IOSR Journal Of Applied Physics (IOSR-JAP)
e-ISSN: 2278-4861.Volume 12, Issue 6 Ser. IV (Nov. – Dec. 2020), PP 09-21
www.Iosrjournals.Org

Stellar Core Collapse Models are Erroneous and Misleading

Gurcharn S. Sandhu[1]
[1] *Independent Researcher*
#48, Sector 61, Mohali, Punjab – 160062, India.

Abstract:
The notion of electron degeneracy pressure in stellar core collapse models is founded on the assumed non-interacting characteristic of electrons and ions. As non-interacting particles, electrons and ions are assumed to be identical to the ideal gas particles in kinetic theory, which produce kinetic pressure through exchange of momentum in elastic collisions. Actually, electrons cannot exchange momentum with positive ions due to their electrostatic interaction and hence cannot provide the much-acclaimed degeneracy pressure. This non-interacting characteristic of electrons and ions is also assumed to invoke the use of hydrostatic equilibrium equations for analysing the stability of high-density solid stellar cores. By taking into account the electromagnetic interactions among electrons and ions we show that the high-density stellar cores transform into gravity induced solid state, which can support the gravitational loading through development of radial and hoop stresses. In solid state the induced stresses can only be analysed by equilibrium equations of elasticity. Their solution for a spherical solid body yields the radial and hoop stresses proportional to square of radius. Hence, the self-gravitation induced stresses are maximum at the periphery and zero at the centre, which makes it impossible for a massive stellar core to collapse under self-gravitation into fictitious Black Holes. We conclude that all stellar cores which are said to be degenerate, where some sort of degeneracy pressure is invoked to prevent their gravitational collapse under hydrostatic equilibrium conditions, are in fact solid stellar cores which acquire their stability under self-gravitation through equilibrium equations of elasticity.
Keywords: *Core Collapse, Self-gravitation, Hoop Stress, Degeneracy Pressure, Black Holes*

Date of Submission: 30-12-2020 Date of Acceptance: 13-01-2021

I. Introduction

There are two types of gravitational collapse in astronomical structures. The first type of gravitational collapse is that of a gas cloud of interstellar matter. A star is born through the gradual gravitational collapse of a large gas cloud. The compression caused by the collapse raises the temperature until thermonuclear fusion occurs at the centre of the star. When the outward thermal pressure gradient balances the gravitational forces, a star is said to be in hydrostatic equilibrium and consists of a central high-density stellar core and an outer low-density gaseous shell. The second type of gravitational collapse is that of a high-density stellar core at the end of nuclear fusion stage. When a star has exhausted its fuel supply, the core will cool down and undergo a contraction that, as per current models, can be halted only by electron or neutron degeneracy pressure. With this second type of gravitational collapse, a high-density stellar core may collapse into a White Dwarf, a Neutron Star or a Black Hole, depending on the core mass [1]. In this paper we critically examine the gravitational collapse of stellar cores and show that it is impossible for high density stellar cores to collapse under self-gravitation into Black Holes.

As per current models of core collapse, no form of cold matter or physical mechanism can provide the force needed to oppose gravity in cold stellar cores of mass greater than twice the Solar mass. Hence, the gravitational collapse continues with nothing to stop it. Once a body collapses to within its Schwarzschild radius, it forms what is called a Black Hole, meaning a space-time region from which not even light can escape. Accordingly, at the end of life cycle of large stars, the remnants of Core Collapse Super-Nova explosions (CCSNe) are believed to produce the Black Holes or Neutron Stars [2]. It was only in 1939 that J. Robert Oppenheimer and his student Hartland Snyder published a paper entitled "On the Continued Gravitational Contraction", the first to confirm that gravitational collapse could happen for supermassive stars, a conclusion that would later evolve into the concept of Black Holes [3]. As per Oppenheimer, "*There would then seem to be only two answers possible to the question of the 'final' behavior of the very massive stars: either the equation of state we have used so far fails to describe the behavior of highly condensed matter or the star will continue to contract indefinitely, never reaching equilibrium. Both alternatives require serious consideration*". Eddington also intuitively expected that the properties of matter would somehow, counter-balance the consequences of gravitational attraction. He trusted in a *yet-to-be-discovered* mechanism inside the star that would maintain equilibrium.

