HST images of dark giants as dark matter:
Part I. The black cocoon stars[•] of Carina nebula region*

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[•] New terminology derived from the concept of the inherent Visual Luminosity Attenuation (*VLA*) sequence of red giant stars that belong to the galactic disc population (III) introduced in XIV, XV and XVI Celis's papers: In 1995, the paper XIV[1] introduces the inherent stellar encocooning phenomenon by dark matter that attenuates the luminosity of the central star and it anticipates the existence of dark giants with the *VLA* sequence. In 1997, paper XV[3] (IDM96, Sheffield, England) shows the implications of the cocoon stars or attenuated red giants stars as contributors to the baryonic dark matter. In 1999, paper XVI[4] (IDM98, Buxton, England) confirms, with a HST image, the encocooned radial structure of the red giants belonging to the stellar population of the disc or arms of the Galaxy.

In an evolutionary scenario, the existence of isolated dark giant objects known as *Post M latest spectral type stars*[1] (or black cocoon stars[•]) are in the last stage of their life and, as extremely advanced old age objects, they cease to be stars. The photographic images of Carina nebula taken by the Hubble Space Telescope (HST) have been used to detect the *post M-latest stars* as dark silhouettes. The luminosity attenuation equation of M late stars[1], $A = \alpha S^3$, points out the baryonic dark matter envelopes the oldest red giants that produce earlier dark giants. This equation says that when the red giant star finishes to produce baryonic dark matter, the central star is extinguishing and transforms into dark giants and dusty globules that disperse cool gaseous matter into the interstellar space. These old dark objects have a size from 400 to 600 astronomical units (AU). The advanced dark giants, the *dusty dark giants*, might not contain a star within the molecular cloud that envelops it. In this case, the dark giants might produce the smaller and less massive dark globules of the Thackeray's globules type (less than 4 solar masses) where, Reupurth *et al.*[2] found that these globules are now in an advanced stage of disintegration and they found no evidence of star formation in any of these objects. The high-resolution of the Hubble images allows: The observation of isolated dark giants, dusty globules with central dark giants, the observation of partial eclipses or transiting of giant stars and the estimation of linear and angular diameters of giant stellar objects. The dark giants of the image identify them as objects with observed angular diameter. The large quantity of dark giants in a small sector of the sky suggests that they are densely populated (population stars III) and ubiquitous in the galactic disc. They can be located in isolated form or associated in dense *Conglomerations of dark giants.* At the same time, conglomerates of dark giants can be connected to each other to form *Unions of conglomerates.* The associated objects might configure a dark *network* structure that belongs to the spiral branches. The contribution of mass is indicated by the large amount of dark giants, which widely surpasses the luminosity matter of the Galaxy. Over 7600 of these objects, located in a small sector of the Carina nebula image, were individualized by their clear definition. There are more than 60,000 objects in the full Carina nebula image. Assuming that this number of dark giants of the Hubble image is representative of all dark giants, it is possible to conclude that they might represent 96.3% - 98.9% of the Galaxy's matter. This percentage of dark giants could also represent the needed mass required to explain the dynamic of the galactic disc if they had an average of 0.8 solar masses.

The physical characteristics observed[5] in the Galactic disc can be summarized as follows: 1. The stars have orbital velocities that are higher than those predicted by Kepler Laws. 2. The local mass density of the stars falls very slowly with the distance at the centre of the galaxy and this diminution is not parallel to the luminosity extinction. 3. The integral mass increases lineally with the radius, but this should be constant in the disc. 4. The mass-to-luminosity ratio increases steadily with the central distance, but this needs to be constant. These properties confirm the existence of an additional mass that has no visual luminosity and that is ubiquitous *in the spiral* of the galaxies.

The contribution of faint stars -baryonic objects- has received special attention in the search for dark matter. The estimated abundance of dwarf objects, such as, white dwarfs[6], red dwarfs[7], brown dwarfs[8], blue white-dwarf stars[9-10] and neutron stars[11] have also been studied. Nonetheless, *these stars are not dark matter.* Their faint luminosity requires a huge amount of them in order to satisfy the required mass within the galactic disc. Therefore, both the mass and the amount of observed dwarf objects seem to be insufficient to explain the necessary gravitation found in the dynamic of the spiral of the galaxies. Any other candidates must represent at least 10 times the baryonic luminous mass. The present literature does not show any candidate that proves to compensate for the missing mass in the spiral arms. Moreover, the gravitational microlensing experiment[6-12], as searching method, usually used to detect dwarf invisible objects produces not conclusive results.

