Theories on the Formation and Evolution of ~2D Planar Celestial Kinematics

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Abstract:

The existence of essentially 2-dimensional planar solar systems and galaxies would seem to be a contradiction to the 2nd Law of Thermodynamics relating to the tendency of natural processes toward spatial homogeneity of matter and energy. During the formation process of celestial systems, an equal dispersion of matter throughout 3-dimensional space would have been a more logical result to satisfy entropy/disorder increasing at all times. Conventional belief is that the ~2D planar geometry of galaxies and solar systems is largely due to rotational kinetic forces and matter collapsing due to its own gravity; this project seeks to expand and enhance the potential forces to explain ~2D planar celestial kinematics. Computational mathematics utilizing programming in C# will analyze various potential forces and relative magnitudes to determine proposed force-balances during these formation processes. A better understanding of the formation process (and the forces that govern them) of galaxies and solar systems can help explain their evolutions to steady state; for this, the derived mathematical models will be computed and translated to visual models in 4-D space-time over various time frames.

Background and the Physics of Model Development:

The impetus for this project began with two factors:

- The unusual phenomena of the evolved state of solar systems and galaxies being largely ~2D planar in shape (herein, “largely ~2D planar” refers to the observed fact that our solar system and Milky Way galaxy are vastly wider than their depth, and that the planets in our solar system all orbit in an essentially 2D plane relative to the vast 3D space in which they could be orbiting)
- The unusual phenomena of gas/matter oriented perpendicular to a central accretion disk during “phase 3” of star formation¹

Both of these phenomena would appear to violate the law of entropy in that they do not match the tendency of matter/energy toward spatial homogeneity in 3D space (in 4D space when considering the time factor in formation and evolution). The perpendicular orientation of some of the gas/matter relative to the central accretion disk during star formation guided the first direction of this project: to consider that electromagnetic fields/forces play a substantial role. This is because electromagnetic vectors comprise exactly perpendicular components (the magnetic field being perpendicular to the magnetic force, and the magnetic field being perpendicular to the electric field). Subsequently this led to the consideration of the cause of magnetic field/force; the natural choice being the existence of a continuous electric current and/or a changing electric flux that generates an electric field (and corresponding magnetic field/force) according to Maxwell’s Equations.

The main focus of this project then became the interaction of the predicted substantial electromagnetic forces during formation of stars and galaxies with the kinetic forces present during formation. While this will be modeled with various computation algorithms simulating a variety of possible conditions, it is beneficial to first describe physical visualizations from which the mathematical equations will be derived and kinematic constraints will be set, as follows.

The kinetic process during formation will be modeled as a colossal “fire-tornado”- with extremely rapidly rotating gases/dust/plasma at extreme temperatures during star formation or during the formation of a galaxy. The proposed fire-tornado is akin to a fire-tornado observed on Earth- in that its kinetic energy (rotational motion and ability to pull in additional gas/matter to a central vortex region) is heat-driven, and becomes a self-feeding process of increasing intensity as long as “fuel” is available to do so. In the case of a fire-tornado in space, the initial fuel is cosmic gas (mostly hydrogen) and the frictional heat generated from collisions of gas molecules and dust particles. As the vortex of the fire-tornado intensifies, velocity of rotation and heat becomes so great that plasma forms and becomes an integral part of the formation process.

Figure 1: Modeling the initial formation of a star or galaxy as a fire-tornado

Figure 1 shows the proposed progression of gas/dust gradually forming an initial fire-tornado with distinct central vortex hole (eye of the fire-tornado) around which the gas/dust rotate within a cylindrical shell that will become the solar (or galactic) accretion region in this model (Stage 1), followed by further intensification leading to a fire-tornado that is taller in height with a tighter central vortex hole (eye) and white-hot plasma around the eye (Stage 2). The changing fire-tornado geometry for this part of the proposed model is due to enormous rotational velocities pulling matter toward the core; with no other place to go, in the absence of other forces this would normally cause matter to distribute along the “height axis” due to forces such as increasing gas pressure and electric repulsion. As the centripetal acceleration (v^2/r) of matter increases with decreasing distance toward the central core, the temperature of the matter becomes hotter and hotter- leading to white-hot plasma around the central core region.