We have established in this paper that for high density stellar cores, where mean separation between two adjacent particles is less than 50 pm and particles are in pressure ionized state, the Equation of State derived from hydrostatic equilibrium conditions actually breaks down. The electrons, protons and ions can no longer be assumed to be non-interacting. The physical mechanism that had been alluded to by Eddington, Oppenheimer and Wheeler for preventing massive stars from collapsing under self-gravitation, consists of hoop stresses developed in gravity induced solid state of cooled down high-density stellar cores.

In a recent paper [4] it has already been shown that Black Holes are a mathematical fantasy and not a physical reality. Specifically, it has highlighted the impossibility of photon capture in any gravitating stellar body. The standard gravitational redshift formula under strong gravitation field conditions, relates escaping photon frequency ν_2 to the emitted frequency ν_1 as,

$$\nu_2 = \nu_1 \sqrt{\left(1 - {R_s}/{R_0}\right)} \tag{1}$$

where Schwarzschild radius $R_s = 2GM/c^2$ and R_0 is the physical radius of the spherical stellar body of mass M. This predicts photon capture by the gravitating body whenever the Schwarzschild radius R_s is equal to or greater than physical radius R_0. However, the correct gravitational redshift formula, as derived in the paper, is

$$\nu_2 = \nu_1 e^{-\frac{R_s}{2R_0}} \tag{2}$$

This shows that the escaping photon frequency ν_2 cannot vanish under any circumstances. The error in gravitational redshift as given by equation (1), is essentially rooted in the wrong use of standard gravitational potential, derived with a test body of constant mass and used for the redshift analysis of a photon of variable frequency in the gravitation field.

It has also been shown [5] that the popular notion of spacetime curvature applied to 3D space, leads to incompatible deformation of space with physically impossible voids and discontinuities. Common usage of the terms 'region of spacetime' or 'ripples in spacetime' are quite misleading as they give the impression of spacetime being a physical entity. In reality the 'spacetime' is just a mathematical construct in the general theory of relativity (GR). As per GR, at the centre of a Black Hole lies a gravitational singularity, a region where the spacetime curvature becomes infinite. The appearance of singularities in GR is commonly perceived as signalling the breakdown of theory. Given the bizarre nature of Black Holes, it has since long been questioned [6] whether "Schwarzschild singularities" could actually exist or whether they were merely hypothetical solutions of mathematical models.

Electron degeneracy pressure is the most crucial phenomenon that is assumed to protect a star from gravitational collapse when its thermal pressure starts decreasing at the end of nuclear fusion stage. Building on the foundations established earlier by Fermi, Dirac formulated Fermi–Dirac statistics in August 1926. In December 1926, R. H. Fowler applied Fermi–Dirac statistics to explain the puzzling nature of white dwarfs. In a pioneering paper on compact stars, he proposed that the electron degeneracy pressure, derived from Fermi-Dirac statistics, could be the pressure that holds up the massive stellar cores from gravitational collapse. Ever since then the electron degeneracy pressure has assumed a crucial pivotal role in all models of gravitational collapse of massive stellar cores [7]. However, a significant point, which is often overlooked, is that the Fermi–Dirac distribution applies only to a quantum system of non-interacting fermions. Hence the notion of electron degeneracy pressure is founded on the implied assumption of electrons, protons and ions to be non-interacting free particles. As non-interacting particles, electrons, protons and ions are assumed to be identical to the ideal gas particles in kinetic theory of gases [8], which produce kinetic pressure through exchange of their momentum in elastic collisions. Actually, electrons cannot exchange momentum with positive ions due to their electrostatic interaction and hence cannot provide the much-acclaimed degeneracy pressure.

