Why does Saturn have many tiny rings ?

or

Cassini-Huygens Mission: New evidence for Gravitomagnetism with Dual Vector Field

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Abstract

This publication is based on the fundamentals of the dynamics of masses interacting by gravitation, given by the Maxwell analogy for gravitation or the *Heaviside field*. In our paper "*A coherent dual vector field theory for gravitation*" © oct 2003, we have developed a model.
This dynamics model allowed us to quantify by vector way the transfer of angular movement point by point, and to bring a simple, precise and detailed explanation to a large number of cosmic phenomena.
With this model the flatness of our solar system and our Milky way has been explained as being caused by an angular collapse of the orbits, creating so a density increase of the disc. The constant velocity of the stars has been calculated, and the halo explained. The "missing mass" (dark matter) problem has been solved without harming the Keplerian motion law.
The theory also explains the deviation of mass like in the d*iablo* shape of rotary supernova having mass losses, and it defines the angle of mass losses at 0° and above 35°16'.
Some quantitative calculations describe in detail the relativistic attraction forces maintaining entire the fast rotating stars, the tendency of distortion toward a torus-like shape, and the description of the attraction fields outside of a rotary black hole.
Qualitative considerations on the binary pulsars show the process of cannibalization, with the repulsion of the mass at the poles and to the equator, and this could also explain the origin of the *spin-up* and the *spin-down* process. The bursts of collapsing rotary stars are explained as well. The conditions for the repulsion of masses are also explained, caused by important velocity differences between masses. Orbit 'chaos' is better explained as well. Finally, the demonstration is made that gyrotation is related to the Relativity Theory.

The detailed photographs of the Saturn rings made by the Cassini-Huygens mission gives us new evidence for the validity of Gravitomagnetism. It explains the presence of the flat rings around Saturn, the presence of thin parallel rings, the shape of the edges of the F-ring and the reason why such rings are present at the border of large ring zones.

Keywords. gravitation – star: rotary – disc galaxy – repulsion – relativity – gyrotation – Saturn – methods : analytical
Photographs : ESA / NASA

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1. Introduction.

1.1. The Maxwell Analogy for gravitation

Heaviside O., 1893, transposed the Electromagnetism equations of Maxwell into the Gravitation of Newton, creating so a dual field: gravitation and what we propose to call *gyrotation*, where the last field is nothing more than an additional field caused by the velocity of the considered object against the existing gravitation fields.

The formulas (1.1) to (1.5) form a coherent set of equations, similar to the Maxwell equations. Electrical charge is then substituted by mass, magnetic field by gyrotation, and the respective constants as well are substituted (the gravitation acceleration is written as $\boldsymbol{g}$, the "gyrotation field" as Ω , and the universal gravitation constant G as $G^{-1} = 4\pi\,\zeta$). We use sign $\Leftarrow$ instead of $=$ because the right hand of the equation induces the left hand. This sign will be used when we want to insist on the induction property in the equation.

$$\boldsymbol{F} \Leftarrow m\,(\boldsymbol{g} + \boldsymbol{v} \times \Omega) \qquad (1.1)$$

$$\nabla \,.\, \boldsymbol{g} \Leftarrow \rho \,/\, \zeta \qquad (1.2)$$

$$c^2 \nabla \times \Omega \Leftarrow \boldsymbol{j} \,/\, \zeta + \partial \boldsymbol{g} / \partial t \qquad (1.3)$$

where $\boldsymbol{j}$ is the flow of mass through a surface.

It is also expected
$$div\, \Omega \equiv \nabla . \Omega = 0 \qquad (1.4)$$
and
$$\nabla \times \boldsymbol{g} \Leftarrow -\,\partial \Omega \,/\, \partial t \qquad (1.5)$$

All applications of the electromagnetism can from then on be applied on the *gravitomagnetism* with caution. Also it is possible to speak of gravitomagnetism waves, where

$$c^2 = 1 \,/\, (\,\zeta\, \tau\,) \qquad (1.6)$$

1.2. Law of gravitational motion transfer - Equations.

In this theory the hypothesis is developed that the angular motion is transmitted by gravitation. We can indeed consider each motion in space as a curved motion.
Considering a rotary central mass m_1 spinning at a rotation velocity ω and a mass m_2 in orbit, the *rotation transmitted by gravitation* by m_1 to m_2 (dimension [rad/s]) is named *gyrotation* Ω from m_1 to m_2.

