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10. THE NEW KIND OF STAR MODEL

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By comparing the G energy yields given in E7.10 with those of nuclear fusion of H, it is inferred that most of the energy emitted in a matter cycle should come, ultimately, from gravitational work of contraction. From the exponential form of such relations, it is concluded that most of such energy should be released in the strongest G field gradients produced by the densest states of matter, i.e., around neutron stars and black holes.

This stands out the importance of the new MS star model proposed before[1,3,7], and above. This is mainly because most of the observed energy comes from stars and, therefore, the neutron stars must be rather hidden inside of the stars[1].

Notice that, in general, the neutron stripping reactions occurring around a neutron star surface would transform, mainly, burnt out matter (He and heavier elements) into protons of high kinetic energy and high nuclear latent energy per unit of mass.

When the neutron star is within an external shell of more dense matter, these ejected protons would dissipate most of their kinetic energies in the interface between the core and the external envelope[2]. Such high energy densities should keep the interface nuclei in partially dissociated states within a space with higher densities of photons and protons. This would keep *a lower density material* between the neutron star and the external envelope of more dense atomic matter. This material would give rise to *convection currents* that would carry upward nuclear latent energy that would be liberated in upper levels after nuclear fusion. This process *would prevent overheating and collapse due to neutrino cooling.*

These kind of heterogeneous stars would have well defined core surfaces, with better-defined internal field gradients[3]. Such gradients would also control the nuclear fusion reaction rates that, in the end, would fix the net luminous power of the star. Thus, these kinds of stars should have *well defined mass-luminosity relations* whose theoretical values, derived below, are consistent with the observations. They would get power from both, *nuclear fusion of H*, that generates nuclear neutrons and releases energy, and from *neutron stripping*. The last reactions also liberate G energy and regenerates free H (recycled atomic fuel).

10.1 The energy yield of the main sequence star model

According to the NL mass-energy conservation, *the net energy released per nucleon* captured in the neutron star is independent on the intermediate steps in which is done. From E7.10, the net NL energy released per H atom, after nuclear fusion and neutron stripping, is equal to the differences of the NL rest mass of the H at the initial place and the final NL rest mass of the neutron in the NS core. The last one would have a radius r^c, with respect to the observer at r^*. This net energy yield is equal to the sum of the energy released in the nuclear fusion reaction zone, ($\Delta E^{f}_{r^*}$), and the energy released in the nuclear stripping zone ($\Delta E^{st}_{r^*}$).

$$\Delta E^{tot}_{r^*} = \Delta E^{f}_{r^*} + \Delta E^{st}_{r^*} = m^{H}_{r^*}(0, r^{f}) - m^{N}_{r^*}(0, r^{c}) \qquad \text{E10.1}$$

In more detail, for the nuclear fusion of H,

$$4m^{H}_{r^*}(0, r^{f}) = m^{He}_{r^*}(0, r^{f}) + 2\Delta E^{f}_{r^*} \qquad \text{E10.2}$$

Its energy yield per unit of NL mass converted in nuclear neutrons in He is:

$$Y^{f} = \frac{\Delta E^{f}_{r^*}}{m^{H}_{r^*}(0, r^{*})} = \frac{4m^{H}_{r^*}(0, r^{f}) - m^{He}_{r^*}(0, r^{f})}{4m^{H}_{r^*}(0, r^{*})} \approx 0.007 \qquad \text{E10.3}$$

Assume an idealized case in which a new *He* atom at r^f falls down, freely, up to the neutron stripping zone, at r^c, where it looses its two neutrons after neutron stripping carried out by the central macro nuclei. After this the two rejected protons travel freely up to the nuclear fusion zone, coming there with some extra kinetic energy that is released after a stop. The NL mass-energy balance is as follows:

Initially Intermediate state Final state after the stop

$$m_{r*}^{He}(0,r^f) = 2m_{r*}^{N}(0,r^c) + 2m_{r*}^{H}(\beta,r^f) = 2m_{r*}^{N}(0,r^c) + 2m_{r*}^{H}(0,r^f) + 2\Delta E_{r*}^{gr}$$ *E10.4*

In which ΔE_{r*}^{gr} is the net NL kinetic energy *per proton* given away after nuclear stripping of one neutron. $m_{r*}^{N}(0,r^c)$ is the final NL rest mass of a neutron in the neutron star. After adding up E10.*2* and E10.*4*, and by dividing by *2*, it may be verified that the net mass-energy released between r^f and r^c, per neutron captured by the neutron star is just that given in E10.*1*.

According to E10.*1* the net G energy yield per unit of mass-energy captured by the core can be written in the form:

$$Y^{tot} = \frac{\Delta E_{r*}^{tot}}{m_{r*}^{H}(0,r^f)} = \frac{m_{r*}^{H}(0,r^f) - m_{r*}^{N}(0,r^f) + \left[m_{r*}^{N}(0,r^f) - m_{r*}^{N}(0,r^c)\right]}{m_{r*}^{H}(0,r^f)}$$ E10.*5*

Using *E7.10*, and the NL mass- energy yield per unit of mass

$$Y^{tot} = \frac{\Delta E_{r*}^{f} + \Delta E_{r*}^{gr}}{m_{r*}^{H}(0,r^f)} = Y^f + Y^{gr} \cong .0007 + \left\{1 - \exp\left[z(r^f) - z(r^c)\right]\right\}$$ E10.*6*

$$Y^{tot} \cong 0.0007 + \Delta z(r^c)$$ E10.*7*

10.2 The low neutrino luminosity of the Sun

The rate of nuclear fusion events occurring in the Sun can be derived after knowing the rate of neutrinos emitted by it. Some of those neutrinos can be detected by different experimental methods. This makes possible a fair estimation of the total number of the real rate of fusion events occurring in the Sun.

ACCORDING TO E7.10, the differences between the observed energy yield and that of nuclear fusion is just the G energy released after neutron stripping.

$$Y^{gr} = Y^{tot} - Y^f \cong \frac{E_{r*}^{tot} - E^f}{m_{r*}^{H}(0,r^*)}$$ E10.*8*

The observed *total energy yield* derived from the neutrino flux of the Sun is of the order of *0.02*, i.e., it is about *three times of that of nuclear fusion*. Thus, from E10.*7, the value of* z(r) in the S core would be of the order of *0.013*.

$$z_{r*}(r^c) \cong \frac{GM}{r^c} \cong \frac{G^{new}M^{new}}{r^c c^2} = \frac{G^{new}4\pi\rho^{new}\left[r^c\right]^2}{c^2} \approx 0.01$$ E10.*9*

If the core had a density somewhat higher than the nuclear one, of the order of 10^{18} - 10^{19} kg/m^3, the Sun may have a neutron star core with a radius between

$$r^c = \sqrt{\frac{c^2 z(r^c)}{4\pi\rho^{new}G^{new}}} \approx 1-3\ [km] \qquad , \qquad \text{E10.}\mathit{10}$$

With a mass range between

$$M^{new} = \frac{4\pi\rho^{new}\left[r^c\right]^3}{3} \approx 4x10^{27} - 19x10^{27}[kg] \approx 3x10^{-3} - 9x10^{-3}\, M^{Sun} \qquad \text{E10.}\mathit{11}$$

Thus *the Sun would be using up only about one third of the estimated consumption of H*. The two thirds would come from neutron stripping done by the core's G field. In this way, the new stellar model also *solves the problem that the current star model has after the small observed rate*[24].