The non-interacting characteristic of electrons and ions is also assumed to invoke the use of hydrostatic equilibrium equations for analysing the stability of solid stellar cores by treating the high-density solid core constituents as fluids. However, by taking into account the electromagnetic interactions among electrons, protons and ions we show that the high-density stellar cores transform into gravity induced solid state which can support the gravitational loading through development of radial and hoop stresses.

II. Stellar Pressure and Temperature Profiles under Hydrostatic Equilibrium

A star grows out of gravitational collapse of an interstellar neutral plasma or gas cloud. It attains a sort of hydrostatic pressure-gravity equilibrium through conversion of gravitational potential energy of the collapsing gas cloud [9] into its thermal pressure. From the ideal gas law, the pressure P, volume V and temperature T relation is given as, $P\,V = N\,k_B\,T$, where N is the number of non-interacting ideal gas particles, molecules or atoms. Let mass of each particle be μ time the atomic mass unit m_n. In terms of gas density ρ and the universal gas constant R_u, the P-T relation takes the form,

$$P = \frac{N.\mu.m_n}{V}\frac{1}{\mu}\frac{k_B}{m_n}T = \frac{\rho}{\mu}R_u T \tag{3}$$

Whereas the temperature of the constituents depends on the mean kinetic energy of particles the pressure depends on the average momentum as well as the number density N_u of the constituent particles. For hydrostatic equilibrium, let us consider a spherical shell of radius r and thickness dr, with gas density ρ. Until the gravitational and pressure forces attain an equilibrium, there will be a net acceleration acting on the gas particles. If M(r) = (4/3)πr^{3}ρ is the mass of the gas enclosed within radius r, then resulting equation of motion is simply,

$$\frac{dP}{dr} + \mathrm{G}\frac{M(r)\rho}{r^2} = -\rho\frac{d^2r}{dt^2} \qquad (4)$$

When the hydrostatic equilibrium is achieved, the acceleration term in equation (4) will vanish and the equilibrium equation for pressure P will be given as,

$$\frac{dP}{dr} = -\mathrm{G}\frac{M(r)\rho}{r^2} \qquad (5)$$

In general, any change in hydrostatic equilibrium will lead to mass transfers between different radial shells that will be governed by equation (4). The density and pressure profiles will get readjusted before a new equilibrium is achieved. Here, for obtaining a qualitative picture of pressure and temperature variations across an active burning star, we may neglect a small contribution of radiation pressure.

2.1 Radial variation of Pressure, Density and gravitational acceleration

Since the hydrostatic pressure in a gravitating body of mass M becomes maximum P_c at the centre, its density ρ may also vary with radius r and become maximum ρ_c at the centre. We may therefore, assume a gradual reduction of density with increasing radius from centre to maximum R_m as,

$$\rho = \rho_c e^{-nx} \qquad \text{where} \quad x=r/R_m \text{ and n are an empirical constant.} \qquad (6)$$

Therefore,

$$M(r) = \int_0^r 4\pi r^2 \rho_c e^{-nx}\, dr = 4\pi\rho_c R_m^3\left[\int_0^x x^2 e^{-nx}\, dx\right] \qquad (7)$$

Evaluating the integral, let

$$f(n,x) = \int_0^x x^2 e^{-nx}\, dx \qquad (8)$$

Then,

$$M(r) = 4\pi\rho_c R_m^3[f(n,x)] \qquad (9)$$

Substituting this value of M(r) and ρ from equations (6) and (9) in equation (5) we get,

$$\frac{dP}{dr} = -\mathrm{G}\frac{M(r)\rho}{r^2} = -\frac{4\pi G R_m \rho_c^2 e^{-nx}}{x^2}[f(n,x)] \qquad (10)$$

Integrating equation (10) for radius from 0 to r or 0 to x and pressure from P_c to P we get,

$$\int_{P_c}^{P} dP = -\,4\pi G R_m^2 \rho_c^2 \int_0^x \left[\frac{e^{-nx} f(n,x)}{x^2}\right] dx$$