The physics of the proposed model continue with the colossal fire-tornado spawning an equally colossal electric field from the electrostatic charge generated from intense motion/collisions, friction, and heat. Electrons are stripped from atoms (most especially in the extreme conditions of the white-hot plasma) and in free motion about the fire-tornado. The colossal electric field spawns an equally colossal magnetic field.

This leads to the second key component of the proposed models: the spawned colossal magnetic field creates enormous magnetic pressure that compresses the height of the fire-tornado into the familiar ~2D planar shapes of solar systems and galaxies. While multiple variations of magnetic fields (and electric current / changing electric-flux from which the magnetic fields are generated) are possible, the key feature of the proposed model is that they will all result in the production of magnetic pressure (magnetic force per area of action) such that the *net direction and magnitude of this pressure compresses the kinetic-force created fire-tornado along the height ($+\hat{Z}$ and $-\hat{Z}$) axis*. As the fire tornado is modeled as an outer cylinder filled with solar accretion matter rotating around an inner hole (eye) that marks the central core vortex region, the mathematical models will result in the following general process for all of the proposed models:

Figure 2: The compression of the fire-tornado model via spawned magnetic pressure

Several additional concepts of the proposed mathematical force models can be visualized in Figure 2:

- The heat intensity increases in the diagrams going from left to right; the vortex core (eye of the fire-tornado) is surrounded by increasing amounts of white-hot plasma.
- Both a continuous electric current and a displacement current are predicted to increase going from left to right in the diagrams, due to the factors above. This leads to increasing magnetic field strength and associated magnetic pressure (shown with the blue lines) accordingly
- The density of the solar accretion cylinder increases going from left to right stages as the fire-tornado is compressed. The plasma-state is considered like a liquid metal, and as such the density of matter within the cylindrical shell will increase as more plasma is

formed from gaseous hydrogen and the magnetic pressure acting in the $+\hat{Z}$ and $-\hat{Z}$ axis strongly compressing the matter within.

As seen in Figure 2, the theories set forth could help explain observed $\sim 2D$ planar geometry of solar systems and galaxies wherein the width axis is considerably longer than the height axis of orbital kinematics. Because the magnetic field lines would form continuous closed loops, their net magnetic pressure vectors would act like a vise compressing the solar accretion matter within the cylindrical shell of the fire-tornado equally from $+\hat{Z}$ and $-\hat{Z}$ directions.

The gas/dust/plasma rotating about the central vortex comprises the central accretion cylinder; for solar systems, this central accretion cylinder is the solar accretion cylinder and would result in the eventual coalescence of matter into a star (Stage 4 in the convention of the proposed model). In the case of our solar system, the central accretion cylinder would be approximately 99.8% of the total mass of the solar system; the balance of matter forming planets and asteroids in the outer rings of accretion matter.

The proposed colossal magnetic field / force would extend far enough from the central accretion cylinder to impart magnetic pressure to the outer accretion cylinder rings, resulting in the familiar $\sim 2D$ planar geometry in which the planets of our solar system orbit. For galaxies, the central accretion cylinder for many galaxies (including the Milky Way) is proposed to still be in the fire-tornado state due to epic heat, rotational velocity, and continued availability of fuel for the engine.

The proposed model would also explain the unusual perpendicular orientation of some of the gas/dust/plasma during star formation and the perpendicular plasma-jets expelled by many galaxies to this day. Some of the plasma near the central vortex region could be caught in the powerful magnetic field and (and potential extreme repulsion field that may exist in the central vortex eye region) and be ejected into space, revealing the presence of the normally invisible fields.

