The Doppler Effect, Dark Universe, Variable Stars and Galaxies

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Abstract

The dark universe represents a concept of present physics and cosmology that regards whether great stellar systems or elementary particles. The first question, that has to be considered, concerns its effective existence because there are at present only a few experimental proofs and its existence is purely theoretical and it is due to the difference between total matter and energy predicted by theoretical calculations and those deriving from experimental measurements. The second question regards its physical nature. In general at least a part of dark matter is explained in the present physics by the gravitational theory like in the event of black holes. In the order of the Theory of Reference Frames (TR) dark matter, in all possible shapes including black holes, is explained by the relativistic theory of the Doppler Effect, whether for cosmological systems or for elementary particles and besides the Doppler Effect represents also an useful theoretical tool for explaining the physical behaviour of variable stars and galaxies.

1. Introduction

In present physics dark matter would be represented by matter of the universe that would emit electromagnetic energy in no band of frequencies and it would be detectable only as per its gravitational effects that however are smallest at great distance. In the Theory of Reference Frames dark matter is the matter that even thought it emits e.m. energy on macrocopic and microscopic scale, that energy isn't detectable by observer and by conventional instruments of measurement. It is manifest that there is a clear difference between the two explanations: in the first case (present physics) there isn't emission of e.m. energy, in the second case (Theory of Reference Frames) the emission of e.m. energy there is but it isn't possible to detect it.
Dark matter not must be confused with antimatter that a low energy isn't detectable and it doesn' exist because of the Principle of Asymmetry[1]. At highest energy instead elaborate methods of measurement have detected the presence of particles of antimatter in quantities that are comparable to particles of matter. As we specified[1] it is due to the fact that in high energy unstable antiparticles don't tend to group together but they maintain the free state and don't generate like this phenomena of annihilation and consequently they are detectable at high energy.

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At low energy instead antiparticles of antimatter (largely positrons and antiprotons) tend to group together like particles of matter, respectively electrons and protons, but unlike particles, they generate unstable atomic systems that produce annihilation particles-antiparticles and consequently dissolution of antimatter.
According to calculations of postmodern physics in the universe there would be about a 5% of known matter, about a 27% of dark matter and about a 68% of dark energy.
The reliability of these calculations has to be demonstrated and it is based on the hypothesis of knowing the exact total quantity of matter existing in the universe and on the difference between the theoretical calculation and the result of matter that has been effectively measured. In TR (Theory of Reference Frames) the total quantity of matter that is present in the universe isn't hypothesized and percentages of dark matter in different shapes aren't given, but anyway it is proved the dark matter can be in the following shapes:

a. dark bodies on macroscopic and cosmological scale
b. dark particles on micro and nanoscopic scale relative to elementary particles

Macrophysical and cosmological systems, that generate an effect of dark matter in concordance with what it has been said in the order of TR, are called "dark bodies", i.e. matter that emits e.m. energy but it isn't detectable and measurable. Similarly "dark particles" are microphysical and nanophysical systems that generate the same effect.
Black holes, that represent a shape of dark matter, are explained in postmodern physics by the gravitational theory, in TR instead they are explained by the relativistic theory[2].
It is suitable to specify dark bodies don't have to be confused with "black bodies" that are bodies that absorb perfectly all incident electromagnetic radiation without reflecting it, including the visible radiation, and then they emit largely in frequency band of non-visible infrared radiation of thermal origin, from which the name of black body.
Besides some celestial bodies, like planets of the Sun system, don't emit electromagnetic energy because they don't generate it, but reflect e.m. coming from stars and therefore they are visible and don't belong to dark matter.

3. Black holes in the gravitational theory

Black holes belong to dark matter and they are unobservable celestial bodies because they don't emit electromagnetic radiation. The physical nature of black holes is explained in postmodern physics by the gravitational theory that considers black holes like supermassive bodies in which the attractive force (in the Newtonian model) and the curvature of spacetime (in the Eisteinian model) would be so strong that the escape velocity would be greater than the speed of light, preventing like this any matter object and any energy radiation from going out through the region bounded by the event horizon of black hole. In the Newtonian model the escape velocity is given by[2]

$$v_e = \sqrt{\frac{2GM}{r}} \tag{1}$$

For light and for electromagnetic radiations, that travel at the physical speed of light c, the escape speed v_{ec} is

$$v_{ec} = c = \sqrt{\frac{2GM}{R_S}} \tag{2}$$

in which M is mass of body that generates the black hole and

$$R_S = \frac{2GM}{c^2} \tag{3}$$

is Schwarzschild's distance that represents the maximum distance from the barycentre of black hole where light and e.m. radiations remain trapped into black hole. That distance would coincide with the radius of the event horizon.
For a black hole with the Sun mass, the Schwarzschild distance is 2.95km and with the Earth mass is 8.85mm, therefore in both cases Schwarzschild's radii are smallest with respect to ordinary radii of the two celestial bodies. Recently a few groups of research have announced they have observed black holes with greatest masses, however calculations show a black hole has to respect always the relation $M \geq 0.675 \times 10^{27} R_S$ [kg].
In the Einsteinian model the gravitational explanation of black hole is given by the combination of the Schwarzschild distance with the relation of the curvature spacetime C demonstrated by Einstein in General Relativity (1916)

$$C = \frac{4GM}{c^2 r} \tag{4}$$

At the Schwarzschild distance it is

$$C_S = 114.65° \text{ (angular degrees)} \tag{5}$$

that is the smallest bending in order to have a black hole for any mass. It is possible in the Einsteinian model, like in the Newtonian model, only if in the universe there are celestial bodies that have $M/R_S \geq 0.675 \times 10^{27}$ [kg/m].
Therefore, whether in the Newtonian model or in the Einsteinian model, black holes are supermassive celestial bodies that don't emit light and e.m. radiations outside the even horizon.
In the Theory of Reference Frames instead a different interpretation of this phenomenon is considered, based on the hypothesis that those celestial bodies emit light and e.m. radiations, but these are unable to reach the observer and consequently they cannot be detected by instruments of measurement.