The Carina region observed with the Hubble images gives evidence of an interstellar dark matter in the form of dark objects, angularly measured as d*ark giants*. This work attempts to explain both the baryonic nature and the huge amount of these dark objects. These objects have size from ~0.2 to ~0.1 arcsec and have been observed in the limits of the resolution of the HST *false-colour image*. The analyses of dark giants can be observed in the environment of the Carina nebula**.**

This analysis tries to show the stellar nature of this type of dark giants that could represent the interstellar dark matter. The total of these dark giants would be both *necessary and sufficient* to explain the lack of luminosity of the dark matter and the four physical properties that have been seen. Also, it is possible to establish a natural connection between dark giants and the red giant stars that belong to the extreme end of the inherent *Visual Luminosity Attenuation* (*VLA*) sequence. The baryonic evidence[3-4] was showed with the existence of the attenuated cocoon stars, which are embedded in a cocoon of ionised gases[•]. This evidence showed that only objects of stellar genesis are massive enough to explain the gravitational effects on the visible stars.

The opacity of the spiral galaxies[13] might be explained by the presence of these infrared stars, which are visually faint and dark. These objects are approaching the black limit of *VLA*. The visually dark cocoon stars are located at the bottom right of the new HR diagram[1-3]. The absolute *VLA* of red giant stars due to gaseous matter covering the star was called *stellar inherent molecular encocooning* (see Methods), and it was derived according to the spectrum-photometrical property and distance antecedents obtained from long-term observation programmes since 1972 at the Cerro Tololo Inter-American Observatory, CTIO. The results of such observations proportioned the preliminary clues to establish these new morphological properties.

Carina region objects

The Carina nebula is a region near to the Sun. The dust clouds are reflecting the spectrum of Eta Carina[14]. The clear red colour of the nebula is a dominant fluorescent emission coming from the strongest spectral line of Hydrogen. This emission is caused by an intense ultraviolet radiation of hot and massive stars within it[15]. The Carina nebula is a visual frontier at 2500 pc, useful as a backdrop for the identification of the stellar objects found in front of the nebula. The HST image makes it possible, in a small sector of the sky, to observe for the first time non-embedded objects. A scanning of the image reveals the existence of: false colour red cocoons, which are giants, attenuated, with no glow or glare; extra-solar transits; stellar alignments; false colour brown giants and dark giants are detected and silhouetted against the backdrop of the bright Carina nebula.

Different types of objects appear with the following proportions: 50% corresponds to attenuated false colour red giants and super-giants with 225 identified stars; false colour brown giants (13%), dusty globules (12%) and typical stellar luminous objects (25%). The dark zones cross out all the extension of the image with different densities or intensities which have a granulate appearance.

The photospherical diameter is not detected in any of the stars that appear in the Hubble image. Most of the objects are very attenuated compared to the bright stars of the same image. Thanks to the inherent attenuation and large size of the cocoons of red giant stars, it is now possible to estimate their angular dimensions. Because all the objects have a very faint intrinsic luminosity, the probability that they are found near the frontier nebula is high and the difference of their individual size is relatively low. Therefore, their dimensions are comparable. Figure **1** shows the comparative angular dimension and morphology of different giant objects solved in the high-resolution image. The objects have noticeable angular sizes. They have giant and super-giant cocoons, which are less bright and have no glow or glare, but have an irregular surface area. The comparison of the more relevant objects reveals stellar details seen for the first time.

Line **1**, box 1-39, shows *close* binary of attenuated red giants. Box 1-19 shows the head of the dusty cometary globule that seems smaller than the red supergiant cocoon located at the box 1-39. Therefore, the cocoon star is either closer or bigger than the cometary globule. Box 1-40 reveals a double system, where the supergiant cocoon gives gaseous material to the giant cocoon, the same way as that shown in Mira[4]. This exchange of gaseous material reveals its mutual proximity.

Line **2** outlines the cocoon morphology of red giant stars according to their apparent size. The concentric rings of the inherent attenuated stars have a projected sharp edged silhouette defining the spherical-type cocoon morphology. The area of the centre of the surface is translucent to the central star luminosity in the line-of-sight for the largest objects. Box 5-46 shows a bright star together with a red giant star. If this bright star is found nearer to us than the cocooned star, the bright star also should show morphologic features. So, the luminosity excess of the strong glare (without cocoons) hides its close environment and any stellar morphological features. Box 3-1 and 5-48 display well defined cocoon structures of red giants.

Line **3** compares the closest binary stars. Box 6-34 shows two close bright stars (spectroscopic binary). Box 7-1 presents binary cocoon stars. The more attenuated stars are fully embedded within their cocoons. In Box 8-58 there are faint binary stars of small cocoons. The length of the binary image indicates that they are exchanging gaseous material and, therefore, it shows the relative nearness among them.

Line **4** exposes objects with an apparently small size. Box 1-30 compares a brown giant with a dark giant and a red giant with angular diameters of 0.3 arcsec. In box 6-8 a dark giant and a white star are aligned. Box 4-7 seems to be exhibiting a collision of two dark giants. These images show that the isolated dark giants might not be Box globules[16].