Equation (1.3) can also be written in the integral form. Hence, one can write:

$$\iint_{\boldsymbol{A}} (\nabla \times \Omega)_n \, d\boldsymbol{A} \Leftarrow 4\pi\, G\, \dot{m} \,/ c^2 \qquad (1.7)$$

In order to interpret this equation in a convenient way, the theorem of Stokes is used, and applied to the gyrotation Ω.

$$\oint \Omega \,.\, d\boldsymbol{l} = \iint_{\boldsymbol{A}} (\nabla \times \Omega)_n \, d\boldsymbol{A} \qquad (1.8)$$

Hence, the transfer law of gravitation rotation (*gyrotation*) results in:

$$\oint \Omega \,.\, d\boldsymbol{l} \Leftarrow 4\pi\, G\, \dot{m} \,/\, c^2 \qquad (1.9)$$

1.3. Gyrotation of rotating bodies in a gravitational field.

For a sphere, we found:

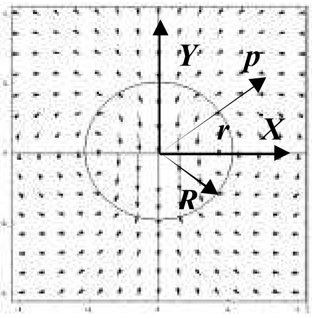


Fig. 1.1

$$- \Omega_{int} \Leftarrow \frac{4 \pi G \rho}{c^2} \cdot \left[\omega \left(\frac{2}{5} \cdot r^2 - \frac{1}{3} \cdot R^2 \right) - \frac{\mathbf{r} \cdot (\mathbf{r} \bullet \omega)}{5} \right] \qquad (1.10)$$

$$- \Omega_{ext} \Leftarrow \frac{4 \pi G \rho R^5}{5 r^3 c^2} \cdot \left[\frac{\omega}{3} - \frac{\mathbf{r} \cdot (\omega \bullet \mathbf{r})}{r^2} \right] \qquad (1.11)$$

(Reference: Eugen Negut, www.freephysics.org)
The drawing shows equipotentials of $-\Omega$.

For homogeny rigid masses we can write :

$$- \Omega_{ext} \Leftarrow \frac{G m R^2}{5 r^3 c^2} \cdot \left[\omega - \frac{3 \mathbf{r} \cdot (\omega \bullet \mathbf{r})}{r^2} \right] \qquad (1.12)$$

2. Saturn's rings.

2.1. Basic data

Some basic data concerning Saturn will allo w us to calculate the gyrotation at any point of space.

- diameter at its equator : 120.536 kilometres
- mass : 5,69 E+26 kg
- rotation period : 10,233 hours

- Saturn's rings :

Name	Distance* (km)	Width (km)	Thickness (km)	Optical Depth	Mass (g)	Albedo
D	66,000 - 73,150	7,150	?	0.01	?	?
C	74,500 - 92,000	17,500	?	0.05 - 0.35	1.1×10^{24}	0.12 - 0.30
Maxwell Gap	87,500	270				
B	92,000 - 117,500	25,500	0.1 - 1	0.8 - 2.5	2.8×10^{25}	0.5 - 0.6
Cassini Div	117,500 - 122,200	4,700	?	0.05-0.15	5.7×10^{23}	0.2 - 0.4
A	122,200 - 136,800	14,600	0.1 - 1	0.4-0.5	6.2×10^{24}	0.4 - 0.6
Encke gap	133,570	325				
Keeler gap	136,530	35				
F	140,210	30 - 500	?	0.01-1	?	0.6
G	164,000 - 172,000	8,000	100 - 1000	10^{-6}	10^{20}	?
E	180,000 - 480,000	300,000	1,000	10^{-5}	?	?

* The distance is measured from the planet centre to the start and to the end of the ring.

2.2. Formation of rings.

Every orbital mass will get a pressure towards Saturn's equator plane. We consider a prograde orbit (fig.2.1).

