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A new, mainly dynamical, two-stage scenario for forming the Sun's planetary system and its relation to exoplanet findings

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As Jeans [1] showed, endorsed by Lyttleton (1941) and Gold (1984), a single contracting solar nebula (SCSN) is dynamically incapable of forming both the Sun and the planets, due to the 6 degree tilt of the planetary plane and their huge (x 137,000) mean specific angular momentum (a.m.) relative to the Sun's. Yet the SCSN model is still pursued by cosmochemists and astronomers, believing them to have been formed in a single event, from a common body of material.

We report here the further development of a two-stage scenario [2, 4]. In this the protoSun is formed as a star (possibly in an SCSN mode) in one nebular dust cloud, subsequently traversing a second, from which it acquires a 'coating' of different material and establishes a disk in which the planets are formed. This basic scenario provides for (1) the possible input of material unconstrained by canonical nebular collapse times, (2) receipt of short-life radionuclides from a near-by stellar event at any time along the traverse, (3) the enhanced metallicity characteristic both of the Sun and of many exoplanet-harbouring stars, (4) the tilt of the planetary plane, a relic of the motions within the second cloud.

This paper is offered as test-case support for the hypothesis [2 - 5], arising from the author's ongoing work in fundamental physics [5] that a gravitation-related radial electric field exists around the Sun (and drives stellar winds generally, supervening radiation pressure) and that it dominated the acquisition dynamics of this second-cloud material. There resulted an in-at-the-poles, out-near-the-equator flow, within which CAIs were formed and then took up to 2 Ma to spiral outward to the asteroid belt, where chondrules were being formed. Some of the flow 'contaminated' the supra-tachocline zone of the Sun, so its composition compares well with the planets. Protoplanets were nucleated successively close to the Sun, where magnetic coupling provided prograde spins and dust shielded them from solar radiation, and were then pushed outward by the plasma-driven Protoplanetary Disk Wind (PDW), with smaller material moving past them as feedstock.

This purely radial force offers a unique (and demonstrably quantitative) resolution of the planetary a.m. problem - the a.m. grows as radius from the centre increases, and none of it came from the Sun. To achieve an individual planet' a.m. both the protoplanet and its feedstock must have acquired similar a.m., so planetary growth must be largely completed while the PDW is present. This conflicts with the current belief, based on time-demanding models for iron core formation by percolation, that accretion had continued for long after nebular departure.

In our new scenario, however, the infall, being from a very cold (~10K) second-cloud source, and much of the flow having been dust-shielded from solar heat, yielded a disk at <600K, potentially denser than in SCSN. This low temperature ensured oxidized material for planetary construction, their iron cores being rapidly formed, not by percolation but by convective transport following nebular reduction of erupted FeO WHILE the nebula was present, thus generating the solar system's water [3] - a model long favoured (1960-1978) by A.E. Ringwood to resolve this still-extant problem.

The prograde orbits that characterize the satellite populations of the Giant Planets tells us their ~10ME silicate'cores' were completed by tidal capture [3], their massive gas envelopes being final acquisitions as the nebula was expelled from the inner solar system. Viewed overall, the spacing and silicate core masses of the solar planets crudely profile the cloud density during the traverse.

This 2-stage scenario for the solar system bears close comparison with several exoplanet features. Of the 334 discovered (as at Jan 2009), 73 lie within 10 solar radii of their star's axis, far too close to have been there long, and certainly much less than the age of their star. We must be seeing them soon after leaving their second cloud and now deprived of the shielding by its dust. Contrasting with the solar system, the exoplanet database shows both that substantial eccentricity is widespread, and that it seems to grow with orbit radius. In our scenario this could arise from an infall column that was far from polar, making the (near-equatorial) PDW much stronger on one side of the star, which would 'puff' protoplanets additionally as they passed, building up their eccentricity. The scenario may have potential for building brown dwarfs and even disparate binaries.

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