Thus, the effective real morphology of stellar cocoons of red giant stars can be observed at the *visual range* in the Carina nebula image. Consequently, the attenuated objects can be considered to have a definite angular dimension with real details. In general, the Infrared Astronomical Satellite (IRAS) observations at 60 and 100 μm reveal the largest circumstellar dust shell (~35 arcmin) around the star W Hydrae[28], a Mira cocoon star type[4]. The far-infrared diameter of this star is about 20,000 AU if we use the spectral photometric M_V relation to estimate its distance of 11 parsecs with the equation 2 (using V = 7.7 magnitudes and S = 8.0, M_V is 5.6 magnitudes).

Even though Carina nebula distance is contingent, the linear dimensions of Carina attenuated objects can be estimated by a simple proportion of their angular size and the adopted nebula distance (2500pc). The relative three-dimensional location and the extreme attenuation of these objects suggest that all of them are located at a distance of the same order. The objects and nebula features, the large quantity of red giants stars, and the dark giants show that all these belong to the Carina Spiral Branch. Moreover, the attenuated objects of the image are located in a small sector of the sky and their interstellar absorption is the same in all of them. Therefore, the attenuation of red stars does not correspond to the strong interstellar absorption, nor to the nebula effect, but to the *inherent molecular encocooning* (see Methods).

The lineal dimensions are referred to the size of the cocoon that is embedding the star. Very large preliminary sizes were found for each of the stellar objects shown in the Blue, Visual and Infrared wide bands composed image (see Method). The cometary globule (box 1-19) of Figure **1** (line 1) would have a length of 5600 AU and the head diameter, 1400 AU. The cocoon star with larger diameter turns out to be of 1800 AU. The brown giant (box 1-30, line 4) has 600 AU. The dark giants located in all Figures turn out to be with linear diameter between 400 and 600 AU. These large sizes of dark giants would imply the existence of a very active *backwarming effect*[17] (paper VI): The concentrated heat within the dark giant cocoon produces high internal temperatures and pressures and defines the largest diameter of the *earliest* dark giants.

Dark giant images and dusty dark giants

Figure **2** shows aligned giants but with an appreciable diameter. The boxes of line **1** indicate that the objects are probably bounded gravitationally in a binary system. For the first time, boxes 1-55 and 5-58 present partial eclipses or stellar transits. The most interesting boxes, 2-8 and 4-48, reveal partial eclipses where one dark giant is seen transiting an attenuated supergiant cocoon and the other, a bright star. Lines **2** to **6** present isolated dark giants that can be seen both against the close clear Carina nebula (boxes with brown backdrop) and out of it, (boxes with blue backdrop). The dark giant images are very well defined. The contrasted images reveal small differences in different apparent sizes and morphologies. The dark giants of line **7** are of different forms and sizes. These isolated dark giants show that they do not come from a fragmentation of a dark molecular cloud of the Carina nebula.

The dusty dark giants are dark giants embedded in dusty globules or dark molecular region. Figure **3** shows typical dusty and molecular globules located near the Carina nebula and against the clear Carina nebula. The images of the bottom of lines **1** and **2** are amplified and contrasted. The molecular gases of the globules that surround them give a diffuse appearance. The globules can be spherical, oval, amorphous, elongated and irregular and are situated out of the denser part of the nebula. Boxes 5-16, 1-42 and 1-83 show, inside the globules, at least two interacting dark giants. The contrasted boxes reveal the presence of dark giants within elongated globules. These images confirm the existence of dark giants located inside each gaseous globule. They might be exchanging molecular material or expelling nebulous dust to the interstellar space.

Line **2** shows larger and extensively molecular clouds that are receiving the stellar wind emitted by the bright stars in the direction of the arrow. The incident ionising radiation smoothly moves the gas and the dust, allowing an internal dark giant complex to be seen. The dark giants are seen veiled due to the molecular cloud. The result confirms that there is a smooth ionisation of the more external sector of the globule and of the dark giants contained within it. Box 5-83c clarifies at least eight dark giants. Finally, the radiation pressure of the near bright star displaces the dusty material that envelops the dark giant, giving it the cometary morphology of the *dark giant-molecular cloud* system (Box 1-19).

Hence, the sequence of increasing dusty globules analysed would indicate that in a final evolutionary stage, the dark giants are giving nebular material to the interstellar medium. This scenario justifies the molecular clouds that configure the large opaque nebulas of the spiral galaxies. The ejected-formed material also justifies the cool and dark appearance of the central sector of the globules. In such a case and in accordance with Reipurth *et al.*[2] the dusty globules are not forming stars.

Conglomerates of dark giants and Unions of conglomerates

Line **3** of Figure **3** contains well-defined dark and larger amorphous globules. If the body of the nebula is the clear backdrop, the larger globules occupying an extensive area over the nebula are forming a dark area. Numerous dark giants are inside these sectors. They are translucent to several internal dark giants. At least five dark giants can be observed in each contrasted box. Line **4** defines individual *Conglomerates of Dark Giants* embedded in the largest and most extended globules. The boxes contain more than twenty dark giants. Most of them are seen diffuse by the molecular or dust of the environment. Line 4, Boxes 4-80c and 4-81c might also reveal false colour brown giants, which can be intermingling with dark giants. Box 7-102c unveils extended conglomerates of dark giants implanted in darkens zones. This suggests that the globule loses its morphology with the expansion of its molecules. Line 5 shows irregular globules situated out of the nebula. The extension of dark zones is increasing from box 5-89c to 5-91c. Their diffuse morphology suggests the expansion of the already formed molecules, which finally constitutes the large part of the dense nebula.