10.3 The Mass-Luminosity relationship of main sequence Stars

Due both to the high density of the neutron star core and to its rather constant value, *the gradients* of the mass distribution in the star should be mainly fixed by the strong G field gradients. They would concentrate the masses closer to the center. Thus the total value of $z_{r*}(r)$ in the nuclear fusion reaction zone can be roughly approximated by

$$z_{r*}(r) \cong \frac{GM}{r} \qquad ; r >> r^c \qquad \text{E10.}\mathit{12}$$

In which M is, roughly, the star mass[4].

On the other hand, the power of the MS star model depends on the rate of generation of new nuclear neutrons occurring in the nuclear fusion reaction zone. This one is proportional to the corresponding volume. The volume of such reaction zone is fixed by well-defined temperature and pressure limits. They in turn depend mostly on the limiting values (minimum and maximum) of *z*, (or *f*) provided that the rest of the variables remain relatively constant Assume that the minimum values of *z* are z1, and *z2*, in which *z1* is small compared with *z1*. For a particular star this means a nuclear fusion reaction zone of volume *V*, grossly delimited by two radius, say *a* and *b*. Thus, these radiuses and the net volume of the nuclear reaction zone would depend on these constant values of *z* according to:

$$a = \frac{GM}{z^1} \quad \text{b} = \frac{GM}{z^2} \quad \text{a - b} = \frac{GM}{z^1} - \frac{GM}{z^2} \quad V = 4\pi a^2 (a-b) \qquad , \qquad \text{E10.}\mathit{13}$$

$$V = \frac{4\pi G^3}{(z^1)^3}\left\{1-\frac{z^1}{z^2}\right\}M^3 \cong KM^3 .$$

E10.*14*

On the other hand, according to E7.10, the net G energy yield, per neutron traveling from the star surface up to the neutron star, is:

$$Y(grav) \cong \frac{GM_o}{r^c} \cong \sqrt[3]{\frac{4\pi\rho}{3}}GM_o^{2/3}$$

E10.*15*

Thus, the net energy released by the star in a steady state should be proportional to both the rate of production of neutrons and to the net energy yield per neutron captured by the core. The neutron production rate is proportional to the volume of the nuclear fusion reaction zone. Thus from E10.14 and 10.15,

$$L \propto VY(grav) \propto M_o^{3.67} \qquad L \propto M^{3.67}$$

E10.*1 6*

This value is slightly higher than the values normally given in the literature for *MS* stars[25]. This higher value is also expected from the approximation done in E10.12

It is most important to notice that only MS stars have a rather well defined mass-luminosity relation. This can only occur if the core has a better-defined density that fixes the G field gradients.

10.4 The role of neutron stripping in astrophysics

It is interesting that nuclear stripping unifies a variety of phenomena occurring in the universe.

For example, when a neutron star or a similar body becomes surrounded with a gaseous shell of plasma, single charged particles would fall preferentially towards Polar Regions. They would be driven by magnetic fields, either steadily or in discrete fronts thus producing pulses or bursts of high-energy particles and electromagnetic radiation’s going away from the neutron star. In this way, the net G work of the captured neutrons (or its G potential energy) is converted into other forms of available *energies*, like mechanical and nuclear ones. The last ones, in turn, can be converted into lower forms of energy, in other places, according to the conventional mechanisms. These last conversions may occur either inside or around the same star or in other external bodies, it escapes from the star.

In principle, the neutron stripping reactions can unify the mechanisms of energy generation in all of them: main sequence stars, pulsars, bursars and cosmic jets. This kind of reaction seems to be main way that nature has for the energy recycling in the universe.

According to this reaction, the burned out materials, like He and heavier elements can be partially recycled as fresh protons or proton rich materials of high kinetic energy. This must occur at the cost of the lower G potential of the neutrons left over in neutron stars or black holes. This accounts for the cosmic rays whose average kinetic and nuclear latent energies per unit of mass seem to be the highest ones in the universe.

This leads to conclude that neutron stripping should be one of the most important mechanisms for the releasing and transforming G energy into more conventional forms of energy, i. e., by transforming burnt out materials into renewed H. Most of these events would occur in the strongest G field gradients existing in the universe.

