On the geometry of rotary stars and black holes

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Abstract

Encouraged by the great number of explained cosmic phenomena by using the Maxwell Analogy for Gravitation(7,8,9) (or the "Heaviside field") instead of the General Relativity Theory, we study closer the fast rotary stars that we have studied earlier(7). We find the detailed reason for the double-lobes explosions of supernova, and for the equator explosions. A part of the star is insensible to fast rotation, and at the contrary is more attracting the faster it spins. We find for spherical stars important velocity-independent angles, defining partly their final torus-like shape.
We found this by recognizing that moving masses generate a second field, analogue to magnetism, that we call *gyrotation*(7).

Keywords. Maxwell analogy – gravitation – star: rotary – black hole – torus – gyrotation – methods : analytical
Photographs : ESA / NASA

Index

The first and second chapter are summaries of chapters 1 to 4 of reference 7.

1. Introduction : the Maxwell analogy for gravitation, summarized.

The Maxwell Analogy for gravitation can be put in the compact equations, given by Heaviside[(4)].

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 $\mathbf{g}$, the so-called "gyrotation field" as $\boldsymbol{\Omega}$, and the universal gravitation constant as $G = (4\pi\ \zeta)^{-1}$. We use sign ⇐ 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. $\mathbf{F}$ is the induced force, $\mathbf{v}$ the velocity of mass m with density ρ. Operator × is used as a cross product of vectors. Vectors are written in bold.

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

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

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

where $\mathbf{j}$ is the flow of mass through a surface. The term $\partial\mathbf{g}/\partial t$ is added for the same reasons as Maxwell did: the compliance of the formula (1.3) with the equation

$$\text{div}\ \mathbf{j} \Leftarrow -\,\partial\rho\,/\,\partial\, t$$

It is also expected

$$\text{div}\ \boldsymbol{\Omega} \equiv \nabla\ \boldsymbol{\Omega} = 0 \qquad (1.4)$$

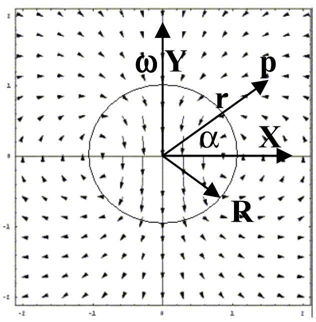
and

$$\nabla\times\mathbf{g}\ \Leftarrow\ -\,\partial\,\boldsymbol{\Omega}\,/\,\partial\, t \qquad (1.5)$$

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

2. Gyrotation of spherical rotating bodies in a gravitational field.

For a spinning sphere, the results for gyrotation are given by equations inside the sphere (2.1) and outside the sphere (2.2):



$$\boldsymbol{\Omega}_{\mathbf{int}} \Leftarrow \frac{-4\,\pi\,G\,\rho}{c^2}\left(\boldsymbol{\omega}\ \left(\frac{2}{5}\ r^2 - \frac{1}{3}\ R^2\right) - \frac{\mathbf{r}\ (\mathbf{r}\bullet\boldsymbol{\omega})}{5}\right) \qquad (2.1)$$

$$\boldsymbol{\Omega}_{\mathbf{ext}} \Leftarrow \frac{-4\,\pi\,G\,\rho\,R^5}{5\,r^3\,c^2}\left(\frac{\boldsymbol{\omega}}{3} - \frac{\mathbf{r}\ (\boldsymbol{\omega}\bullet\mathbf{r})}{r^2}\right) \qquad (2.2)$$

fig. 2.1

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

wherein • means the scalar product of vectors. For homogeny rigid masses we can write :

$$\boldsymbol{\Omega}_{\mathbf{ext}} \Leftarrow \frac{-\,G\,m\,R^2}{5\,r^3\,c^2}\left(\boldsymbol{\omega} - \frac{3\,\mathbf{r}\ \ (\boldsymbol{\omega}\bullet\mathbf{r})}{r^2}\right) \qquad (2.3)$$

At the surface of the sphere itself, we find, by putting $r = R$ in (4.2) and by replacing the mass by $m = \pi R^3 \rho \, 4/3$ the following equation:

$$\mathbf{\Omega_R} \Leftarrow \frac{-G\,m}{5\,R\,c^2}\left(\boldsymbol{\omega} - \frac{3\,\mathbf{R}\;(\boldsymbol{\omega}\bullet\mathbf{R})}{R^2}\right) \qquad (2.4)$$

When we use this way of thinking, we should keep in mind that the sphere is supposed to be immersed in a steady reference gravitation field, namely the gravitation field of the sphere itself .