Figure **4** consists of a large view located in Sector 1 of Figure **1**. Zone **A** is a non-dusty area of the image located close to the nebula, that reveals a large conglomerate of dark giants on the outside of the denser part of the Carina nebula. These dark giants are not forming dusty globules. The number of dark giants is similar to the number found in darker zones over the nebula.

Figure **5** shows the darkest part of the nebula located in Sector **4** of Figure **1**. In Zone **B** there is an endless number of well-defined dark giants. In the line-of-sight, the attenuated stars are located in the foreground. The bright nebula is located in the background. Well-defined dark giants are located in a second plane. A comparison between zones **A** and **B** reveals that the conglomerates of dark giants can be independent of the nebula presence.

The dark giants of the dark nebula areas are seen in Figure **1**. Conglomerates of dark giants can be seen forming large zones. These large concentrations define softened dark regions. The appearance is a smooth dark nebulous aspect when they are seen in images with a low resolution. Figure **1** shows at least six *Unions of Conglomerations*. A typical Union of Conglomerates is **U1**. The Unions **U1** and **U2** have similar appearance and sizes. Part of Union **U3** is found outside the Hubble image that suggests that some dark zones located at the periphery of the image also might be unions of conglomerates.

Distribution, abundance and mass of dark giants

These dark giants are distributed in a separate and discrete form to make Conglomerates of dark giants and Unions of Conglomerates. These associations of dark giants are not necessarily bounded to the bright HII region, due to:

1. The existence of isolated dark giants (Figure **2**).
2. The dark giants are also found within the dusty globules. They can be understood as molecular material expelling outwards (Figure **3**)
3. The dusty globules tend to have a cometary form only when receiving an external radiation pressure (Figure **3**, line **2**). This proves the massive character of dark giants.
4. There exist conglomerates of dark giants fully separate from or outside the large and dark molecular cloud (Figures **4** and **5**).
5. The noticeable dark giants obstruct part of the background luminosity. They are identified as projected dark silhouettes over a bright nebula (Figure **6**).

The observed distributions seen in the above Figures help to explain the very complex regions apparently observed as convoluted molecular clouds of various sizes and shapes, illuminated by massive stars. The enormous quantities of dark giants, densely conglomerated, darken the clear tri-dimensional sectors of the galaxies producing the opacity of the galactic discs. From the preliminary clues of a large number of individual dark objects that appear in the image it is possible to derive the probable amount of these. They are irregularly distributed and are structuring conglomerates with different sizes and density in the whole image. At the same time, this configuration can be seen out of the image in Figure 7. Therefore, the dark objects of the same image can be taken as initial random representative sample of the components that are present in the galactic disc.

On the other hand, if the dusty globules that embed the dark giants were Thackeray's globule types (4 solar mass[2]), then they would have a similar mass. At the same time, most of the boxes show a diffuse granulated backdrop and a clear zone encircling many of the dark giants. The defined images of dark giants magnify the luminosity of the nebulous backdrop. This halo surrounding some of the dark giants as well as the conglomeration of dark points give a rough aspect to the nebula in all the sectors where they are found. This configuration reveals a probable gravitational lensing effect of the dark giants over the nebula and homologous bodies. The objects are dark and the nebula is not a punctual bright object. Thus, the probable CCD underlining digital information cannot produce this effect. In such a case, the clear zone might be indicating the massive nature of the dark giants. However, this interpretation is not conclusive.

Considering the hypothetical quantity of stellar mass and its abundance, the total mass of the visible stars in the Galaxy is $1.8*10^{11}$ solar masses[19] or $1.5*10^{11}$ solar masses[20]. Thus, if the Galaxy has $2*10^{11}$ optical stars, the stars have an average solar mass of 0.9-0.7. Consequently, if the dark giants have a stellar origin, each one would also have an average of 0.8 solar masses.

Figure **6** amplifies the Union **U1** in which was made the probable preliminary recount of dark giants (see Method). The quantification of the concentrated dark giant of Union **U1** turns out to have 7600 objects as a minimum quantity of Sector 8. As a result, a 96.3%-98.9% of the dark giants would represent the baryonic dark mater in Sector 8. To estimate the total of dark giants present in the full image (Figure **7**), it is be possible to consider that:

1. Part of Sector 4 is a more transparent; in which there are dark giants independent of the densest region of the nebula. Here, another union of conglomerates, called Union **U2**, was found.
2. In Sectors 1 and 5 the Unions **U6** and **U4** that are located outside the densest area of the nebula are identified.
3. Most of area of Sector 2 is a clear zone of the nebula, but it is possible to observe the strongest and most complex Union (**U5**), which also takes up part of Sector 6.
4. In Sectors 3 and 7, there are dark giants widely distributed which obstruct the background luminosity of the nebula.

