VENUS, THE HOT BRAKE HYPOTHESIS. A. K. Bijkerk[1]

Introduction: It is assumed that the accretion process of protoplanet Venus originally emerged much similar to Earth. Then it appears that the current enigmatic condition of Venus could be consistent with the planet having exchanged its rotational kinetic energy for heat energy at some moment in time. For instance, the rotational energy of Earth is ~2E32 Joule. Heating up from freezing and subsequently boiling away all earth oceans would require ~1E30 Joule[2], only a half percent of Earth's rotational energy. Hence, if Earth stopped spinning, perhaps due to internal friction forces, the resulting heat breaking to the surface, would be ample to evaporate the oceans and heat up the surface substantially, creating an event that could be similar to the 'resurfacing' of Venus. Moreover several chemical reactions would occur; most notably: virtually all carbon in Earth's mantle and lithosphere would either burn or have a reduction reaction with water vapor resulting in $C+2H_2O \rightarrow CO_2 + 4H_2$. The Hydrogen gas would be outgassed into space eventually, whilst the CO_2 would form a dense atmosphere, as is seen on Venus.

Hence, if Earth would seize rotating, the resulting internal heat would break to the surface eventually, and this would turn the planet into a condition much similar to Venus. Therefore we have to consider hypotheses for possible mechanisms that could have caused Venus to stop spinning and consequently, why it did not happen to Earth.

Rotation history of Venus: Van Hoolst 2015[[1]] an references herein compile the notion that Venus's current slow retrograde spin cannot be taken as an indication for a primordial slow rotation. '*Instead of being locked in a spin– orbit or spin–synodic resonance, the rotation of Venus is thought to be the result of a balance between solid-body tidal torques, which drive Venus to synchronous rotation, and atmospheric torques, which drive it away'* Assuming that proto-planet Venus rotated in a similar manner as other terrestrial planets did, the gravitational tides and friction torques at the core mantle boundary may have been more pronounced than other planets and did decelerate the rotation of Venus, also the dense atmosphere is thought to have contributed.

Correia et al (2003)[[2]] propose that the process may have been enhanced by Venus passing the chaotic zone, when resonance between both precession and obliquity cycles are approximately equal, leading to extreme perturbations of the direction of the spin axis, the chaotic zone[3]. However numerical simulations[4] suggest that the primordial rotation should have been much less than Earth's rotation, while the process was continuous, which limits the rate of rotational energy depletion.

Touma and Wisdom (2001)[[5]] have a different approach, resonance in the core mantle boundary of terrestrial planets as a result of orbital forcings (Milankovitch cycles). They have identified and derived the main resonance contributions near the principal core-mantle precession resonances. This would cause the core rotation axis to lose alignment with the mantle, which would lead to considerable dissipation of rotational energy into heat. For Earth the different geographic polarity of the 'inner inner' core[[6]] could be evidence of such an event as well as extensive volcanic activity in the geologic past (Siberian traps). For Venus, if the planet had been born spinning retrograde, the resonance process would be much more intense and they propose that this could have led to the resurfacing event of Venus[[7]]. There is some speculation of some primordial massive impacts in the earliest moments of the solar system, that could have caused retrograde spin, however nowadays there is little support of such a notion.

Discussion: We evaluated both hypotheses and we must conclude that neither could explain the current condition of Venus in full. However elements of both combined may do so.

The hypothesis of Correia et al (2003) is based upon the planet passing a chaotic zone in which resonance between precession- and obliquity cycles, are causing extreme oscillations of the spin axis of the mantle of the planet. However, it does not consider internal core-mantle resonance and it seems not sufficient to explain the extreme heat generation as seen on Venus.

The hypothesis of Touma and Wisdom (2001) is based on resonance in the core-mantle boundary and it could explain Venus's current hot condition if its primordial rotation was retrograde. However there appears to be little support of the latter. They do not

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[2] Volume oceans 1.33E+09km3; specific heat water times 100(k) times 4.18 J/g times evaporating 2257 J/g = 1.26E30J

consider extreme mantle spin axis oscillations due to passing the ‘chaotic zone’.

It appears that merging both hypotheses into the “hot brake hypothesis” may result in a workable idea that answers to all enigmatic features of Venus, if both resonance of core-mantle boundary would have happened during passage of the chaotic zone of the resonance of the precession- and obliquity cycle, the resulting chaotic spinning could have resulted in the planet ‘toppling over’ from prograde- to retrograde spinning while dissipating most of its spinning energy into heat.

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