3. Explosion-free zones and general shape of fast spinning stars.

The Critical Compression Radius for Rotary Spheres

When a supernova explodes, this happens only partially and in specific zones, forming so a magnificent symmetric shape. The purpose here is to find out why this happens so. Only the surface situation is analysed here. The accelerations due to gyrotation come from (1.1).

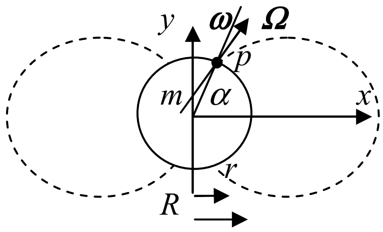


fig. 3.1

$$a_x \Leftarrow x\ \omega\,\boldsymbol{\Omega}_y = \omega R \cos\alpha\,\boldsymbol{\Omega}_y \qquad (3.1)$$

and

$$a_y \Leftarrow x\ \omega\,\boldsymbol{\Omega}_x = \omega R \cos\alpha\,\boldsymbol{\Omega}_x \qquad (3.2)$$

To calculate the gravitation at point p, the sphere can be seen as a point mass. Taking in account the centrifugal force, the gyrotation (we use (2.4) for that) and the gravitation, one can find the total acceleration :

$$a_{x,\,tot} \Leftarrow R\,\omega^2 \cos\alpha\left[1 - \frac{Gm\,(1-3\sin^2\alpha)}{5\ R\,c^2}\right] - \frac{G\,m\cos\alpha}{R^2} \qquad (3.3)$$

$$-\,a_{y,tot} \Leftarrow 0 + \frac{3\ Gm\,\omega^2 \sin\alpha\cos^2\alpha}{5\,c^2} + \frac{Gm\sin\alpha}{R^2} \qquad (3.4)$$

The gyrotation term is therefore a supplementary compression force that will stop the star from exploding. For elevated values of ω^2, the last term of (3.3) is negligible, and will maintain below a critical value of R a global compression, regardless of ω. This limit is given by the Critical Compression Radius, which is found by setting the non-gravitation terms in $a_{x,\,tot}$ equal to zero:

or

$$R = R_{C\alpha} \le R_C\,(1 - 3\sin^2\alpha) \qquad (3.5)$$

where R_C is the Equatorial Critical Compression Radius for Rotary Spheres :

$$R_C = G\,m\,/\,5\,c^2 \qquad (3.6)$$

The fig. 3.2 shows the gyrotation and the centrifugal forces at the surface and the outside of a spherical star, and fig. 3.3

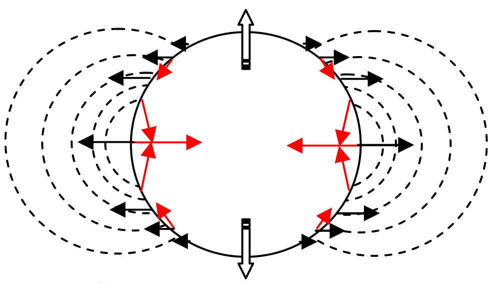


fig. 3.2

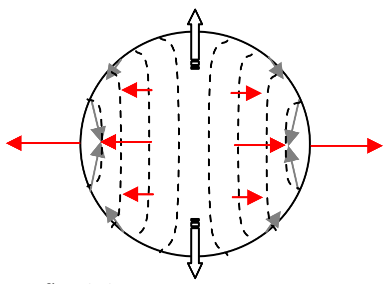


fig. 3.3

shows the gyrotation lines and forces at the inner side of the star. This can be found with (2.1) and (2.2).

Surface compression of fast rotating stars.

For spheres with $R \leq R_C$, a global surface compression takes place for each angle α wherefore $-\alpha_C < \alpha < \alpha_C$, and wherefore

$$\alpha_C = \text{arc sin } (3^{-1/2} (1 - R/R_C)^{1/2}) \qquad (3.7)$$

Remark that always $\alpha_C \leq 35°16'$, and it's value depends from the sphere's radius. Hence, explosions are exclusively expected under $-\alpha_C$ and above α_C .