Thus, all Sectors have, on average, (concentrated or dispersed), the same quantity order of dark giants found in Sector 8. Consequently, the full Carina image has more than 60,000 dark giants. The dark objects found in the whole image may be considered as a representative sample of the dark objects that are located at the Carina spiral branch. Therefore, they can also be representative of the dark giant present in the galactic disc. In such a case, if dark giants have 0.8 solar masses on average, the needed mass would be satisfied in the galactic disc with this type of objects.

As a result, dark giants may constitute the dark zones of the galaxies. The conglomerates of dark giants form ramified structures. Their *networks* and the large number suggest that the dark giants are the gravitational support in the spirals of the galaxies.

Evolutionary scenarios

The inherent molecular encocooning (see Methods) is the progressive covering of the star by molecules and gases when expels own photospherical stellar material to form a cool dark cocoon that envelopes it. This occurrence explains the strong encocooning of red giant stars that belong to the galactic disc population and that produce an extreme visual attenuation of the central star. In an evolutionary scenario, the sequence of M spectral type stars (old stars) represent a progressive ageing from M-early, M-medium, M-late and M-latest types to finally reach the *Post M-latest stars*, which cease to be seen as stars and are transformed into dark giants. The dark giants would no longer contain a star in this final stage. Hence, a strong encocooning powerfully attenuates the luminosity of the central star. Finally, the very attenuated cocoon stars are located at the end of the inherent *VLA* sequence of the red giants.

The attenuation sequence broadens the HR Diagram toward the right side while the visual absolute luminosity of the red giants goes down[1-3]. The inherent observed visual attenuation reaches up to 20 magnitudes from the top to the bottom. Considering that the attenuation of the red giant stars (equation 2) is independent from both the interstellar extinction and the visual attenuation by large distances, it is possible to derive the existence of a new stellar population in the galactic disc. This population is mixed with the stars of population I. Carr[11] presented population III as representative of the massive dark matter. This population located at the galactic spirals contains mainly white dwarfs, red dwarfs and brown dwarfs (faint stars). The stellar holes and the massive and super-massive holes (dark objects) also may be associated with the stellar population III objects. Now, by using the concept of inherent attenuation, it is possible to add to the population of stars III the attenuated giants, the brown giants and the dark giants of the galactic disc. To support this statement the following criteria has been applied:

1. The stars of population II are found in globular clusters and in S galaxies nucleus (bright stars).
2. The attenuated red giants are located within the galactic disc.
3. The attenuated red giants do not belong to population I (early spectral types, young stars).
4. The attenuated red giants are *M-type* stars or later stars of the disc (old stars).
5. The *M0-M6 early-medium spectral type*s, are bright attenuated red giant stars (M_V = -3.2-0.0 mag)
6. The attenuated red giant stars cross the Red Giant Branch of the new HR diagram[1-3].
7. Population III and I are complementary stellar bodies in the spiral arms.

The most attenuated visible giants (*M6-M10 late-latest spectral types*) have a faintest visual absolute magnitude (M_V from 0 to 17 mag). They are totally separated from the red giant branch. In this star type, Hagen[21] found that the metals in the stars of the spectral type *M6* or later appear almost entirely as grains. The internal radius of the envelopes is not well determined, and the observed shell is found in an extended turbulent region on the top of the photosphere; the lying grains attenuate the emitted light by the central star. Consequently, the attenuated red giants of the spiral branches cannot evolve as the bright red giants of population II.

The Carina nebula is a molecular complex cloud that is forming massive stars giving birth to star clusters[14-15]. In general, gaseous globules of molecular clouds were analysed in relation to the molecular cloud-star formation[22-23]. However, Reipurth *at al.*[2] found no evidence for star formation in any of the similar globules (Thackeray's globules) in the southern HII region IC2944 and the globule complex is now in an advanced stage of disintegration. The more or less uniform distribution of dark giants and their enormous quantity suggest their ubiquity in the disc of the Galaxy. This statement complies with the opposed character of *Bright Region HII* (with new star formations) and *Dark Molecular Region* (with formation of molecular globules from the stellar growing old). On the other hand, if a molecular cloud only forms stars, the origin of nebula molecular clouds themselves is not being well defined. This situation produces two possible evolutionary scenarios to explain the presence of the dark giants.

The first indicates that the attenuated objects can be understood as a natural consequence of local star formation in the Carina nebula environment and, as a general rule, in all the space where HII regions are present. The star formation initially follows the fragmentation of a supergiant dark and cool molecular cloud. The fragmentation produces dark giants that would be small rounded, pressure bounded fragments of molecular cloud. That is, the spherical morphology seen in most of them (Figure 2) would be due to the enhanced ambient pressure in a HII region. However, the small fragments have a diameter from 400 AU to 600 AU. That means they would be, as coherent individual objects, the largest objects observed at present. Moreover, they are located outside the bright HII region and/or they partially obstruct, cover or hide from our line of sight, the luminosity emitted by the bright HII region according to their *typical distribution and abundance*. The density of these dark giants is high enough to produce transits or partial eclipses (see Figure 2, line 1, boxes 2-8 and 4-48c).