The next part of the model is the evolution of these forces as stars and galaxies are formed. For stars, the proposed model is for an increasing electromagnetic field / magnetic pressure in the stages shown from left to right in Figure 2. The model proposed predicts a maximum of these forces that marks the end of Stage 3 of star formation as the fuel in the original gas/dust cloud has been consumed into a fully organized maximum-intensity and maximum-compression fire tornado. Without additional fresh fuel, these forces begin to decay; as gas/dust/plasma of the rotating accretion cylinder region lose some of their kinetic energy over time in the form of reduced velocity and cooling, less free electrostatic charge is generated. Both the electric current and changes in electric flux decrease, and the associated magnetic field and pressure decrease accordingly. As cooling increases, the rotating matter within the cylindrical accretion shell ultimately coalesces into a star at Stage 4.

Despite the decay of forces, the work of the proposed colossal electromagnetic field / magnetic pressure in shaping the kinematics of orbital shapes and geometries into $\sim 2D$ planar would have already been completed. Combined with conservation of angular momentum of the kinetic rotations imparted by the fire-tornado, the net electromagnetic (EM) and kinetic forces would result in the familiar $\sim 2D$ planar kinematics we observe today in our solar system. For galaxies, the proposed EM field/forces and kinetic forces generated by the central rotating galactic

accretion cylinder would be so epic as to create the ~2D planar geometry of all galactic matter during the formation process- a mind-boggling perspective on “the power of the Force” and one which is still observed today in the ~2D planar geometry and orbital kinematics of billions of stars and the solar systems throughout the Milky Way at a width of ~100,000 light years and height (depth) of only ~4,000 light years.

Equations and Computational Algorithm Models

Based on the above theories and physical visualizations, the computational models developed for this study will be derived to evaluate various force vectors and ratios for kinetic and EM fields during the formation of stars and galaxies, the interaction between these forces, and the decay rate of these forces over time. The constraints for optimizing the proposed formation forces and decay are the currently observed kinematics (geometric shapes and orbital arrangements) of celestial objects in our solar system and the Milky Way.

The computational algorithm models start with the orbital kinematics and physics of the sun in our solar system, as currently reported by various literature. NASA data² indicate the sun has a diameter (D_{sun}) of 1.3914×10^6 km, mass of 1.989×10^{30} kg, and density of $1,408 \text{ kg/m}^3$ ($1.408 \times 10^{12} \text{ kg/km}^3$). Literature reports that the sun orbits a barycenter region at the center of our solar system that has a diameter between 2-4 solar diameters³. For purposes of this paper, all derived models will assume a value of the space in the center of our solar system at which the sun orbits to have a diameter equal to 2.5 solar diameters (3.4785×10^6 km).

Based on these parameters, an orbital kinematic construct was made in which the sun’s orbit carves out a cylindrical shell that has a “wall” width equal to one sun diameter (for a total wall width of $2 \times D_{\text{sun}}$ counting both walls moving across the diameter), an inner cylinder diameter equal to the barycenter diameter ($2.5 \times D_{\text{sun}}$), and therefore a total diameter of $4.5 \times D_{\text{sun}}$. The height of the cylinder is equal to the diameter of the sun; the ratio of the total width of the cylinder to the height is then seen to be a ratio of 4.5:1. This kinematic construct is shown in Figure 3:

Figure 3: Modeling the Sun’s Orbital path as a cylindrical shell around the barycenter

The volume of the cylindrical shell that the path of the sun carves out around the barycenter is:

$$V = \pi(R_t^2 - R_i^2) * H \quad (\text{Equation 1})$$

Where:

R_t = total radius of the cylinder

R_i = inner radius of the cylinder (radius of the hole in space around which the sun orbits)

H = cylinder height

Whereas the volume of the sun, assuming a perfect sphere, is $V = \frac{4}{3}\pi R_{\text{sun}}^3$