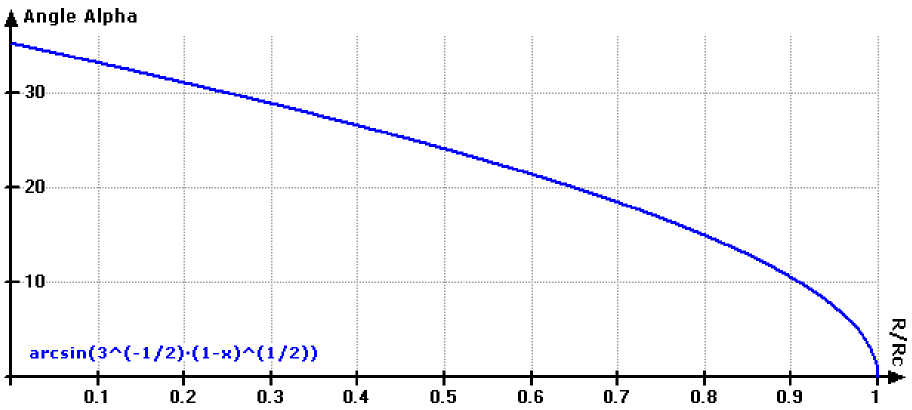


fig.3.4.

In fig.3.4 , the graph shows the relationship (3.7) between R/R_C and α_C for $a_{x,\ tot} = 0$ (we disregard the gravitation acceleration). When $R/R_C = 1$, only the equator is potentially protected against explosion. The smaller R, the larger the protection area ($-\alpha_C \leq \alpha \leq \alpha_C$) is where global compression occur.

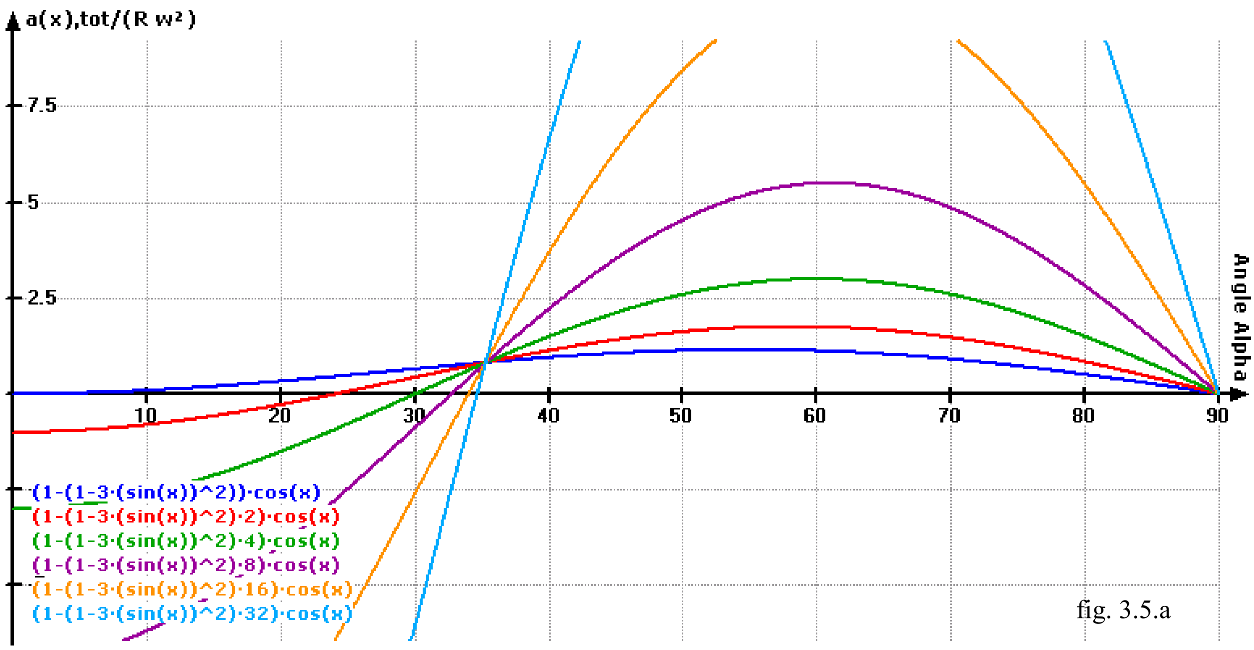


fig. 3.5.a

Another view is given in fig.3.5.a , where the spin-dependent factor of $a_{x,\ tot} /(R\ \omega^2)$ in (3.3), by using (3.6) and by setting $x = \alpha°$, has been calculated for several values of R/R_C (respectively 1, ½ , ¼ ,…, 1/32). Compression occur when the values are negative. We conclude that the smaller R/R_C , the wider the compression-area becomes.