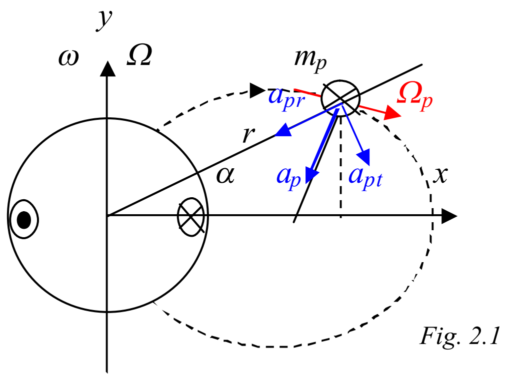


Fig. 2.1

If $v_p = r\ \omega_p$ is the orbit velocity of the mass m_p, it gets an acceleration: $\boldsymbol{a_p} \Leftarrow \boldsymbol{v_p} \times \boldsymbol{\Omega_p}$ where a_p is pointed in a direction, perpendicular on the equipotential path. One finds the tangential component a_{pt} and the radial component a_{pr} out of (1.11).

The acceleration a_{pt} always sends the orbit of m_p toward the plane of the equator of m in a prograde orbit. The component a_{pr} is responsible for an small orbit diameter decrease and a small increase of velocity, due to the law of conservation of energy :

$$v = (GM/r)^{-1/2} \qquad (2.1)$$

2.3. Formation of gaps between the rings

The gyrotation pressure caused by a_{pt} will tend to flatten the rings until almost zero. This is more or less possible as far as the material is exclusively made of solids. With gasses, we will have a different situation, explained in next section.

At the beginning, the gyrotation's angular collapse is causing a high density at every place of the ring because Saturn's gyrotation pressure pushes the ring to be as thin as possible. At first, the density is more or less uniform, slightly increasing or decreasing at larger or shorter distance from Saturn, depending from the original local density of the cloud around Saturn, before the collapse. After the collapse, the gyrotation forces will keep the ring very thin closer to Saturn, and less thin at larger distances.

The following phenomena will occur now, caused by gravitation : the high local density of the ring will force a conglomeration of masses.

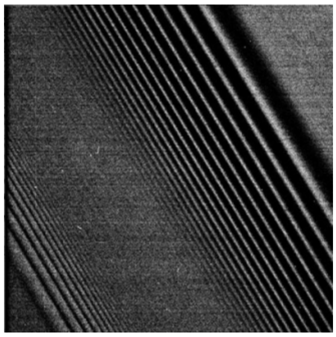
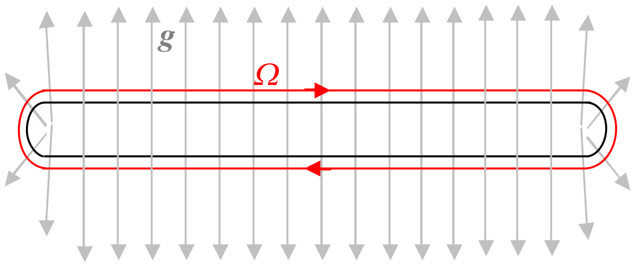


Fig. 2.2 *Saturn's A ring*

We get a ring whose section is shown in fig. 2.3 having its own gyrotation fields. The gyrotation from Saturn is not taken in account here, because it gives a quasi uniform extra almost vertical field. In fig. 2.4, we show the gyrotation forces working on the ring, and a field which is perpendicular to it, representing gravitation.

Fig. 2.3



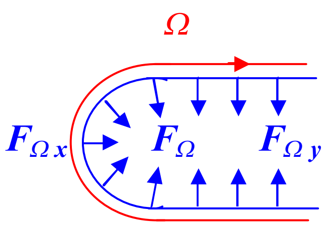


Fig 2.4

Near the edges of the upper side of the ring, a gyrotation force is acting due to the velocity of the edge's part and its mass, given by equation (1.1).

The gyrotation force has got two components, and the vertical one, $F_{\Omega y}$ (fig. 2.4) tries to reduce the thickness of the ring, and exactly the same is happening at the down side of the ring, at the same place x, where an upwards $F_{\Omega y}$ acts.