In the Theory of Reference Frames these celestial bodies (black holes) are called in actuality "dark bodies" and it is clear that the concept of even horizon in this interpretation is altogether unnecessary.

4. Dark bodies in the Theory of Reference Frames

In the Theory of Reference Frames[2] dark bodies are celestial bodies that move away with a greater relativistic velocity **V** than the physical velocity **c** of light with respect to the reference frame S[O,x,y,z,t] of the observer, supposed at rest (fig.1).
Let us suppose that **c** is the physical velocity of light or of any electromagnetic radiation generated by these bodies, referred to the reference frame S'[O',x',y',z',t'] of the same body in inertial motion, let us suppose still that these celestial bodies have a departure speed V>c with respect to the reference frame S of the observer, supposed at rest. Then the relativistic speed c_r of light and of electromagnetic radiations emitted by the body, with respect to the system S, is directed always into reverse with respect to the observer and consequently those radiations will reach never the observer causing an optical phenomenon of darkening.
In fact the relativistic velocity $\mathbf{c_r}$ of light and of electromagnetic radiations with respect to the reference frame of the observer is given in vector shape by

$$\mathbf{c_r} = \mathbf{c} + \mathbf{V} \qquad (6)$$

and it is directed always into reverse with respect to the observer, like in figure, because for hypothesis V>c.

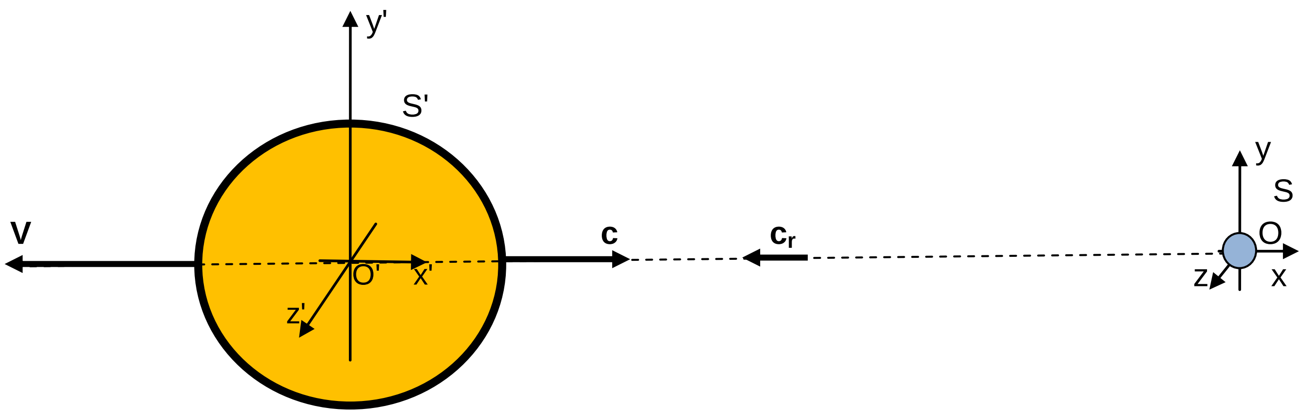

Fig.1 Graphic representation of dark bodies in TR

In TR the existence of dark bodies is explained therefore by the relativistic theory and the effect of dark body happens when the departure speed of the celestial body with respect to the reference frame S of the observer, supposed at rest, is greater than the physical speed of light (V>c). The same effect happens also when V=c.

The physical behaviour of dark bodies may be explained and interpreted also by the relativistic Doppler effect.

5. Doppler effect of dark bodies with linear motion

In fig.2 S[O,x,y,z,t] is the resting reference frame and S'[O,x',y',z',t'] is the moving reference frame, the relative velocity v is for the sake of argument parallel to the common direction of axes x and x'. Light moves, always for sake of argument, along the direction OO', Φ_1 is the angle between the direction of light ray and the direction of **v** when the light source is in O' and the observer in O, $\Phi_2=\pi-\Phi_1$ is instead the angle between the direction of light and the direction **v** when the light source is in O and the observer is in O'.
The analytic study of frequency shifts due to the Doppler effect[3][4][5]6] shows that equal results are obtained in the following two cases, independently of whom is moving:

a) observer at rest and source in motion
b) source at rest and observer in motion

It proves there is a perfect physical symmetry in the two situations and frequency and wavelength shifts depend ony on the relative velocity **v** and not on whom is in motion.
If we call f_m and λ_m the frequency and the wavelength measured by observer and f_s and λ_s the frequency and the wavelength emitted by the source we have shifts of frequency and of wavelength for every direction depend on the angle Φ_2 and they are given by

$$f_m = f_s\sqrt{1+\frac{v^2}{c^2}-2\frac{v}{c}\cos\Phi_2} \qquad (7)$$

$$\lambda_m = \frac{\lambda_s}{\sqrt{1+\frac{v^2}{c^2}-2\frac{v}{c}\cos\Phi_2}} \qquad (8)$$

The longitudinal Doppler effect is deduced putting in (7) and (8) $\Phi_2=0$ from which $\Phi_1=\pi$ (case of departure between source and observer) and $\Phi_2=\pi$ from which $\Phi_1=0$ (case of approach), for which in frequency we have

$$f_m = f_s\,(1 \pm \beta) \qquad (9)$$

and in wavelength

$$\lambda_m = \frac{\lambda_s}{1 \pm \beta} \qquad (10)$$

with β=v/c, in which v represents the relative speed between the two reference frames, f_m and λ_m are frequency and wavelength measured, f_s and λ_s are frequency and wavelength of emitted radiation by source.

