts, with the rest of the protoplanetary disc.

Could finding the Higgs illuminate gravitation so usefully as does even this one result of recognizing the G-E Field?

Osmaston M. F. (2010) Providing solar system water and high planetary angular momentum, using a return to Ringwood's core formation model, supported by the behavioural evolution of the mantle. *Goldschmidt 2010, Knoxville, Tennessee. Geochim. Cosmochim. Acta* **74**(S1), A 779.

Osmaston M. F. (2011a) 3 stages of Earth evolution - core formation, ocean emergence and the 2.3 Ga rise of atmospheric oxygen: How are they linked? *Mineralogical Magazine*, Goldschmidt 2011 Conference Abstracts, Prague, 1576.

Osmaston M. F. (2011b) Europa - an appeal to the Ringwood core model for the origin of its core and its water: set within a new Solar System scenario that uniquely meets the constraints of planetary high angular momentum and Europa's capture into the Jovian family. *JUpiter ICy moon Explorer (JUICE) workshop. Meudon Observatoire, Paris. 31 Aug-1 Sept 2011.*, Poster #21.