Table 1: Numeric Summary of Present-Day Solar Kinematic Construct

Mass of Sun (kg)	Diameter of Sun (km)	Diameter of Barycenter (km)	Total Diameter of Cylinder (km)	Height of Cylinder (km)	Volume of Solar Cylindrical Shell (km ³)	Volume of Sun (sphere, km ³)	Density of the Sun (kg/km ³)
1.989E30	1.3914E6	3.4785E6	6.2613E6	1.3914E6	2.9619E19	1.4104E18	1.410E12

Utilizing this present-day orbital kinematic construct, the key features to set as constraints for deriving models for the formation period of the sun become:

Model 1: The assumption is made that the present-day kinematic construct is equivalent to the cylindrical shell of the solar accretion cylinder *at the end* of Stage 3 of the present model, and that this corresponds to ~4.6 billion years ago (i.e. both constructs have the same height, total diameter, and inner diameter). During Stage 3, this construct is modeled as a cylindrical fire-tornado of gas/dust/plasma rotating in the cylindrical shell around a central vortex hole (the inner cylinder of empty space) that has a diameter equivalent to the present-day barycenter upon which the sun orbits. The total mass of gas/dust/plasma during this formation period is assumed to be equal to the present day solar mass plus an estimate of the amount of hydrogen consumed by fusion in the sun over the last 4.5 billion years. Utilizing the mass and cylindrical shell volume from Equation 1, the density of matter dispersed throughout the volume of the solar accretion cylinder can be calculated. It is assumed that 4.6 billion years ago marks the maximum intensity, maximum-compression fire-tornado; with no additional gas/dust from the original cosmic cloud to drive the heat-vortex engine, reductions in kinetic energy and electromagnetic fields/forces allowed the solar accretion matter to coalesce into a natural surface-tension minimizing sphere during Stage 4. This coalescence is typically estimated to occur over ~50 million years over which time the sun as we know it was fully formed.

Model 2: The same concepts as Model 1, except assume the volume of the spherical sun 4.5 billion years ago was 25% smaller than it is today (as an estimate for the expansion of the outer layers of the sun due to fusion and internal pressure from 4.5 billion years of hydrogen fusion to helium). Utilizing the volume of sphere equation, the updated radius of the sun (and associated parameters of Figure 3 updated accordingly) can easily be calculated by again assuming that the central vortex hole-region of the fire tornado at the end of Stage 3 maintained the same diameter (D_i) as today's solar-orbit barycenter region. The density of solar accretion cylinder is again

calculated using the mass within the accretion cylinder divided by the volume of accretion cylinder from Equation 1; of course being higher than Model 1 due to the same matter packed into lower volume of cylinder shell.

The mathematical relations for finalizing kinematic constraints for Model 1 and 2 become:

Mass of solar accretion region (kg) = $1.9885 \times 10^{30} + 5 \times 10^9 \times 365 \times 24 \times 3600 \times (4.5 \times 10^9) = 1.9892 \times 10^{30}$ kg (assumes a hydrogen consumption rate of 5 billion kg/sec for the last 4.5 billion years)

Volume of solar accretion cylinder (km³) = $\pi \times (R_t^2 - R_i^2) \times H$

Density of solar accretion cylinder = Mass / Volume (kg / km³)

Table 2: Kinematic constraints at the end of Stage 3 of our sun's formation (~4.6 billion years ago)

Model	Mass of solar accretion region (kg)	Total Diameter of Cylinder (km)	Diameter of Central Core (Inner Cylinder, km)	Height of Cylinder (km)	Volume of Solar Accretion Cylindrical Shell (km ³)	Density of solar accretion region (kg/km ³)
1	1.9892E30	6.2613E6	3.4785E6	1.3914E6	2.9619E19	6.7161E10
2	1.9892E30	6.0068E6	3.4785E6	1.2642E6	2.3811E19	8.3540E10