At the edge however, a greater compression is created by the component $F_{\Omega x}$, which increases the density of the edge. The mass flow density increases as well, and gyrotation increases, helping the gravitation forces. Indeed, the ring is made of blocks, and gyrotation forces make these blocks really move. Every motion however will have consequences for the energy conservation law between gravitation and centrifugal forces, expressed by (2.1).

The blocks that move away from Saturn will get an orbit which slows down and the blocks at the other edge of the ring will get a faster orbit velocity. Very probably, the blocks at each edge will get a turbulent double circular motion and consequently endure many collisions (fig. 2.5.a), while the rest of the ring tries to remain in the correct orbit without turbulences. The edges become more compact but turbulent, and probably the blocks become smaller and more numerous because of the many collisions. In section 2.4 , it will become more obvious how we come to this turbulent double circular motion, when we will handle the process with gasses.

Even a small change of the edge's outline, or a small gap between the edge region and the rest of the ring will allow the

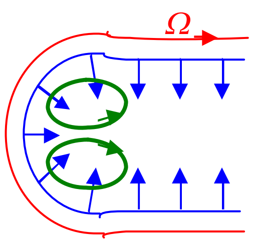


Fig 2.5.a

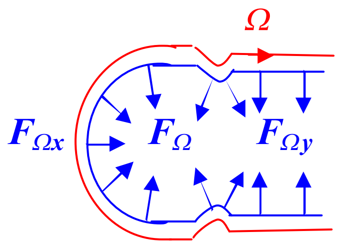


Fig 2.5.b

gyrotation forces to change it's shape (fig. 2.5.b) and get opposite gyrotation forces $F_{\Omega x}$ at the split point. Slowly but surely, the edge's shape becomes circular due to the new orientation of the gyrotation forces.
Turbulent motions decrease and a more stable tiny ring is created out from the edge, helped by both gravitation and the novel gyrotation forces.

When this part has been separated (and the same happened at the other edge of the ring) we get a new shape of the gyrotation equipotentials ' paths, as shown in fig. 2.6.

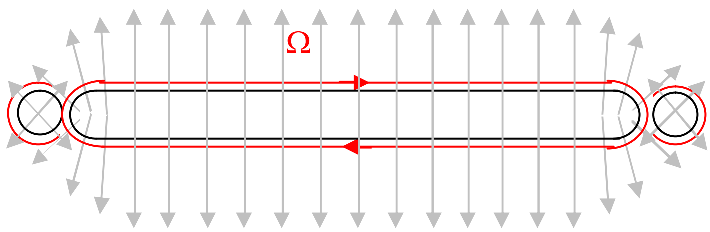


Fig. 2.6

The separations reduces the width of the remaining ring.

But still, the same process is able to split off another mass of the new formed edges. In this example, the next separated mass will be all nearly as big as the first one. In reality, the size of the new ring is somewhat different : the influence of the first separated tiny ring reduce slightly the compression power of Ω at the new edges of the large ring. Every new separated mass is then successively slightly smaller than the previous one.

The result is a succession of separations of ring-shaped masses, which become smaller and smaller the more we reach the centre of the original ring.
The larger the separated mass, the larger the gap near it, what means that the average density remains uniform as it was before the separations.

2.4. Ring F : rotating gasses.

The shape of a part of the ring F is strange: its looks like drops or clumps; it was thought that it was a succession of tiny moons (fig. 2.6). In fact, we will show below that it is a beautiful demonstration of the gyrotation forces.

Let's start from the assumption that this part of the ring is a gas cloud, or made out of fine particles.
The gyrotation acceleration on a particle of the cloud is pointed perpendicularly on the gyrotation :

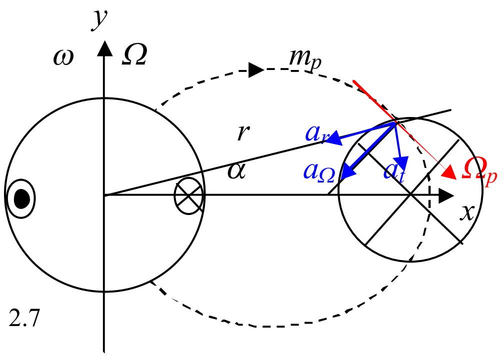


Fig. 2.7

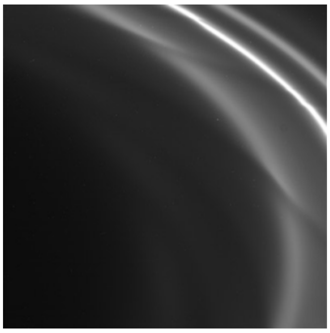


Fig. 2.6 Ring F

$\boldsymbol{a}_\Omega \Leftarrow \boldsymbol{v} \times \boldsymbol{\Omega_p}$ (fig. 2.7).