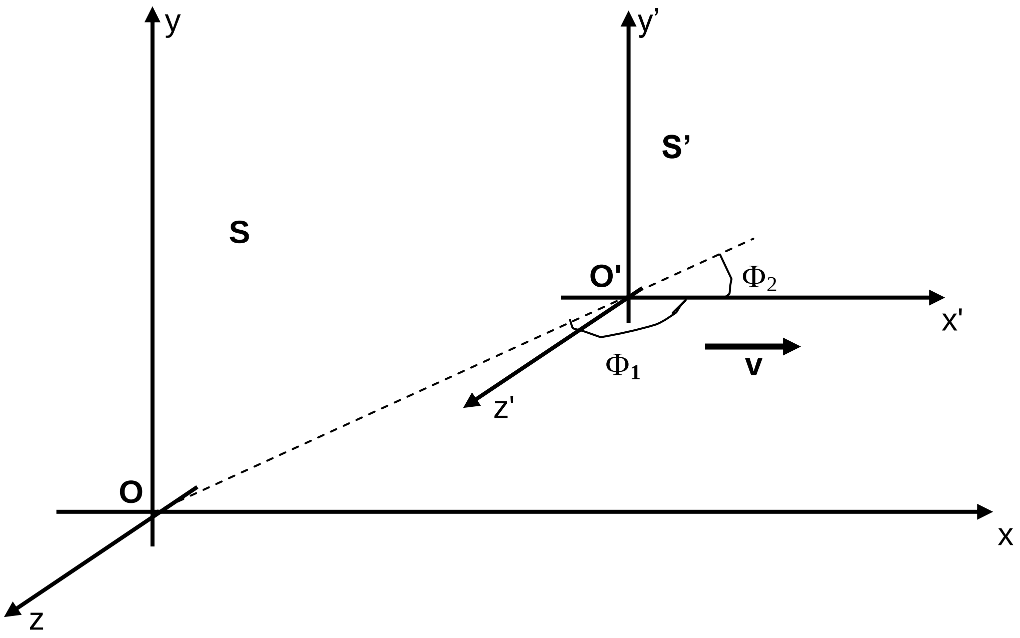

Fig.2 S[O,x,y,z,t] is the resting reference frame and S'[O',x',y',z',t'] is the moving reference frame. In the graph is $\Phi_2 = \pi - \Phi_1$.

In relations (9) and (10) the blueshift is defined by the sign + and the redshift by the sign - , consequently in the event of departure it occours to consider the sign -.
Doppler effects that generate redshift are graphed in fig.3 relative to frequency and in fig.4 for wavelength relative to the longitudinal effect. In figure only redshift effects are graphed because only them are revealing in the study of dark matter.
Let us observe from (9) and (10) a relative velocity v, equal to the physical speed c of light, generates zero Doppler frequencies and infinitely great Doppler wavelengths.
Greater relative speeds than the physical speed of light generate decreasing negative frequencies and increasing negative wavelengths. In physics only complex quantities can generate problems, while negative real quantities raise no problem.
The positive redshift for smaller relative speeds than the physical speed of light between source and observer is simple to interpret: in fact it defines a decrease of measured positive real frequency and an increase of measured positive wavelength when the relative speed of departure between source and observer increases.
The negative redshift due to greater relative speeds than the physical speed of light corresponds just to the physical situation of bodies that move away with greater relative speed than the physical speed of light, that we examined in the preceding paragraph, and therefore they are dark bodies that in that case are also dark Doppler sources.