The second scenario would imply that the direction of the evolution is the opposite. The evolutionary direction goes from the brightest stars (M early-late types) to the more attenuated stars (M-latest type) and from here form dark giants. In advanced brown giants, the cocoon blocks the way of the visual flux, but not the near infrared flux. The shifting of the effective wavelength to the medium or far infrared is an effect of the extreme spectral darkening. The external surface area of the cocoon is affected by a strong encocooning. The dark giants as *post M-latest spectral type stars* are in the last stage of their life and they are not seen as stars. This thermodynamic condition suggests that the diameter of the opaque cocoon must have a large dimension to make the internal thermal pressure equilibrium in the *advanced central star - dark cocoon system* stable. The large observed angular sizes of the dark objects suggest this solution to the advanced stars of population III. Finally, the adiabatic tendency of the cocooning gases finishes by expelling gaseous material in the latest stage of this evolution.

Nevertheless, both solutions are independent of dark giant presence in the Carina spiral arms, which are located inside or outside the nebula. Hence, the evolutionary discussion is open for future.

Methods

Inherent molecular encocooning

The *Visual Luminosity Attenuation VLA* of the red giants is either the absorption or the weakening of the visual stellar radiation emitted by the central star while its flux is crossing the cocoon that is holding the star. This stellar structure moves the effective wavelength of the flux toward the infrared or *shift of the effective wavelength* of red giants according to *colour reddening sequence* (papers VII[24], VIII[25], IX[26], XII[17], XIV[1] and XV[3]). It is also possible to see this attenuation with the *visual spectral darkening sequence* (papers IX[26], XIV[1], XV[3] and XVI[4]) that begins with bright stars, where the non-attenuated visual absolute magnitude $M_0 = -3.12$ is the zero point of the inherent *VLA*. If M_V is the visual absolute magnitude of the star with L_V luminosity, then the attenuation from the zero point is $A(L_V) = M_V - M_0$ and the luminosity variation by attenuation is:

$$dA(L_V) = 3\alpha S^2 dS \qquad 1$$

where $\alpha = 0.017$ is non-dimensional constant and S is the numerical part of *M* decimal spectral type from *M0.00 onward* when $M_V \geq M_0$ that determines the attenuation of brightness by encocooning according the intensity of TiO (papers XIV[1], XV[3] and XVI[4]). The solution of the equation 1 is:

$$A(L_V) = \alpha S^3. \qquad 2$$

Equation 2 was determined in an experimental form in paper XIV. It used both the calibrations between M spectral type as a function of V-R and R-I colour indices and the *median visual absolute magnitude* as function of the photometric spectral type with 134 near red giants (up to 2500 pc). The observed range of the $A(L_V)$ attenuation goes from -3.12 to 17 mag. Then, by using the equation 2 it is possible to anticipate the extreme attenuation of red giant stars by the visual spectral darkening sequence and show the existence of infrared giant stars by extrapolation of the analytical function. These stars are the molecular covered stars located at the extreme end of the attenuating sequence or M latest stars are the *brown giants* with insignificant visual luminosity. The advanced objects or post-M latest stars are the *dark giants*.

HST images of the Carina nebula objects

Four different pointing made with HST in April 1999 assembled the high-resolution image of Carina nebula. The area framed in Figure **7** shows a zone of the Carina nebula (NGC 3372) observed with the Wide Field Planetary Camera 2 of HST. The image is centred in the optical range and it is composed with filters Blue, Visual and near Infrared (wide band) and filters OIII, Hα and SII (narrow band). The image has an area of 3.8 x 2.5 arcminutes. The false colour of the image only helps to facilitate this analysis of the new objects and is not used to describe its physical nature. Only the TIFF image was used to examine the detail and objects that it contains, because:

1. The digital version of the Carina nebula image has the highest resolution and the best angular definition of the objects in an area.
2. The Hubble image can separate objects of 0.1 arcsec. Its resolution is 10 times larger than an analogous image taken by the 4m telescope of CTIO. (Walborn N. R. The Carina Nebula, (www.stsci.edu/~jmaiz/carina.html)
3. This resolution permits small sectors to be enlarged to easily identify the enormous quantity of dark giants.

The TIFF format Hubble image has been divided into 8 equal Sectors and these were amplified 200%. A detailed examination of the Carina image reveals the presence of many stellar objects in different places of each Sector. Most of them were extracted in small boxes. The same angular amplification in each box of the Figures was used to compare objects of similar characteristics that appear inside of them. Each box can show more than one object. The boxes have been classified according to the number of the Sector they belong to, plus an identification number. The top line of each box represents 1 arcsec in all small figures to perceive the resolution power of the Carina image. Several of the boxes are contrasted (c). Usually 40-50% of contrast was applied *only* to highlight the silhouettes of the black points (dark giants) seen in the images with defined angular sizes.