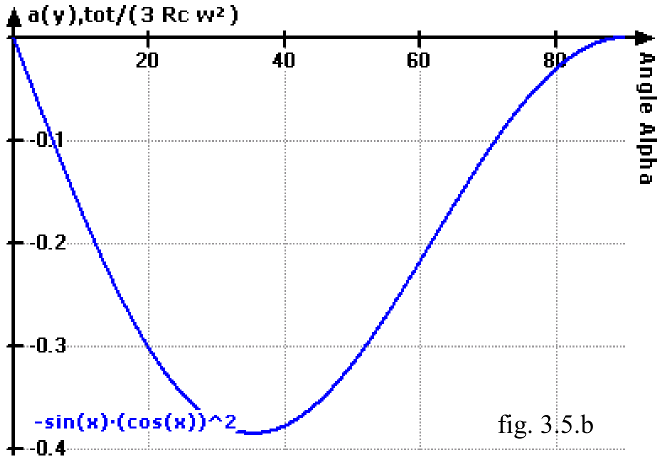


fig. 3.5.b

But even with very small values of R, only the range $-35°16'$ to $35°16'$ is a candidate to be explosion-free. Above $35°16'$ and under $-35°16'$, gyrotation is not able to provide any protection against outbursts. The most looseness area is obtained around 60°, becoming more explicit with decreasing values of R/R_C.

To a certain extend, fig.3.5.a shows the deformations at the surface of the rotating star with a non-rigid plasma.

In fig.3.5.b , where α is shown in [rad], we have drawn the values of (3.4), simplified to $a_{y,\ tot} /(3\ R_C\ \omega^2)$. Also here, we get the important angle $35°16'$, and this time it is the maximum compression angle.

The internal compression acceleration by gyrotation

Let us simplify the model for rigid and homogeny masses, and look inside the sphere at the accelerations. Using (2.1) and (3.1), and replacing ρ by $3\ m /(4\ p\ R^3)$ we find:

$$a_{x,\ tot} \Leftarrow r\ \omega^2 \cos\alpha \left\{ 1 - \frac{Gm}{5\ R^3\ c^2} \left[r^2\ (6 - 3\sin^2\alpha) - 5\ R^2 \right] \right\} - \frac{Gm\cos\alpha}{(1/r)R^3} \qquad (3.8)$$

$$-\ a_{y,tot} \Leftarrow\ 0 + \frac{3\ Gm\ \omega^2\ r^3 \sin\alpha \cos^2\alpha}{5\ R^3\ c^2} + \frac{Gm \sin\alpha}{(1/r)R^3} \qquad (3.9)$$

and we see immediately that condition (3.5) has to be amended : at the equator, $\mathbf{\Omega_{y,int}}$ becomes in fact zero at $r = (5/(6 - 3\sin^2\alpha_E))^{1/2} R$, which results in $r = 9/10^{th}\ R$ at $\alpha_{E,min} = 0°$, and at other values of α_E , the zero equipotential gradually evolutes to $r = R$ at $\pm\alpha_{E,max} = 19°28'$.

Consequently, the centrifugal force will be able to act effectively around the equator area and provoke explosions of about $1/10^{th}$ of the star's radius.

These very important equatorial ring-shaped mass losses are possible even when $R_{\alpha=0} < Gm/5c^2$ and thus, even when there is a global compression at the equator area. We need a further analysis of this zone in next section when we shall take in account the centrifugal acceleration as well.

From (3.5) also results that the shape of fast rotating stars stretches toward a toroid with a missing equator: if $\alpha \geq 35°16'$ the Critical Compression Radius becomes indeed zero. Radial contraction of the star will indeed increase the spin and change the shape to a kind of "tire" or toroid black hole.

In the next section, we will have a closer look at the internal conditions for absolute compression.