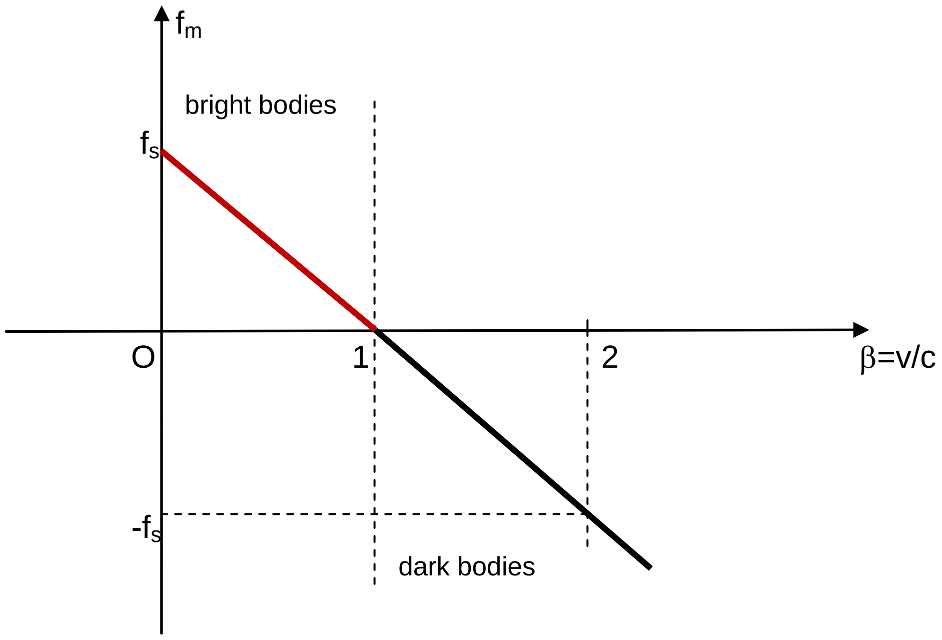

Fig.3 Redshift of the longitudinal Doppler effect in frequency

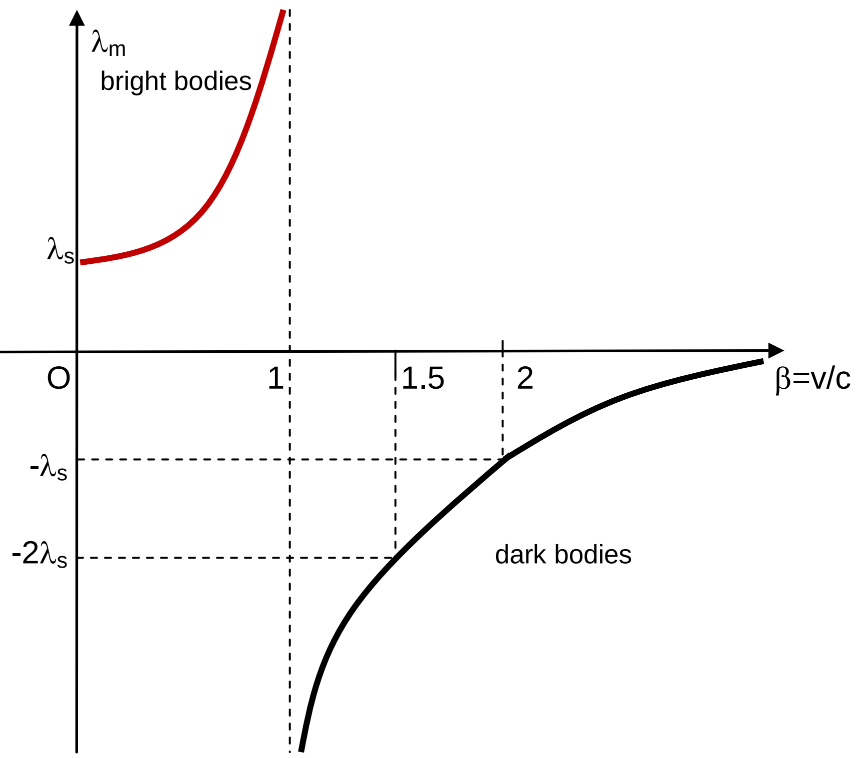

Fig.4 Redshift of the longitudinal Doppler effect in wavelength

The behaviour of dark bodies is represented in figures by graphs in black.

6. Cosmological systems with rotary motion and variable stars

The Doppler effect can be defined also for rotary systems, in particular for rotary stars and galaxies that emit electromagneyic energy from the surface. Let us suppose that stars and galaxies have spherical symmetry. Let us distinguish two cases:

6.1 Fixed rotary stars or galaxies
6.2 Moving rotary stars or galaxies

6.1 Fixed rotary stars and galaxies

S[O,x,y,z,t] is the reference frame, supposed at rest, of the observer, and S'[O',x',y'z',t'] is the reference frame, supposed at rest of rotary star or galaxy (fig.5). Let us suppose then axes x and x' are parallel and concident, what we will say for stars is valid also for galaxies. If R is the radius of rotary star, supposed with spherical symmetry, and d_o is the distance between the origins of the two reference frames, generally it is $R \ll d_o$ and $d \approx d_o$. If still Φ_t is the latitude and Φ_g the longitude (fig.6) of any point that is placed on the surface of the rotary system with clockwise constant angular speed ω, with the axis of rotation that is perpendicular to plans (z',x') and (z,x), we have from fig.5

$$r = R\cos\Phi_t \qquad (11)$$

in which r is the radius of the parallel to the latitude Φ_t and R is the radius of the parallel at the equator.