Next, the assumption is made that the organization of free cosmic gas/dust was organized via heat-driven kinetic vortex forces into a maximum-height fire-tornado (left-most diagram of Figure 2) at the end of Stage 2 and gradually progressed as shown in Figure 2 to the substantially-compressed cylinder of the right-most diagram at the end of Stage 3. To keep the initial model simulations focused more on the concepts, it will be assumed that these kinetic forces result in the tall fire tornado with central-vortex hole of radius R_i and total cylinder radius R_t being calculated directly from $\frac{1}{2}$ the diameters shown in Table 2, and that these values stay constant throughout Stage 3. It is expected that the spawned electric and magnetic fields will begin to increase in strength concurrently with the increasing kinetic and heat forces of the fire-tornado vortex, so that compression of the solar accretion cylinder will occur concurrently with intensification of the fire tornado; this will be modeled with more complexity as research progresses.

The volume and density of the solar accretion region (the fire-tornado cylinder) will be float-calculated using variations in height H of the solar accretion cylinder. Two key points of consideration are:

- The predicted minimum cylinder height ($H_{\min}$), which is modeled as the diameter of the sun (the diameter of the sun today for Model 1, and a diameter corresponding to a sun that had 25% less volume when it first formed as a sphere 4.5 billion years ago for Model 2). From these values, the minimum volume of accretion cylinder (and corresponding maximum accretion cylinder density) can easily be calculated; these values correspond to those in Table 2. Since $H_{\min}$ represents maximum compression, this point in time also corresponds to the maximum magnetic pressure (and corresponding maximum magnetic

and electric field strength). As indicated above, these minima/maxima limits are modeled as occurring 4.6 billion years ago.

- For all other accretion cylinder density and volume, the value of cylinder height H is floated while keeping R_t and R_i constant (calculated as $\frac{1}{2}$ the diameter values shown for Models 1 and 2 in Table 2). Details on the maximum cylinder height will be discussed in the results.

With tabulated values of cylindrical accretion volume as a function of cylinder height ($V(h)$) the compression force P_m (magnetic pressure) needed to compress the accretion cylinder can be calculated utilizing:

$$\Delta P_m = - \left(\frac{\Delta V(h)}{V_o} \right) * K \quad \text{(Equation 2)}$$

Where:

ΔP_m = the change in magnetic pressure generated by the magnetic field (N/m^2) at each step of the compression process

$\Delta V(h)$ = change in volume of the solar accretion cylinder from one height to the next

V_o = initial volume at each step of the height compression

K = the Bulk Modulus of the solar accretion matter (N/m^2)

The Bulk Modulus (K) of the solar accretion matter is expected to change over time as the density of the accretion matter within the accretion cylinder continues to increase with the proposed magnetic pressure compression. To obtain accurate values of P_m would require accurate values of $K(\rho)$ which is problematic; nevertheless the main point of this analysis is to highlight the concepts and propose the basic force equations with calculations where possible. As such, the key factors of $K(\rho)$ for the proposed models are:

$K(\rho)$ maximum (K_{max}) of solar accretion cylinder Model 1 will be assumed to be that of experimentally and theoretically-proposed values for the bulk modulus of Lithium plasma^{4,5}. This value is chosen in consideration that the maximum solar accretion density at the end of the proposed Stage 3 will correspond to the most-intense fire-tornado and that the accretion matter will comprise of mostly white-hot plasma at that time; this plasma is modeled as a liquid metal using the element closest to hydrogen (no value for the bulk modulus of hydrogen plasma was found in the literature at the time of this publication).

K_{max} for solar accretion cylinder Model 2 will be assumed to be higher by the density ratio of ρ_{max} Model 2 vs ρ_{max} Model 1. Each subsequent $K(\rho)$ for all other compressions of solar accretion cylinder height will be calculated by multiplying the ratios of density between each incremental step of expansion (going further back in time) from the maxima compressed cylinder of 4.6 billion years ago. Mathematical details are described in the Results section.