The equatorial explosion area

By analysing the zero-force equipotential inside the sphere at a certain radius r , we can work out the angle α in relation to this radius r at which the total acceleration is zero.

The compression condition for r in $a_{x,tot}$ is found when the left hand of (3.8) is negative, or:

$$r^2 \leq \frac{R^2\ (1 + 5\ R_C/R)}{R_C/R\ (6 - 3\sin^2\alpha)} \qquad (3.11)$$

In order to simplify, we have considered the gravitation force as being insignificant, which is true for fast rotating stars.

In fig.3.6, we show the graph of (3.11) for R = ¾ R_C , R = ½ R_C , R = ¼ R_C , and for very small R/R_C. The boundary of the sphere is shown as well. The x-axis is α and the y-axis is r/R. In the case of R = ½ R_C , only a very small region wherefore $-17°43' \leq \alpha_N \leq 17°43'$ is affected by an explosion zone, based on the spherical intersection point with the explosion area. About 4% of the equator radius can be blown out. We call R_N the remaining equatorial radius.

And when we take the limit to very small values of R, the following graph is found: an explosion zone around the

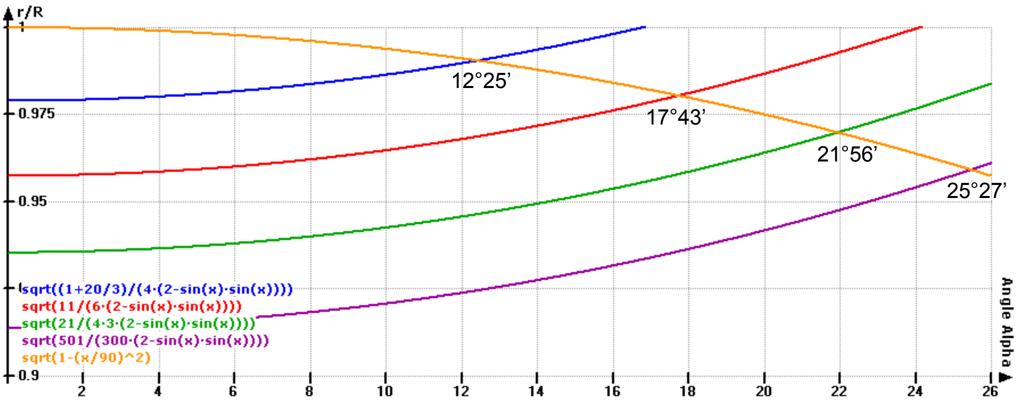


fig.3.6

equator of the sphere until about $\alpha_{N,max}$=25°27' with a blow-out opportunity of 9% of the radius (fig.3.6).

At this stage we are able to stress the global shape of fast rotating stars and to define the location of the possible outbursts.

The shape of fast rotating stars

Until now, we have found a number of criteria that are valid for fast rotating spheres:

1) When $R \leq R_C$, there exist a zone where no explosion can occur (considering gravitation as negligible).
2) The smaller R/R_C , the bigger the zone between the equator and the maximal compression angle α_C , where no outbursts can occur. The maximal possible explosion-free zone is $-35°16'$ to $35°16'$.
3) The equator is not explosion-free: when $R \leq R_C$, there exists a ring-shaped zone inside the sphere where an explosion may occur, pushing an equator belt outwards.
4) The smaller R/R_C , the larger the exploded zone around the equator, and the maximal explosion angle is about $\pm\alpha_{N,max}$=25°27', while about 9% of the equator can be blown out.
5) The area around 60° , having a top value (α , $a_{x,tot}$) depending from R/R_C , is the most looseness area.

The maximum compression area of $a_{y,tot}$ goes until $\pm\alpha = 35°16'$.