We may evaluate this integral from 0 to x, for any specific n, by numerical integration.

$$F(n,x) = \int_0^x \left[\left[\frac{\mathrm{e}^{-\mathrm{nx}}\mathrm{f(n,x)}}{\mathrm{x}^2}\right]\right] dx$$

Hence,

$$P - P_c = -4\pi G R_m^2 \rho_c^2[F(n,x)]$$

Since density ρ and pressure P at the outer surface of the body is nearly zero, substituting r= R_m or x=1, we get,

$$P_c = 4\pi G \rho_c^2 R_m^2[F(n,1)] \qquad (11)$$

The pressure P(x) at radius fraction x = r/R_m induced by the gravitational pull, is obtained by substituting P_c from equation (11) into previous equation, as

$$P(x) = 4\pi G R_m^2 \rho_c^2[F(n,1) - F(n,x)] \qquad (12A)$$

The corresponding temperature T(x) at radius fraction x, is obtained from equations (3), (6) and (12A) as,

$$T(x) = \frac{\mu}{R_u}\frac{P(x)}{\rho(x)} = \frac{\mu}{R_u}\frac{4\pi G R_m^2 \rho_c}{e^{-nx}}[F(n,1) - F(n,x)] \qquad (12B)$$

Similarly, using equation (9) we can compute the magnitude of gravitational acceleration g(r) as a function of radius or radial fraction x=r/R_m for different values of stellar mass M with corresponding maximum radius R_m.

$$\mathrm{g}(x) = \frac{G\,M(r)}{r^2} = \frac{4\pi G R_m \rho_c\,[f(n,x)]}{x^2} \qquad (13)$$

The average mass density of sun is known to be about 1400 kg/m^3. Assuming same average mass density in most other similar stars, we can easily plot the variation of magnitude of gravitational acceleration 'g' with radius or radial fraction x=r/R_m for different values of stellar mass M with corresponding R_m. A typical set of such curves for n=9, are shown in figure 1.

Maximum mass density in the central regions of massive stars is found to be of the order of 10^5 kg/m^3. From the considerations of pressure, gravitational acceleration, particle density and the associated fusion reaction zone, the central spherical volume, with radius of about 20 percent of the stellar radius, can be regarded as the stellar core. It is clear from figure 1, representing gravitational loading on the stellar constituents in hydrostatic equilibrium, that the gravitational loading is always zero at the centre and maximum in the peripheral region of a stellar core.

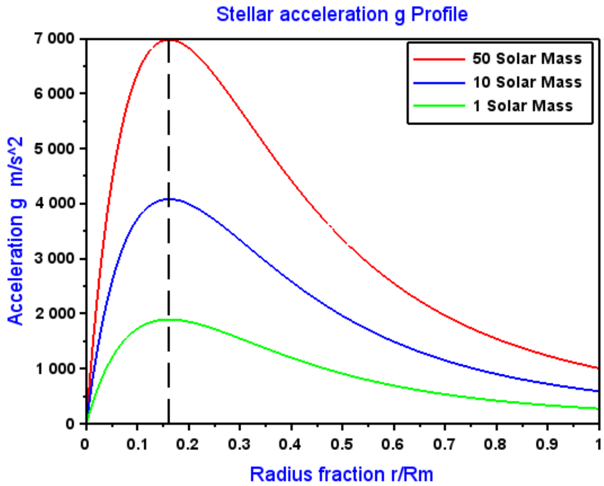

Figure 1. Radial variation of gravitational acceleration for stellar bodies in hydrostatic equilibrium.