The final steps of the main model constructs then becomes calculating the magnetic field strength associated with the magnetic pressure. The component of magnetic force acting in the $+\hat{Z}$ and $-\hat{Z}$ directions would be⁶:

$$P_m = \frac{B^2}{2\mu_0} \quad (\text{Equation 3})$$

Where:

P_m = magnetic pressure (Pascals, = Newtons/m²)

B = Magnetic Field Strength in Teslas

μ_0 = magnetic permeability of free space = $4\pi \cdot 10^{-7}$ Henrys/meter

Utilizing the above, the magnetic pressure and associated magnetic field required to progressively compress the fire-tornado solar-accretion cylinder from the end of Stage 2 to $H_{\min}$ at the end of Stage 3 will be calculated in the computational models.

Results

Values for $V(h)$ and $\rho(h)$ for the solar accretion cylinder starting at $H_{\min}$ were calculated using float values for H in iterative loop scripts of Equation 1 written in C# in the Unity operating platform. Starting at $H_{\min}$, step gain increments were:

$0.127 \cdot 10^6$ km for 20 steps up to ~ 3 times $H_{\min}$

$0.733 \cdot 10^6$ km for 10 steps up to ~ 10 times $H_{\min}$

$5.000 \cdot 10^6$ km for 10 steps up to ~ 50 times $H_{\min}$

The increase in step value was chosen to keep the data for analysis in Excel to a reasonable level, while ensuring sufficient data at all regions of plotted data to show clear trends without ambiguity (noting that for visual computational simulations all functions are essentially infinitely continuous as there are relatively no processing power limitations). The initial end point of maximum height was selected such that the calculated density would be equal to that of free-space hydrogen gas. The results are plotted in Figure 4A:

Figure 4A: Solar Accretion Cylinder Density as a Function of Cylinder Height

As seen in Figure 4, there is a clear approach toward an asymptotic lower density limit as the height of the cylinder increases to the right along the x-axis. Since the present models are focused on the density increase associated with the organization of gas/dust from the kinetic forces of a fire-tornado vortex and subsequent magnetic pressure compression, it is desirable to find the point in H at which the *rate* of density change begins to substantially increase. This is determined by plotting the 2nd derivative of the $\rho(h)$ equations vs. H, to elucidate where the rate of change of the ρ vs H slope begins to noticeably change. The precise equations for $\rho(h)$ for Model 1 and 2, and their second derivatives, are:

$$\rho = \frac{9.344 \cdot 10^{16}}{H} \quad (\text{Model 1})$$

$$\frac{d^2\rho}{dh^2} = \frac{1.869 \cdot 10^{17}}{H^3} \quad (\text{Model 1})$$

$$\rho = \frac{1.056 \cdot 10^{17}}{H} \quad (\text{Model 2})$$

$$\frac{d^2\rho}{dh^2} = \frac{2.112 \cdot 10^{17}}{H^3} \quad (\text{Model 2})$$

The second derivatives are plotted versus H (with the x-axis of H scaled down by 10^{-6} km and truncated where the asymptotic lower-limit behavior is obvious, in order to clearly see the desired region wherein density begins to markedly increase):

Figure 4B: Second Derivative of $\rho(h)$ vs H

Figures 4A & B are important to the further model development in that the point at which the slope of the 2nd derivatives substantially increase will be assumed to be the point of solar accretion cylinder height with sufficient organization such that the central vortex diameter (eye of the fire tornado) achieves equivalence with the current barycenter of space around which the sun orbits. This point is selected as the data point $H_c = 7.728 \times 10^6$ km for both Models 1 and 2, where H_c = **critical vortex height**, and marks the end of Stage 2 (where the kinetic and heat-driven forces of the fire-tornado provide organization of matter) and beginning of Stage 3 (where the strength of the magnetic field and magnetic pressure compress the organized matter into ~2D planar kinematics) of the sun's formation according to the present model conventions.