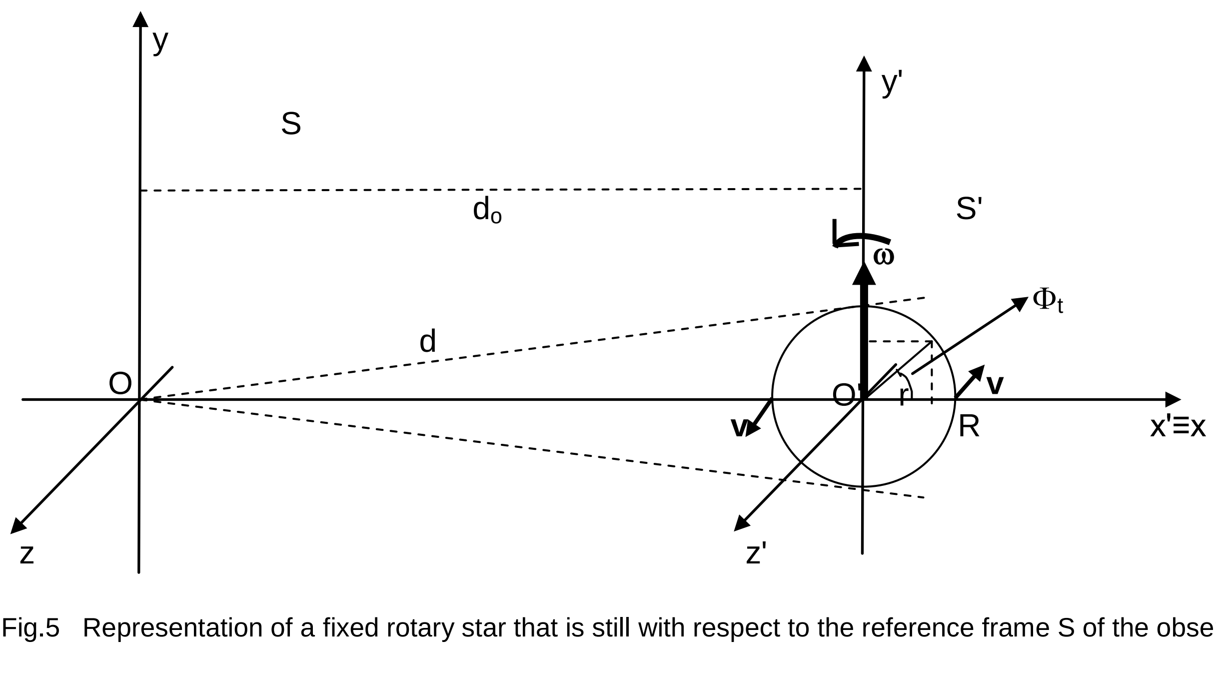

Fig.5 Representation of a fixed rotary star that is still with respect to the reference frame S of the observer

The tangential velocity at the equator is

$$v = \omega R \qquad (12)$$

and therefore the tangential velocity v_r in correspondence of the parallel with radius r, at the latitude Φ_t, is given by

$$v_r = \omega r = \omega R\cos\Phi_t \qquad (13)$$

The tangential velocity is constant along a parallel at all longitudes.
Considering the horizontal section of the spherical rotary star at the latitude Φ_t (fig.6), the component v_{rx} of the tangential velocity at the longitude Φ_g , measured starting from the axis z', is given by

$$v_{rx} = v_r\cos\Phi_g = v\cos\Phi_t\cos\Phi_g \qquad (14)$$

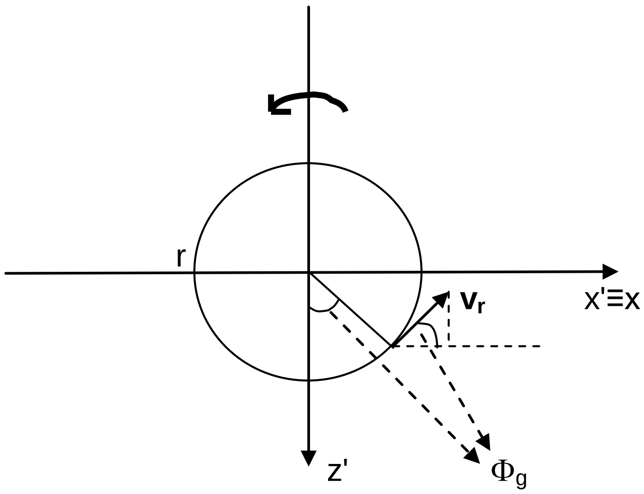

Fig.6 Horizontal section in the plane (z',x') of the fixed rotary star with the longitude Φ_g

The longitudinal Doppler effect at every latitude is given by

$$f_m = f_s \frac{c - v_{rx}}{c} \qquad (15)$$

from which for the (14) we have

$$f_m = f_s \left(1 - \frac{v_r}{c}\cos\Phi_g\right) \qquad (16)$$

Putting $\beta_r = v_r/c$, it is possible to write

$$f_m = f_s - \beta_r f_s \cos\Phi_g \qquad (17)$$

The fig.7 represents the (17), i.e. the graph of the longitudinal Doppler effect, regarding a fixed rotary star, when the longitude Φ_g changes for every value of latitude defined by β_r.

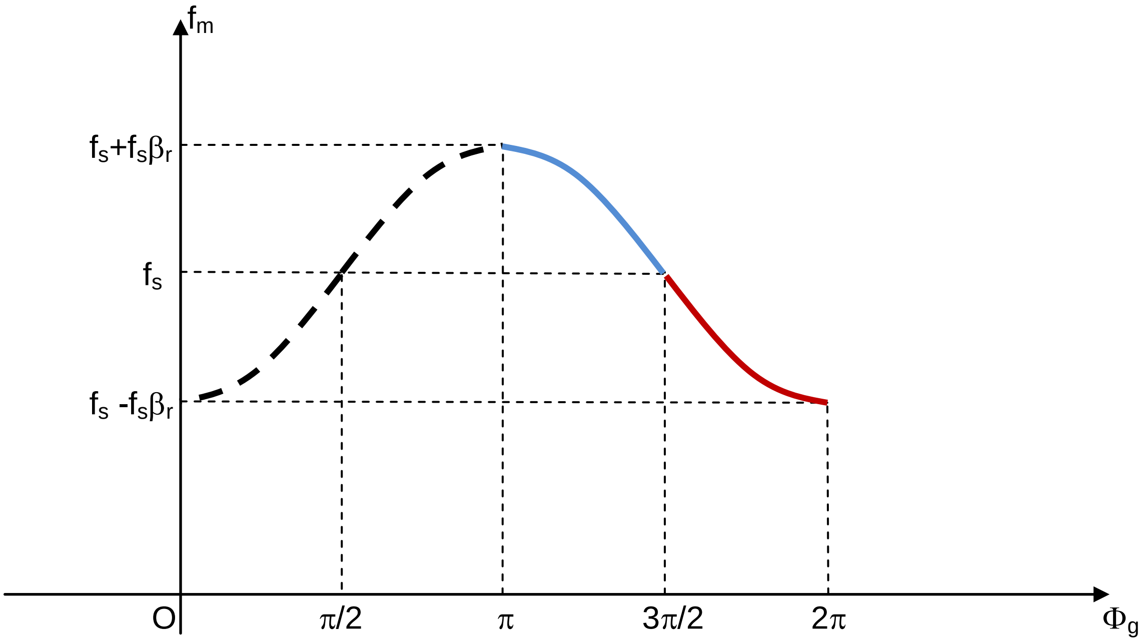

Fig.7 Spectrum of the variable shift in frequency of a fixed rotary star in function of the longitude in the plane (x',z')

We observe in the longitude interval $\Phi_g\,(0, \pi)$ there is no Doppler effect because light is emitted from the dark face of the star and consequently it isn't visible: in figure that interval is dotted. In the interval (π,3π/2) the fixed rotary star generates an effect of blueshift that is variable with the longitude while in the interval (3π/2,2π) it presents an effect of variable redshift. In this meaning a rotary star or a rotary galaxy generates variable stars or variable galaxies. i.e. with shift and colour that are variable with the longitude. If for some value of latitude β_r>1, i.e. v_r>c we have an effect of dark rotary star near the longitude $\Phi_g = 2\pi$.