2.2 Gravitational Collapse of a Stellar Core under hydrodynamic conditions

The primary energy source for young stars is hydrogen fusion. Thermal pressure generated by fusion reactions counteracts the attractive forces of gravity. The fusion of four H nuclei to form He, via either process, increases the mean molecular weight μ of the gas. After a sequence of fusion reactions when the particles become nuclei of Helium, Carbon, Oxygen etc. the increasing average atomic or molecular number μ will lead to decreasing pressure for the same density and temperature (equation 3) in the stellar core. This will be accompanied by more mass transfer into the core leading to increased density and temperature at the centre and reduction in maximum radius R_m. In principle, these cycles of burning and contraction can continue until the nuclear fuel in the star core is exhausted, that is, until the core consists mainly of iron. During this time, as the central density increases, electron degeneracy pressure is believed to increase significantly. Specifically, when a star begins to cool down after the termination of fusion reactions in the core, the decreasing temperature and pressure in the core will be accompanied by more mass transfer into the core (equation 4) with corresponding increase in core density and associated contraction. It is believed that in the absence of high thermal pressure, only a high degeneracy pressure can stop further contraction or gravitational collapse of the stellar core.

All stars originally below a critical value, say in the range of 6 to 8 $M_\odot$, will finally become white dwarfs. The white dwarf stars terminate their nuclear fuel fusion reactions before complete conversion to iron. In this state, stars shed a portion of their mass from the outer shells and radiate away their thermal energy to slowly cool down. Such white dwarf stars are left with contracted cores of final mass of the order of a solar mass. The basic structure expected in a white dwarf consists of a high-density carbon/oxygen core surrounded by a helium layer and an outer hydrogen-rich envelope [10]. The high-density matter in white dwarfs must be completely 'pressure ionized'. The ideal, non-interacting electron gas is believed to account for the dominant contribution in the equation of state at high densities. The core densities are believed to be of the order of 10^9 kg/m^3 where the electron degeneracy pressure dominates their hydrodynamic equilibrium. These densities are in fact not inferred from observations but assumed to invoke the use of electron degeneracy pressure to prevent gravitational core collapse.

Stars of mass greater than ten $M_\odot$, go through various stages of core and shell fusion of heavier elements finally ending with a core of iron [11]. The iron cores in such stars are believed to be supported by electron degeneracy pressure. Solid iron stellar cores are normally surrounded by fusion shells of Si, O, C, He and H. The quasi-equilibrium Si shell fusion continues to grow iron cores up to the Chandrasekhar mass limit. By assuming non-interacting characteristic of electrons, protons and ions, the solid iron core, up to the Chandrasekhar mass limit, is believed to be supported against gravitational collapse by the electron degeneracy pressure under hydrostatic equilibrium conditions. When an iron core attains a mass of greater than 1.4 $M_\odot$, it is believed [12] to undergo an unstable gravitational collapse which cannot be prevented even by the electron degeneracy pressure.

As per the current models, collapse of the critical-mass iron core is believed to accelerate rapidly. The rapid in fall proceeds until the central density exceeds that of nuclear matter. At such densities the repulsive nuclear interaction renders the stellar core incompressible, which halts the collapse of the inner core. The sudden halt launches a strong shock wave back into the supersonically falling overlying layers, driving these layers outward in a process termed 'core bounce'. The sequence of events that follow, lead to the Core Collapse Super Novae explosions (CCSNe). Despite extensive research, several aspects of the mechanism that drives these explosions remain uncertain. A complete understanding of stellar core collapse is crucial for understanding the formation of neutron stars, pulsars and magnetars. The CCSNe problem has been an outstanding challenge in theoretical astrophysics for decades [2, 12]. No other astrophysical event is as complex and conceptually challenging as the death of massive stars in a gravitational collapse and subsequent supernova explosion.

III. Invalidity of Electron Degeneracy Pressure Model

A major assumption in current models of gravitational core collapse concerns the non-interacting nature of all constituent particles like electrons, protons and ions. As non-interacting particles, all electrons and ions are assumed to be freely intermingling and moving past one another, just like ideal gas particles. In a highly ionized state, the unbound or free electrons are supposed to form Fermi electron gas moving at high speeds relative to the ensemble of heavy ions and produce the so-called electron degeneracy pressure [10]. At high core densities, when a star begins to cool down, electron degeneracy pressure is assumed to be the only mechanism available to support the inward pull of gravity in the absence of adequate thermal pressure.