Identification of dark giants as dark matter

With the smallest angular diameters, *dark giants* are observed as dark individual objects. Thus, the basic patterns to identify the dark giants as dark matter in the Hubble image are:

1. They have a well-defined morphology (located in front or beside the nebula).
2. Show absence of blue, visual and near infrared fluxes (seen as black points in the image).
3. Show a turbid morphology and darkening the nebula itself (located within the nebula)

4. Their numerousness, frequency and abundance.

The observed physical characteristics of the spiral galaxies (low luminosity, high density, suitable integral mass and mass-to-luminosity ratio) require that the dark giants as dark matter be composed of candidates that:

1. Have large sizes (massive objects)
2. Be highly opaque (dark objects)
3. Have stellar natures (baryonic matter)
4. Be ubiquitous in the galactic disc

The inherent attenuation sequence of red cocoon stars gives dark giants stellar clues. Equation 2 indicates the existence of dark giants with the largest values of the inherent spectral darkening (see Methods). The location at the end of the sequence defines the stellar nature as stars hidden by opaque cocoons. The attenuated red cocoon stars, also as baryonic candidates, have enough mass (1- 8 solar masses[18]) to produce gravitational lensing events over dark objects enhanced by a clear nebula.

Recount of dark giants

The Union of Conglomerates, **U1** of Sector 8, can be considered as a typical association of dark giants. This is similar to the Unions **U2** and **U3**. The recount of the dark giants was made using **U1**. The dark giants immersed in the dark dusty material have been detached by image contrasting. This image was contrasted 30% and brightened 30% using a suitable tool of the Adobe PhotoShop computer program. The counts are marked with a white point.

The selected dark giants have a separated distribution and are identified as individual points. Because they are located at different distances in the line-of-sight, the closest are noticeable first. Next, are those embedded within the nebula. Finally, the nebula itself hides the most distant dark giants. The selected objects depend on the presented appearance: a dark giant with a soft appearance (less dark) can be detected easily if it presents a clear backdrop. The same type of object is not detected against a dark background. In summary, the recount considered that the dark giants:

1. The objects that do not emit luminosity flux.
2. They present a well-defined morphology that is generally darker and has a relatively larger apparent size.
3. They are defined smoothly at the limit of the resolution of the image, but with a clear ring surrounding it.
4. Those located at the border of some red giant stars are counted as individual objects.

Not considered in the recount were:

1. Very tenuous dark objects that are difficult to individualize. Probably, they are residual dusty matter.
2. Infrared giants, which have a faint visual emission flux, or observed as false colour brown giants.

Therefore, the resulting recount indicates a probable minimum quantity of dark giants that are located at the same order distance. The total sum turns out to be 7603 dark giants. On the other hand, a total of 87 easily distinguishable attenuated stars were recounted in the same sector 8. It was also possible to identify 205 extremely faint stars that suggest their presence within the nebula if the image is suitably amplified. Finally, the dark giants of Union U1 represent 98.9% of attenuated stars, and 96.3% of total present in sector 8.