6.2 Moving rotary stars and galaxies

Let us suppose that the rotary star with angular speed $\boldsymbol{\omega}$ moves also with linear motion towards the axes x'=x. In this situation it occours to distinguish two cases according as the rotary star approaches or goes away. Let us begin considering the rotary star goes away from the observer, like in fig.8, where $\mathbf{v_o}$ represents the departure velocity of the star with respect to the reference frame S of the observer with v_o<c. Defining

$$\beta_o = \frac{v_o}{c} \qquad (18)$$

and repeating calculations like in the event of fixed rotary star we obtain the longitudinal Doppler effect regarding a rotary star in departure when the longitude Φ_g changes for every value of latitude

$$f_m = f_s \frac{c - v_o - v_r\cos\Phi_g}{c} = f_s\,(1 - \beta_o - \beta_r\cos\Phi_g) \qquad (19)$$

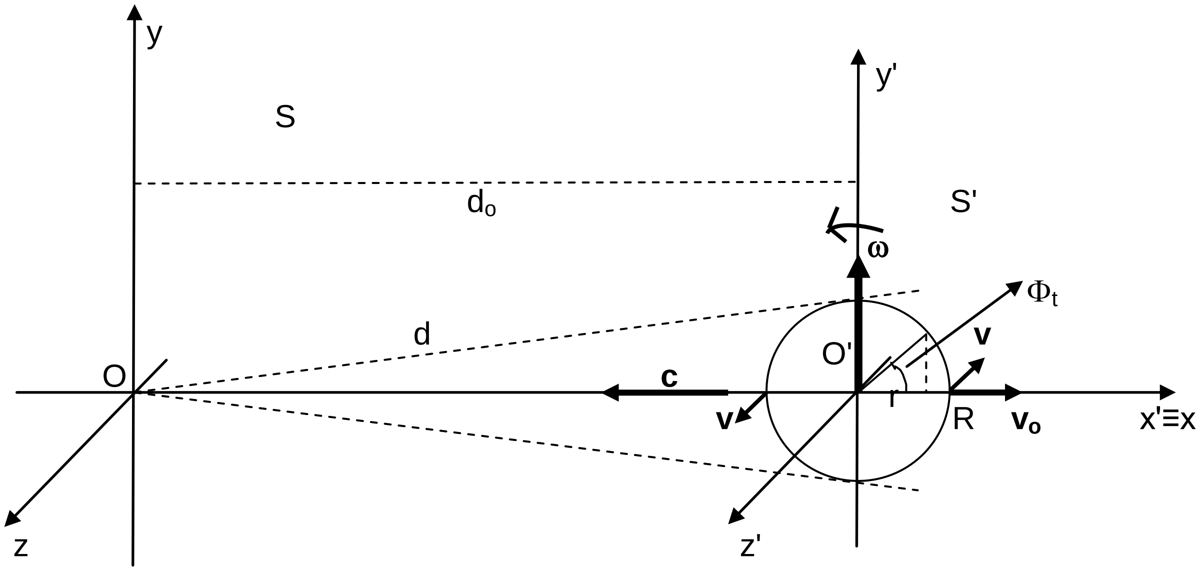

Fig.8 Representation of a rotary star in departure with linear velocity $\mathbf{v_o}$ with respect to the reference frame S of the observer O

The graph of (19) is in fig.9.