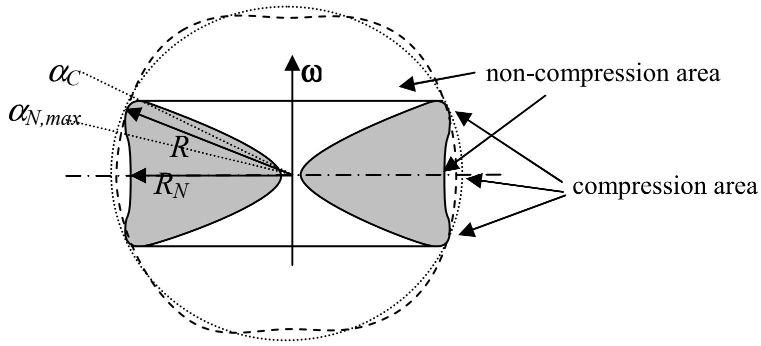


fig.3.7 : exploded rotary black hole

Using these criteria, the general geometry of a fast rotating star can be drawn, and the exploded star can be defined in general lines. A torus, limited by the angle α_C , beyond which no matter is present, and limited as well by the angle $\alpha_{N,max}$, which lays between α_C and the equator. At the equator, the radius is restricted to $R_N \leq R$ that can be found by setting $\alpha = 0$ in (3.11) (see fig.3.7).
The internal radius of the torus-like star is zero or almost zero after the explosion, according to the known criteria.

Validation of the theory

The theory can not yet be verified very precisely because the values of m, G, ω and R are not known for distant supernova and quasars.

However, observation of exploding stars shows the presence of an explosion at the equator and one at a zone above a certain angle, measured from the equator.

We claim the compliance between the theory and observation in its general aspect. In the next chapter however, we will see what happens with the remnants.

When the matter explodes, the theory predicts that the star's gyrotation obliges it to move in a prograde direction. The global motion will be spirally outwards. Finding evidence by observation is difficult for this property as well, because a high astronomic precision is necessary.

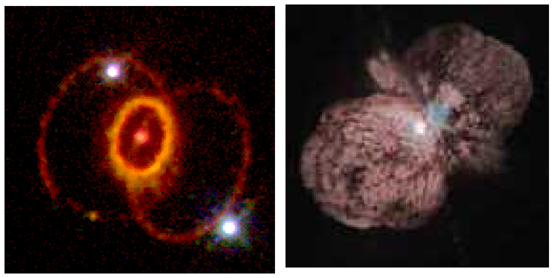


fig. 3.8

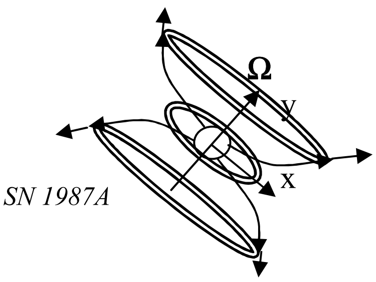
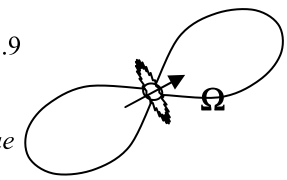


fig. 3.9



SN 1987A: a local mass loss took place on the equator and at the angle α_C. The zone near the poles exploded possibly much earlier, so it became a toroid-like shaped rotary star.

η Carinae : mass loss by complete shells, above α_C , forming two lobes with a central ring.

But in general lines, both observations agree perfectly with the theory with simple analytic calculus, which is a great improvement against the General Relativity Theory.

4. General remnants' shape of exploded fast spinning stars.

In the former chapter, we could see how the gravitation equations of spinning stars could explain their general geometry, and could define the explosion-free zones. In this chapter, we look more closely at the remnants.

Spherical spinning stars.

If a spinning sphere begins exploding, matter is leaving the surface tangentially. Gyrotation equipotentials are as shown in fig.4.1. The gyrotation acceleration will be oriented towards the equator and will generate a deviation of the matter in a widening prograde spiral. In the figure, fine dotted lines show the boundaries of the spirally escaping matter, which knock at the equator level. The plain line curved arrows are the paths of exploding matter.