The acceleration $\boldsymbol{a}_\Omega$ creates a new equilibrium with the centrifugal force besides the pure gravitation, and flattens the cloud. Gasses however do not remain at rest. When a particle is moving in the direction as shown in fig. 2.9.a (a

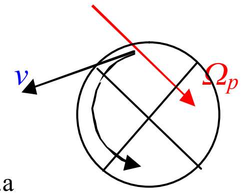


Fig. 2.9.a

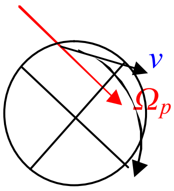


Fig. 2.9.b

detailed view of fig. 2.7), the displacement towards Saturn will result in a higher orbit speed due to equation (2.1).

At the other hand, an acceleration $\boldsymbol{a}_\Omega \Leftarrow \boldsymbol{v} \times \boldsymbol{\Omega_p}$ which is now pointing against the orbit velocity vector, is tending to slow this orbit velocity down. And this will bring the particle again in a higher orbit, farther from Saturn, due to the conservation of energy (potential and kinetic). The result is a left turning screw movement.

A particle however shown in fig. 2.9.b will get a force pointing in the direction of the orbit velocity, increasing it, and this will bring it in a lower orbit due to equation (2.1). And again, the rotation continues, this time as a right-hand turning screw movement. An important difference compared with the case of fig. 2.9.a is that the forces are smaller because of the smaller angle between v and Ω_p.

Fig. 2.9.c

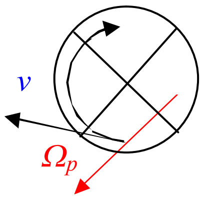
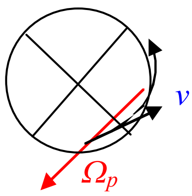


Fig. 2.9.d



As we can see in fig. 2.9.c and 2.9.d, the given velocities will create an inverse rotation compared to the former cases. When $\boldsymbol{a}_\Omega$ is increasing the orbit velocity, this happens in a higher orbit, and when it decelerates the orbit velocity, this happens in a lower orbit.

We conclude that the spiral rotation is double : a mainly left-rotating screw for the upper part of the cloud becoming then larger (fig.2.9.a, then fig 2.9.d), and mainly right-rotating screw for its lower part becoming then also larger (fig.2.9.a, then fig 2.9.d). Both actions are occurring at the same time, and cause drop-like shapes or knots in the rings.


Fig. 2.10 Knots, part of Encke Gap


Fig. 2.11 Rippling rings, part of Encke Gap

Concerning the gyrotation of the gas ring itself, it is only causing a radial or an increasing or decreasing orbital movement (fig. 2.9.e), and does not influence the described phenomena.

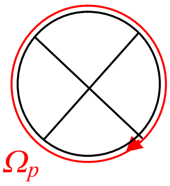


Fig. 2.9.e

Finally, we should insist on the reason why these ribbed rings are more evidently present at the edges of the rings. The reason has been explained in section 2.3 : the turbulence of the original edges is much higher than in the other parts of the ring, causing smaller particles by collisions and by the more adequate orientations of the gyrotation forces.

3. Conclusion

The gyrotation, defined as the transmitted angular movement by gravitation in motion, is a plausible explanation for the formation of the Saturn thin disc, the tiny rings, and the drop-like or ribbed rings. It explains many cosmic phenomena described in : "*A coherent dual vector field theory for gravitation*" De Mees, T., 2003 as well.

4. References

See reference list of :

De Mees, T., 2003, A coherent dual vector field theory for gravitation.