By assuming all ions and electrons to be non-interacting, wrong inferences have been drawn to claim that electron degeneracy pressure can support the pull of gravity. When we take into account the electrostatic interaction between positive ions and electrons, even high energy electrons cannot provide the support against the pull of gravity. In the absence of adequate thermal pressure, gravity will accelerate the heavy ions radially inwards (equation 4) and to counter this inward acceleration, the high-speed electrons will be required to push these ions radially upwards by exchanging their momentum through elastic collisions with these ions. However, electrons cannot exchange momentum with heavy positive ions due to their electrostatic interaction. That is why the whole model of electron degeneracy pressure is founded on the wrong assumption of non-interacting nature of electrons, protons and ions.

In a metal, an atom may lose some or all of its valence electrons and thus turn into an ion. These ions arranged in a lattice structure form a crystal. The valence electrons are no longer bonded to nucleons and can move freely under the combined influence of all ions in a crystal. Because valence electrons can move around, we can treat them as a fermion fluid. When we ignore mutual interactions between electrons and ions, the electrons can be considered as free particles. Different energy states of a particle in the Fermi gas are derived from the study of a particle in a box by using the Schrödinger equation. However, the inference of high energy states derived from the Schrödinger equation is quite misleading due to the erroneous depiction of the potential energy term in the Schrödinger's equation [13].

Let us consider an ensemble of high-density stellar core constituents which are partially or fully ionized. In the ionized state, heavy positive ions will be relatively immobile and the unbound free electrons will be highly mobile and move in the combined field of positive ions. Let the ensemble of positive ions constitute a lattice structure and let L_u be the mean separation between adjacent ions. L_u is also the side length of a cubic unit cell of each particle in the ensemble. Let A, B and C be three such particles on X axis such that AB = BC = L_u. Due to positive charge on all ions, each ion will experience a strong electrostatic repulsion from its adjacent ions. Let us displace particle B towards C by a small distance x, and define the ratio of x to L_u by a displacement fraction δ as,

$$\delta = x/L_u \tag{14}$$

The restoring acceleration 'g_r' acting on the displaced ion will be obtained from the resultant electrostatic force acting between ions A-B and B-C along the line of displacement. Let q be the degree of ionization or charge number, then total charge on each particle will be qe where e is the magnitude of electron charge. If m is the mass of each ion, the restoring acceleration g_r will be given by,

$$g_r = \frac{k_e q^2 e^2}{m(L_u+x)^2} - \frac{k_e q^2 e^2}{m(L_u-x)^2} = -\frac{k_e q^2 e^2}{m}\left[\frac{4L_u x}{\left(L_u^2-x^2\right)^2}\right] = -\frac{4k_e q^2 e^2}{mL_u^2}\left[\frac{\delta}{(1-\delta^2)^2}\right] \tag{15}$$

Here k_e is the electrostatic force constant given by $1/4\pi\varepsilon_0$.

Table 1. Restoring acceleration g_{01} for different separation distances L_u at high core densities.

	$\rho = 10^5$ kg/m^3			$\rho = 10^7$ kg/m^3		
Nuclei of	n_u	L_u (pm)	g_{01} (m/s^2)	n_u	L_u (pm)	g_{01} (m/s^2)
H	6.0e+31	25.5	8.5e+18	6.0e+33	5.5	1.8e+20
He	1.5e+31	40.5	3.4e+18	1.5e+33	8.7	7.3e+19
C	5.0e+30	58.4	4.9e+18	5.0e+32	12.6	1.1e+20
O	3.8e+30	64.3	5.4e+18	3.8e+32	13.8	1.2e+20
Si	2.2e+30	77.5	6.5e+18	2.2e+32	16.7	1.4e+20

Using equation (15) we can compute the magnitude of restoring acceleration g_{01} for δ=0.01, when a particle is displaced by one percent of the mean separation distance L_u. As shown in Table 1, particle restoring acceleration g_{01} for different ions is found to be of the order of 10^{18} to 10^{20} m/s^2 at high stellar core densities. This high restoring acceleration ensures that such ions will get grid locked in a lattice structure leading to the gravity induced solid state of the core constituents. Table 1 shows the order of restoring accelerations g_{01} for different nuclei at high core densities ρ and particle densities n_u. At a core density of about 10^6 kg/m^3 the magnitude of restoring acceleration experienced by a typical He ion, when slightly displaced on either side, is shown in figure 2. It is the rate of rise in restoring acceleration from the zero-displacement position, the steepness of the curve, which imparts grid locking of the ion in the lattice structure.