Received

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1. Celis, S.L. Luminosity Attenuation And Distance Of Red Giant Stars. *Astrophys. J. Suppl*. **98**, 701-738, (1995) (paper XIV)
2. Reipurth, B. at al. Thackeray's globules in IC 2944. Astron. Astrophys. **327**, 1185-1193 (1996)
3. Celis, S.L. the attenuated red giant stars: new direct observational evidences for baryonic dark matter. *The Identification of Dark Matter, IDM96*, Sheffield, England. Ed. N. J. C. Spooner, Word Scientific Publishing C., London, p181-187 (1997) (paper XV)
4. Celis, S.L. HST image of Mira cocoon star as evidence of baryonic dark matter. *The Identification of Dark Matter, IDM98*, Buxton, England. Ed. N. J. C. Spooner and V. Kudryavtsev, Word Scientific Publishing C., London, p150-159, (1999) (paper XVI)
5. Rubin, V. C., Ford W. K. & Thonnard N. Rotational Properties Of 21 Sc Galaxies With A Large Range Of Luminosities And Radii, From 4605 (R = 4 Kpc) To UGC 2885 (R = 122Kpc). *Astrophys J.* **238**, 471-481 (1980)
6. Alcock, C. *et al*. The macho project Large Magellanic Cloud microlensing results from the first two years and the natures of the galactic dark halo. *Astrophys J*. **486** 697-726 (1997)
7. Bahcall, J. N. *et al*. M dwarfs, microlensing, and mass budget of the galaxy. *Astrophys. J*. **435**, L51-L54 (1994)
8. Zapatero, O. M. R. *et al*. Brown Dwarfs in Pleiades Cluster. *Astron. Astrophys. Suppl*. **142**, 537-547 (1998)
9. Hensen, B. M. S. Old and blue white-dwarf stars as a detectable source of microlensing events. *Nature*, **394**, 860-862 (1998)
10. Mendes, R.A.& Menniti, D. Faint blue objects on the Hubble deep field north & south as possible nearby old halo White Dwarfs. *Astrophys. J*. **529**, 911-916 (2000)
11. Carr B. Baryonic dark matter. *Annu. Rev. Astron. Astrophys*. **32**, 531-590 (1994)
12. Kamionkowski, M. Microlensing by stars, *Astrophys. J*. **442**, L 9-L10 (1995)
13. James, P.A. & Puxley, P.J. A measurement of the optical depth through a galaxy disk. *Nature* **363**, 240-442 (1993)
14. Walborn, N. R. & Liller, M. H. The earliest spectroscopic observations of Eta Carinae and its interaction with the Carina nebula. *Astrophys. J.* **211**, 181-183 (1977)
15. Walborn, N. R. Some extremely early O Stars near Eta Carinae. *Astrophys. J.* **167**, L31-L33 (1971)
16. Bok, B.J. dark nebulae, globules, and protostars. *Pub. Astron. Soc. Pacific*. **89**, 597-611 (1977)
17. Celis, S.L. luminosity of the Mira variables. *Astron. Astrophys*. **89**, 145-149 (1980) (paper VI)
18. Blommaert, J. *Miras and OH/IR Stars as probes of the Galaxy*, Thesis Doc., Leiden Universirty, December (1992)
19. Misner, C. W. *et al*. *Gravitation*, Ed Freman and Company, USA. (1973)
20. Lang, K. R. *Astrophysical Formulae, A Compendium For The Physicist And Astrophysicist*. *Ed. Springer-Verlag*, Berlin, New York, (1974)
21. Hagen, W. Circumstellar gas and dust shells of M giants and supergiants. *Astrophys. J. Suppl*, **38**, 1-18 (1978)
22. Yun J.L. & Clement D.P. Star formation in small globules, *Astrophys J*. **365**, L73-L76 (1990)
23. Walborn, N. R. *et al*. Space telescope imaging spectrograph observations of the interstellar velocity structure and chemical composition toward the Carina Nebula. *Astrophys. J*. **492**, L169-L171 (1998)
24. Celis, S.L. The distance of large amplitude red variables. *Astron. Astrophys*. **99**, 58-62, (1981) (paper VII)
25. Celis, S.L. Red variable stars. I. UBVRI photometry and photometric properties. *Astron. J*. **87**, 1791-1802 (1982) (paper VIII)
26. Celis, S.L. Red variable stars. II. Spectral classification of Mira variables with phenomenological and photometric procedure. *Astron. J*. **89**, 527-548 (1984) (paper IX)
27. Celis, S.L. Spectral and luminosity variation of long period red variable stars. *Astron J.* **91**, 405-415 (1986) (paper XII)
28. Hawkins, G.W. IRAS observations of a large circumstellar dust shell around W Hydrae. *Astron. Astrophysics* **229**, L5-L8 (1990)

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FIGURE LEGENDS

Figure 1. Resolution power of the Hubble image and comparative angular dimensions. All box images have the same angular amplification. The top bars indicate 1 arcsec in each box. The objects without strong glare (no shine or glow) have an observed angular diameter.

Figure 2. Isolate dark giants. Line 1 are aligned giant objects, binary systems and partial eclipses between red giants (boxes 1-55 and 5-28) The most interesting boxes, 2-8 and 4-48, reveal partial eclipses where one dark giant is seen transiting over an attenuated supergiant cocoon and the other, a bright star. The angular sizes of dark giants are ~0.2 to ~0.1 arcsec (lines 2 to 7). They present different morphologies in line 7.

Figure 3. Dusty globules in Carina region. Typical globules of lines 1 and 2 are in original and contrasted images. The contrasted image highlights internal dark giants. Globules of line 2 show the incident ionizing

radiation that smoothly displaces the gas and dust in the arrow direction also revealing an internal dark giant complex. Isolate conglomerates of dark giants associated with the Carina nebula in lines 3 and 4. Each individual conglomerate contains a large number of dark giants that are embedded in the largest, darkest and extended dusty globules. Line 4 shows denser conglomerates. Larger conglomerates (line 5) are also close the nebula.

Figure 4. Conglomerates of dark giants. Zone A of Figure 7. This Zone shows dark giants that are fully free of the dense part of the Carina nebula.

Figure 5. Association of conglomerates. Zone B is an extensive area of dark giants associated with the Carina nebula.

Figure 6. A Union of Conglomerates of dark giants. The Union U1 is a large zone of conglomerates associated with the darkest sector of Carina nebula. The embedded dark giants are noticeable when a high contrast is applied.

Figure 7. The Carina Nebula. A color photographs mosaic of Carina nebula taken by the Hubble Space Telescope in 1999. The Hubble Image (rectangle) presented here is divided into 8 sectors. The small frameworks A and B are zones amplified in Figures 4 and 5 respectively. The attenuated stellar objects are invisible at the scale of this image.