As height progresses to the right along the x-axis, the proposed fire-tornado cylinder is less and less compressed and simulates the *initial* stages of formation. In terms of time sequence, going from left to right starts at 4.6 billion years ago and from there progresses *backward* in time; the height axis as shown can therefore be considered as a surrogate for reverse time (various simulations of H(t) will be modeled as part of this ongoing research).

A computational script in C# was then written to calculate the change in volume (ΔV) between each incremental step of compression (incremental decrease in cylinder height H from h_o to h_1) relative to the initial volume (V_o) at the start of that compression step (at h_o). Because Equation (2) is for compression, care is taken in calculating the difference such that the volume at the end of the step (V_1) is the lower (more compressed) volume compared to that at the start of the step (V_o). Mathematically, for the proposed model this becomes:

$$\frac{\Delta V}{V_o} = \frac{(\pi(R_t^2 - R_i^2) * h_1) - (\pi(R_t^2 - R_i^2) * h_o)}{\pi(R_t^2 - R_i^2) * h_o}$$

And since R_t and R_i are assumed to stay constant for a given model, this reduces to:

$$\frac{\Delta V}{V_o} = \frac{(h_1 - h_o)}{h_o} \quad \text{(Equation 4)}$$

Next is a computational C# script for calculating bulk modulus (K) as a function of solar accretion cylinder density $K(\rho)$. As described previously, Model 1 assumes a K_{max} occurring at ρ_{max} , and that K_{max} for Model 1 corresponds to the bulk modulus of liquid lithium found in the literature. K_{max} for model 2 is calculated by:

$$K_{max}(\text{Model 2}) = \frac{\rho_{max}(\text{Model 2})}{\rho_{max}(\text{Model 1})} * K_{max}(\text{Model 1})$$

The same logic is utilized for the C# script for $K(\rho)$ over all time periods (cylinder heights) from these maximum values at 4.6 billion years ago to the height at the *beginning* of Stage 2 assumed to mark the start of the fire tornado intensification phase (H_0), viz.:

$$K(\rho) = \frac{\rho_o}{\rho_1} * K_1 \quad \text{(Equation 5)}$$

Where:

ρ_1 = the solar accretion cylinder density after the compression step
 ρ_0 = the solar accretion cylinder density at the start of the compression step
 K_1 = the solar accretion cylinder bulk modulus after the compression step

Executing the computational scripts for $K(\rho)$ between $H_{\min}$ and H_{f0} results in:

Figure 5: Bulk Modulus of Solar Accretion Cylinder as a Function of Cylinder Height

With all the needed parameters of Equation 2 now calculated, the force (differential magnetic pressure in these models) needed to compress the solar accretion cylinder at each step change of H was calculated in another C# script. The cumulative total pressure from the start of the compression process (at H_{f0} , selected to be 5.639×10^7 km from the asymptotic limit approach to $K_{\min}$ seen in Figure 5) to the end of Stage 3 ($K_{\max}$, $\rho_{\max}$, $P_{\max}$, and $H_{\min}$) of star formation was determined by adding the differential pressure at each stage of compression, and is plotted as:

Figure 6: Cumulative Magnetic Pressure as Solar Accretion Cylinder Height Compresses

Because this is a cumulative build-up in magnetic pressure over time, it is best presented as increasing time (decreasing H) as shown in Figure 6. Previous plots were presented as reverse time (increasing H) to emphasize that it was the most recent projected data point (at 4.6 billion years ago) at which the calculations started, for reasons as indicated in the development of the final Stage 3 kinematic construct derived from the present-day kinematic construct of the sun. Presenting the data in reverse time was useful for emphasizing that point and for projecting where the start of the fire-tornado organization of solar accretion matter started (i.e. by choosing a point that began to approach asymptotic lower limit H_{f0}) and where it could be modeled as reaching maximum vortex organization at the critical vortex height (H_c) after which time the magnetic field strength (**and critical magnetic pressure, P_c at H_c shown in Figure 6**) rapidly builds and compresses the solar accretion cylinder. From here on, the more familiar increasing time (decreasing H) will be utilized; this will also be helpful and more effective in the visual 4D simulation demos and associated script code.

