Meetabst\JUICE-Meudon2011.lwp/pdf.. Poster #21 presented at JUpiter ICy moon Explorer (JUICE) workshop. 31 Aug-1 Sept 2011, Meudon Observatoire, Paris. Athena Coustenis, Pierre Drossart, Mathieu Hirtzig - organisers.

# 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

Miles F. Osmaston

The White Cottage, Sendmarsh, Ripley, Woking, Surrey GU23 6JT, UK miles@osmaston.demon.co.uk; http://osmaston.org.uk

Europa's core and abundant water link it to terrestrial planet formation, so it needs to be studied in a frame that accommodates both. The currently adopted model for core formation invokes the inward percolation of accreted liquid metallic Fe, either from a hot nebula or from an internal magma ocean. But isotopic work has led to the view that, for the Earth, this process must have continued for >30Ma, long after the nebula had departed (<5Ma?). The resulting frigidity at the Jovian orbital distance would likely rule out such models for the cores in the Galilean moons.

Those models, moreover, do nothing for the origin of Solar System water, which is low in star-forming clouds and is still an outstanding problem. On the other hand, Ringwood's favoured model (1960-1978) for making planetary cores uses the nebula to reduce hot FeO, convectively erupted at the protoplanet's surface; the Fe is then 'subducted' to form the core, a process which ceases at the moment of nebular departure, leaving some FeO in the mantle. For Earth this would generate >400 ocean volumes of reaction water, a SS benefit foreseen by Ringwood. Europa's water is of the right order for it to have retained all that resulted from making its core. Nebular opacity would envelop each protoplanet, the heat required being internal (accretion, gravitation, radiogenic) and orbital distance is immaterial; important for these Galilean cores.

Another longstanding problem of the Solar System, first pointed out by Jeans (1919), is the very high specific orbital angular momentum (a.m.) relative to solar (rotational), of the materials forming individual planets. Physically, planetary a.m. is simply the product of orbital distance and orbital velocity, so is precisely known and deserves rigorous attention. For Jupiter's materials the ratio to solar is ~120,000-fold. The mechanism of this apparent partition of a.m. has been a largely unresolved problem. But I have shown [1] that during a cool secondary stage of SS formation (also needed thermodynamically for providing nebular FeO for accretion, not Fe) the nebular flow, separately acquired, would be outward and could sufficiently build up each protoplanet's a.m. as it grew, moving outward too, in the flow. So attaining the high a.m. requires completion of planet growth during nebular presence, ruling out the post-nebula growth in cores-by-percolation models, but validating the Ringwood one. The protoplanetary growth in this model is likely to be by tidal capture, which would explain why almost all of the inner satellites (Europa among them) of the Giant Planets are prograde, the retrograde captures in the feedstock population having been 'wound in' tidally to coalescence with the central body [2,3].

On this poster I will illustrate and discuss briefly both (a) the A.E.Ringwood model for the simultaneous genesis of iron cores and lots of reaction water, and (b) my new 2-stage scenario for solar system formation, referred to in [1]. I offer these new perpectives for consideration during formulation of the JUICE mission to Europa.

1] Osmaston (2006) A new scenario for forming the Sun's planetary system (and others?): dynamics, cores and chemistry (pt 2). *GCA* **70** (18S) A465. Goldschmidt 2006, Melbourne.

Osmaston (2009) 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. *Eur.Planet.Sci.Congr.Abstr*. **4** EPSC2009-264;

Osmaston (2009) Construction and differing evolutionary outcomes of the terrestrial planets; insights provided by the 2-stage scenario for constructing planetary systems. *Eur.Planet.Sci.Congr.Abstr*. **4** EPSC2009-266.

2] McCord T. B. (1968) The loss of retrograde satellites in the solar system. *JGR* **73**, 1497-1500.

3] Osmaston (2011) What can Triton's retrograde orbit tell us about how the Giant Planets (and others) were constructed? *EGU Gen.Assy., Geophys.Res.Abstr.* **13**, EGU2011-1242, 2011.