10.5 The growth of neutron stars

Due to the high binding energy of the neutrons in the neutron star, its mass would grow with the time, inexorably, at the cost of the neutrons captured by it. This capture would occur either directly from interstellar gas or gas clouds or from the gas of some close companion star. Such mass increase would increase the energy yields generated according to E7.10.

In the MS stars of Low Mass, the ratio between the NL mass of the external envelope and the NL mass of the neutron star would decrease with the time. This would occur up to the point in which system should become unstable after the oscillations of the external envelope, especially in resonant conditions[5]. Finally, the thinner star envelope may undergo partial collapses followed by stellar explosions. They would finally leave a rather naked neutron star (a black dwarf) that would cool down when the remaining envelope cannot be contracted any more. Later, the black dwarf may enter a gas cloud and become a more massive and bluer MS star.

In neutron stars more massive, the spherical oscillations of the star envelope with respect to its core can produce partial collapses giving out variable (periodical) stars.   In cases of unsymmetrical accelerations of the external envelope, the internal radiation may eventually be not able to stop all of the initial falling material. This may end with a partial collapse of the stellar envelope and the partial ejection of the star envelope. Such explosions would produce nuclear fusion reactions of elements heavier than iron. Notice that most of the collapses of the external envelopes would be produced over a neutron star that *existed before the explosions*. Of course, the neutron star would always grow with time.

Some partial collapses can also feed up energy to rather stationary oscillations with respect to the external envelope, or vice versa. Thus, continently, the NS may be thrown away from the external envelope. Thus, the NS may get away in some well-defined direction with respect to the expanding shell of atoms. This is consistent with the *supernovas and with the pulsars traveling away from the original gravity center*.

Notice that this mechanism is consistent with *the bluer progenitor of supernova SN1987A*. This was something unexpected, because according to current stellar models, this one should be a red one but not a blue one.

Thus in principle the masses of the neutron stars should grow inside rather blue stars, may be after consecutive stages followed by rather black ones. The last stages may allow the formation of stellar envelopes that can be more massive than the previous ones.

Observe that the more massive bodies, with steeper gradients of G potentials would grow either by capturing matter directly from the space or by stealing it to their closer companion bodies. As usual, the more massive ones would grow up at the cost of the smaller ones.

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[1] Indeed my first trial on the present model, made in 1974, was based on a gradual collapse of the stars, produced around cores of nuclear density. By that time, in the literature that I had at hand, these kinds of stars were not mentioned. Later I found that L. Landau[21] and Gamow have also explored the possibility that a neutron star may exist in stars. However, such idea seems abandoned because it has been thought that local overheating would produce neutrinos that can travel rather freely away from the star. This kind of neutrino cooling would produce the star collapse. However, the nuclear stripping reactions proposed earlier for cosmic ray generation in black hole[11]- Such reactions would prevent local overheating after transforming heavy atoms into free protons of high nuclear potential energy and kinetic energy. They would keep an interface of lower density between the neutron star and the external shell of atoms. This one would prevent the collapse of the external shell of atoms. This is similar to the case of the steam cushion generated between a drop of water and a hot iron.

[2] The more massive neutron stars (or BHs) can produce jets that are more powerful that that can open tunnels through thin external envelopes.

[3] It is reasonable that the interface between the NS and the external envelope is made of a degenerated mater made up of a mixture of rather free protons and neutrons traveling in counter current. The steep G gradients would push down the neutrons and the nuclear fields, mainly the electric one, would push away the protons.

[4] The effective mass below the nuclear fusion zone would be lower than M and, therefore, the true luminosity of the star should be somewhat lower than that estimated here.

[5] The external bodies orbiting around MS stars, can eventually excite rather spherical oscillations that would be “reflected and amplified by the explosive reaction occurring on the NS surface. The high symmetry of those rings is consistent with the rather point like source of the original wavefront.