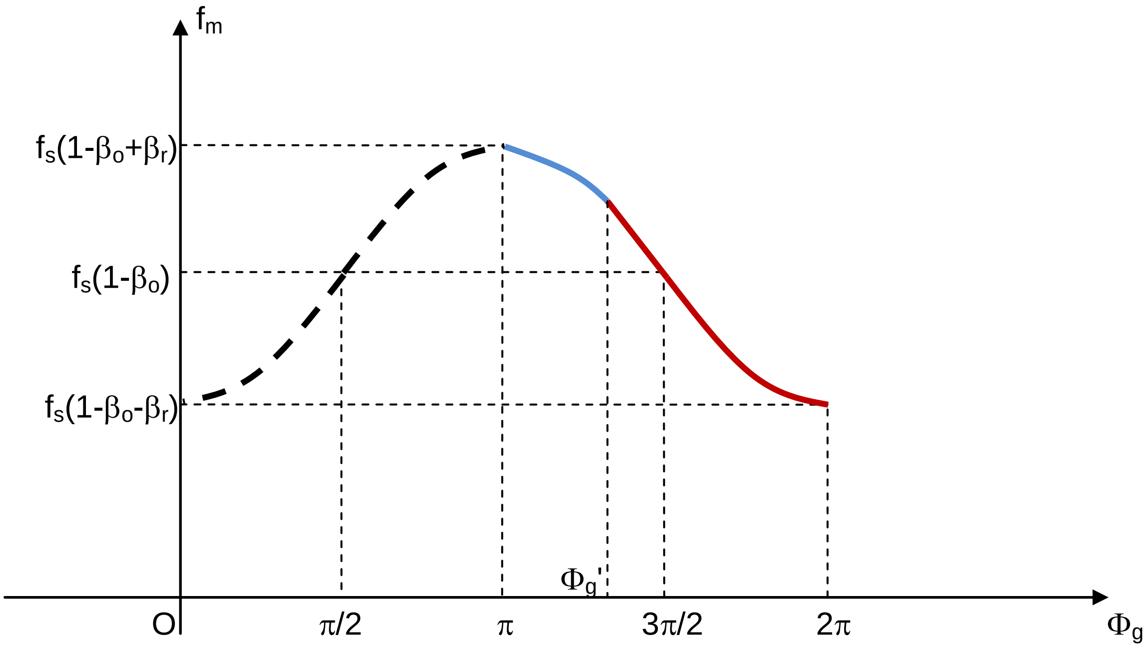

Fig.9 Frequency spectrum of variable redshift of a rotary star in departure in function of longitude measured with respect to the plane (z',x'), in the event that there is also blueshift $(v_r > v_o)$.

Like in the event of fixed rotary stars, in the interval of longitude $(0,\pi)$ light starts from the hidden face and therefore it isn't visible by the observer, consequently in figure the graph is dotted. In the interval $(3\pi/2, 2\pi)$ we have certainly variable redshift, according to the value of longitude, and it is visible by the observer. In the interval $(\pi, 3\pi/2)$ light emitted by star reaches the observer but the type of shift depends on the relation between v_o and v_r

and therefore on the value of latitude. If in the interval (π,3π/2), for any value of latitude, it is always

$$v_r < v_o \qquad (20)$$

then in the interval there is always variable redshift. Whereas instead in the interval (π,3π/2) there are values of latitude for which

$$v_r > v_o \qquad (21)$$

then certainly a value of longitude Φ_g' exists in which $v_{rx}=v_o$ and consequently there is a passage from variable blueshift to variable redshift.
If for rotary stars with linear motion it occurs for some value of latitude

$$v_o+v_{rx}>c \qquad (22)$$

then an effect of dark body happens for the moving rotary star near the longitude $\Phi_g= 2\pi$.
Considering the case of rotary star in approach, the linear velocity of star $\mathbf{v_o}$ is now directed into reverse with respect to the fig.8. Calculations give in that case the following expression for the Doppler effect

$$f_m = f_s \frac{c + v_o - v_r\cos\Phi_g}{c} = f_s (1 + \beta_o - \beta_r\cos\Phi_g) \qquad (23)$$

The (23) is represented in fig.10

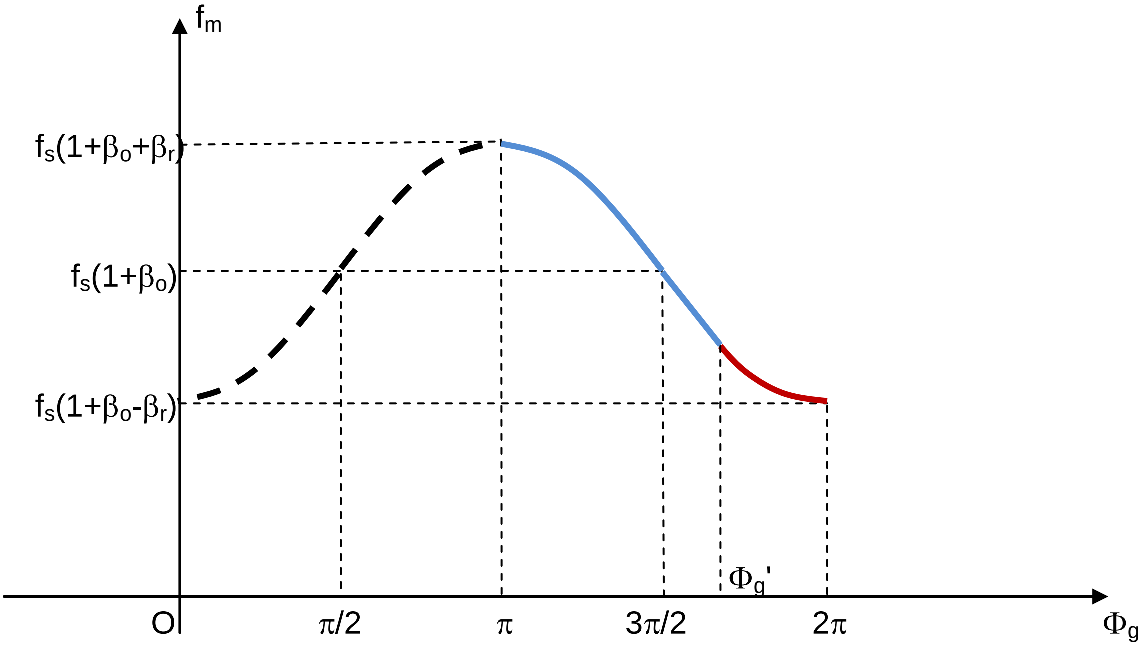

Fig.10 Frequency spectrum of the variable blueshift of a moving rotary star in approach in function of the longitude in the plane (z',x') in the event that there is also redshift.