Now to the exciting grand finale of calculating the magnetic field associated with the colossal magnetic pressures calculated and displayed in Figure 6, and then putting the calculated field strength in perspective by comparing it to the present-day magnetic field strength of the sun. This starts by rearranging Equation 3 to:

$$B_T = \sqrt{2 * \mu_o * P_{mc}} \quad (\text{Equation 6})$$

Where:

B_T = the cumulative magnetic field strength (in Teslas) summed over each stage of compression

P_{mc} = the cumulative magnetic pressure (in N/m^2) summed over each stage of compression

μ_o = magnetic permeability of free space = $4 * \pi * 10^{-7}$ Henrys/meter

The results of C# scripts written for calculating cumulative magnetic field strength and then relating that strength to the sun's current magnetic field are shown in Figures 7A and B:

Figure 7A: Cumulative Magnetic Field Strength (B_T) as the Solar Accretion Cylinder Height is Compressed

Figure 7A shows the model's gradual increase in magnetic field strength starting at H_{f0} at the beginning of Stage 2 and progressing to B_c (at H_c and P_c) at the end of Stage 2 (and beginning of Stage 3) followed by a rapid build in magnetic field strength leading to rapid compression to B_{max} (and H_{min}) at the end of Stage 3 of the sun's formation.

Figure 7B: Cumulative Magnetic Field Strength B_T During the Formation Process Relative to the Sun's Today

Figure 7B puts the magnetic field strength into perspective, with model results predicting a colossal peak magnetic field strength of *1.7 million* times (Model 1) and *1.9 million* times (Model 2) that of the Sun's magnetic field strength today. This could help explain the observed ~2D planar orbital kinematics of the sun and planets about the barycenter of our solar system. With such a massive magnetic field at the solar accretion cylinder during the formation process, sufficient magnetic field (and magnetic pressure vector) would extend far out over 4-D space time to maintain compression and ~2D planar orbital kinematics of the planets within our solar system (formed with the ~0.2% of remaining mass in outer accretion matter rings). The orbital velocities of the sun and planets will have been established by the kinetic forces of the central solar accretion fire-tornado at the end of Stage 3 via conservation of angular momentum, with their orbital path set in ~2D planar motion about the eye of the fully-compressed fire-tornado via the colossal magnetic pressure acting on the matter from which they coalesced into the sun and planets. The eye of the fully-compressed fire-tornado at the end of Stage 3 is proposed to have become the area of space upon which the sun and planets orbit.

The above summarizes the key concepts of the proposed models. The galactic models will be identical in spirit though with magnetic pressure and area of field strength over which it acts to be so epic that it results in the ~2D planar geometry of the central galactic accretion region and all stars and solar systems within the galaxy. The galactic models and other fascinating ramifications will be explored in continuing research.

Authors' notes:

This paper is the product of a father-son team; combining the youthful imagination of a teenager (that conceived the fire-tornado model) and of an older man who still likes to think that way (conceiving the spawned magnetic compression force/field of the fire-tornado). We hope the proposed theories and models for explaining the formation of ~2D planar geometries and orbital kinematics of solar systems and galaxies will pique the curiosity of the scientific community. The content is the foundation of co-author Henry Bushong's senior year scientific investigation project; his specialty is computer programming and he has written algorithms in C# for the computations thus far. He is working on additional computational algorithms and 4-D space-time coded simulations as a visual demonstration tool for the concepts. Anyone wishing to add insights or parameter data is welcome to do so by contacting us via email at:

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