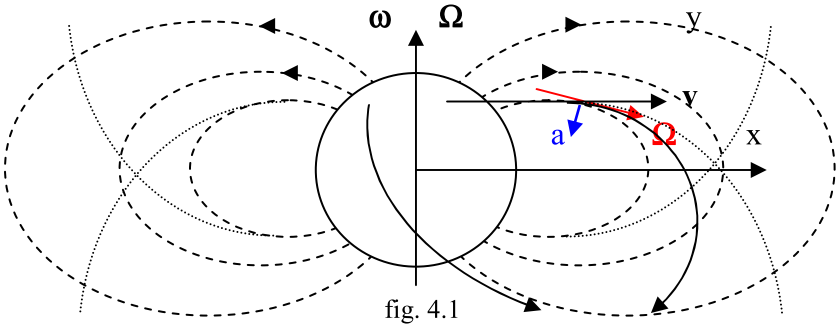


fig. 4.1

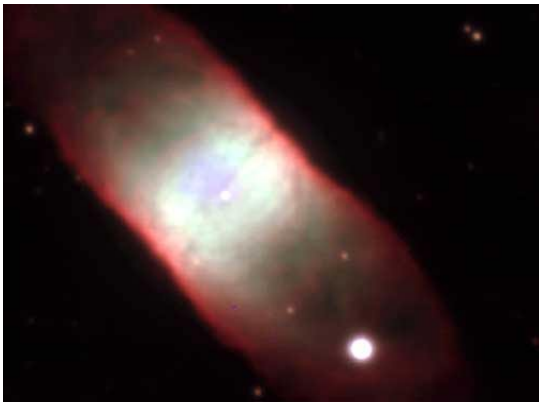


Fig. 4.2

The typical shape of such an explosion is shown in fig.4.2. The remnants are restricted to almost a cylinder. The equatorial region could possibly explode but not necessarily, depending on the rotation velocity. Besides, the star is not necessarily a black hole in order to get such a remnants shape.

We clearly see two cylindrical lobes, with in the middle a huge spherical halo around the spherical star. At the equator level, a line is visible (here, under a slight angle with the equator), which splits the halo in two hemispheres. This is the contact plane of knocking remnants of the northern and the southern hemisphere.

Spinning black hole torus.

The sphere explodes, and becomes hereafter a butterfly-shaped black hole torus.The gyrotation equipotentials of exploded black holes are expected to have a butterfly shape (fig.4.3, dotted lines). When new matter is blown out tangentially, and this happens above the limit α_C (fig.4.3, curved plain line), the gyrotation acceleration will be oriented away from the equator, and deviate the matter in a widening prograde spiral, due to (1.1). In fig.4.3, we have represented a flattened sphere and two sections of the black hole torus.The black hole arose indeed after a strong reduction of the diameter of the original sphere and after a flattening of the poles in an ellipsoid shape, with a strong increase of the spinning velocity as a consequence.

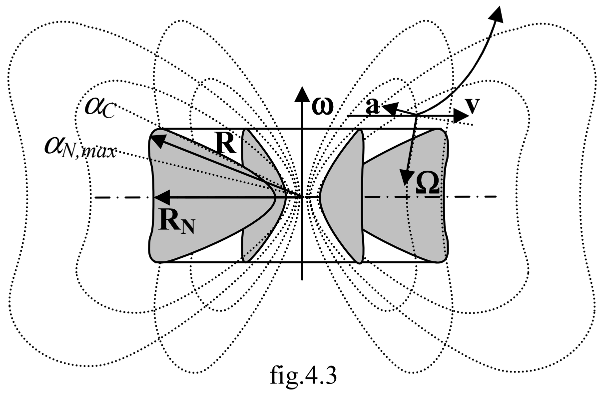


fig.4.3

A typical example for these remnants is given by the supernova *SN 1987A* (fig.3.8), while η *Carinae* doesn't show it as clearly, but has probably also gotten an identical process.

5. Conclusions.

The Maxwell Analogy for Gravitation gives a clear picture of what we can expect as the conditions for a rotary black hole with non-exploding regions.

When $R \leq R_C$, there exist zones where no explosion can occur (if gravitation is negligible). The smaller R/R_C , the larger the area between the equator and the maximal compression angle α_C , where no outbursts can occur. The maximal possible explosion-free zone is $-35°16'$ to $35°16'$.
The equator is not explosion-free: when $R \leq R_C$, there exist a zone where an explosion may occur. The smaller R/R_C , the larger the exploded zone around the equator, and the maximal explosion angle is about $\alpha_{N,max}$=$20°$, while about 9% of the equator can be blown out.

The shape of fast spinning stars that did explode due to the spin velocity, ends-up to a torus-like black hole with a missing equator-zone.

The remnants of spinning spheres will form two lobes of prograde spirally matter, but unlikely an equatorial explosion. At the other hand will the northern and the southern remnants knock at the equator level, and form a halo between the two lobes.
For fast spinning black holes which exploded before, new burst-outs will form two lobes of prograde spirally matter, and will follow a path outwards, without passing over the equator.

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