Like in the event of departure, in the interval of longitude $(0,\pi)$ light doesn't reach the observer for which in figure the graph is dotted. In the interval $(\pi,3\pi/2)$ there is certainly blueshift with variable intensity. In the interval $(3\pi/2,2\pi)$ the type of shift depends on the relation that exists between v_o and v_r and consequently on the value of latitude. If in the interval $(3\pi/2,2\pi)$, for any value of latitude, it happens always

$$v_r < v_o \qquad (24)$$

then in the interval there is always variable blueshift. Whereas instead in the interval $(3\pi/2,2\pi)$ there are values of latitude for which

$$v_r > v_o \qquad (25)$$

then there is certainly a value of longitude Φ_g' in which $v_{rx}=v_o$ and it happens passage from variable blueshift to variable redshift.
Let us observe then, if for rotary stars with linear motion of departure it happens for some value of latitude,

$$v_{rx} - v_o > c \qquad (26)$$

then an effect of darkening of the moving rotary star occurs near the longitude $\Phi_g = 2\pi$.
Let us call, in all cases, **"Hack effect"** the effect of variation of the frequency shift for rotary stars and galaxes, in honour of the astronomer Margherita Hack who studied the phenomenon.

7. Dark particles

By analogy with dark macroscopic or cosmological bodies, dark particles are particles that emit, in determinated physical situations, electromagnetic energy but this isn't detectable by observer and consequently they appear dark. The phenomenon of emission of e.m. energy by particles is nevertheless quantum unlike ordinary bodies and cosmological systems and therefore a particle, in determinate physical situations, appears dark also because it doesn't emit. In fact stable particles emit quanta of electromagnetic energy only when they are accelerated to particular values of speed[6], that are the physical speed c of light and the critical speed v_c. Besides particles emit quanta of e.m. energy when they are unstable[7][8][9], it happens at greater speed than the critical speed and particles generate a process of spontaneous decay with emission of an energy quantum that, according to physical cases, belongs to gamma (γ), delta (δ) or delta-Y (δ-Y). Other important events connected with dark particles happen when they are subject to collision processes. This analysis shows there are numerous possibilities for particles to be in the dark state.
Now we would want to examine the Doppler effect that happens relative to elementary particles that are accelerated to velocities v where they emit an e.m. quantum.
In concordance with the (7), the Doppler effect for accelerated particle is given by

$$f_m = f_s \sqrt{1 + \frac{v^2}{c^2} - \frac{2v}{c} \cos\Phi_2} \qquad (27)$$

In the event of longitudinal approach to the measurement equipment it is $\Phi_2=\pi$ and in the event of longitudinal departure it is $\Phi_2=0$. In the two cases we have therefore

$$f_m = f_s (1 \pm \beta) \qquad (28)$$

where $\beta=v/c$, the sign + is in case of approach and the sign - is in case of departure.
The accelerated particle emits a first quantum at the physical speed c of light with energy equal to $E=m_oc^2/2$ where m_o is the resting mass of the particle and consequently the quantum has frequency $f_s=m_oc^2/2h$[5][6][10] . The Doppler effect of the particle at the physical speed of light is given by

$$f_m = 2f_s \qquad \text{in case of approach} \qquad (29)$$

and

$$f_m = 0 \qquad \text{in case of departure} \qquad (30)$$

The accelerated particle emits then a second quantum, exactly equal to the first, at the critical speed $v_c=\sqrt{2}\,c$. The Doppler effect for this second quantum is

$$f_m = 2.41f_s \qquad \text{in case of approach} \qquad (31)$$

and

$$f_m = -\,0.41f_s \qquad \text{in case of departure} \qquad (32)$$

The preceding analysis shows energy quanta, generated from the emission of accelerated particles, would produce always, with respect to the reference frame of observer, a blueshift for Doppler effect in case of longitudinal approach while in case of longitudinal departure they would produce an effect of dark particle that not would allow to detect the quantum. On the other hand in the absence of collision phenomena, stable elementary particles ($v<v_c$) aren't detectable unless at the physical speed of light where the detected frequency is the double the size of the emitted frequency with a blueshift effect in case of approach. Unstable particles instead emit energy in deceleration or in phase of spontaneous decay. In the second case (spontaneous decay) unstable particles have always greater speeds than the critical speed and they emit energy quanta (neutrinos) that belong to the band of delta frequency if particle is leptonic and to the band of delta-Y frequency if particle is baryonic. In this process of emission of neutrinos the Doppler effect produces a blueshift in case of longitudinal approach of unstable particle while it produces still an effect of dark particle in case of longitudinal departure.
In the event of stable accelerated particles the Doppler effect and the effect of dark particle have quantum nature, i.e. they happen for particular values of speed, while in the event of decay of unstable particles the two effects can occur for any value of speed.

8. Dark energy

Dark matter is represented by ordinary bodies, by star systems and by elementary particles that are into a particular physical state connected with their state of relative motion with respect to the observer. It is possible to observe the question of dark energy almost always is strictly correlated with the question of dark matter because dark matter is always connected with energy, generally at the electromagnetic state, that isn't detectable and measurable by the observer. Where there is dark matter there is also dark energy and viceversa where is dark energy there is also dark matter.

9. Experimental methods in order to detect the presence of dark matter

In order to detect dark matter whether for macroscopic or microscopic systems with linear or rotary motion, we have to make use of the relation of the Doppler effect, given by the (7). In that case frequencies and wavelengths are negative. The negative value of the Doppler effect, that is possible from a physical viewpoint because corresponding to a real physical situation, means just dark matter goes away from observer with greater or equal velocity $\mathbf{V}$ than the velocity of light and consequently light or electromagnetic radiation that leaves dark matter has a relativistic velocity $\mathbf{c_r}$ with respect to the observer given by the (6) and directed into reverse towards the observer. It means light or electromagnetic radiation emitted is unable to reach the observer and in terms of frequency and wavelength it involves negative frequencies and wavelengths. The direct measurement of those frequencies and wavelengths appears very problematic because generally frequencies and wavelengths that reach the observer and his equipments of measurements are positive.

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