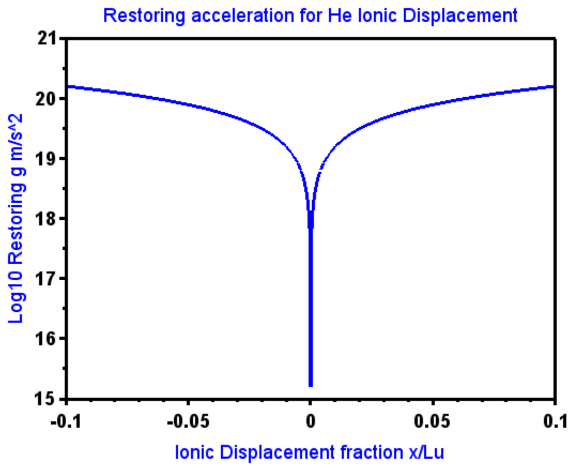

Figure 2. Variation of the magnitude of restoring acceleration g_r with slight displacement on either side for an He ion, at stellar core density of 10^6 kg/m^3.

Since this high core density has been brought about by the gravitational loading of the stellar core, we can say that gravity has induced grid locking of the ions in the lattice structure, resulting in a forced solid state of the stellar core. It is important to note here that when we assume the non-interacting characteristic of electrons, protons and ions, the restoring acceleration g_r of individual ions will be reduced to zero, thereby converting the solid state of the stellar core to a high-density fluid state.

In current models, the electron degeneracy pressure is wrongly claimed to support the extreme pull of gravity in highly dense stellar cores. The electron degeneracy pressure is given by $P_{ed} = n_e.v.p$ where n_e is the number density, v the mean speed and p the average momentum of the degenerate electrons. Since the degenerate electrons cannot exchange their momentum with the heavy lattice ions due to strong electromagnetic interaction, they cannot support the inward gravitational pull experienced by these ions. Hence these degenerate electrons cannot provide the required degeneracy pressure to support the pull of gravity unless we wrongly assume the electrons, ions and nucleons to be completely non-interacting.

To elaborate this point, let us consider a large hollow sphere with rigid casing and fill it up with free electrons up to a density of say, n_e electrons per cubic meter. With density n_e, the mean separation distance (or side of a cubic unit cell) L_u between adjacent electrons will be given by cube root of $(1/n_e)$. Now we need to consider two mutually exclusive and distinct possibilities regarding the physical state of these electrons.

A. The ensemble of electrons in the hollow sphere are assumed to be non-interacting free particles which can move around within the container at high speeds, keep rebounding after elastic collisions with one another and the walls of the container. The Schrödinger's equation and Heisenberg's Uncertainty Principle (HUP) are believed to tell us that at high densities, these free electrons or so-called Fermi particles will acquire high energy and move at extremely high speeds. However, with the assumption of non-interaction characteristic of these free electrons, there is no physical mechanism available for imparting high kinetic energies to them. Still, by using the principles of Quantum Mechanics (QM) we can compute the degeneracy pressure P_d created by these free electrons under non-relativistic and relativistic conditions as,

$$P_{d1} = \frac{(3\pi^2)^{\frac{2}{3}}\hbar^2}{5m_e}(n_e)^{\frac{5}{3}} \tag{16A}$$

$$P_{d2} = \frac{hc}{8}\left(\frac{3}{\pi}\right)^{\frac{1}{3}}(n_e)^{\frac{4}{3}} \tag{16B}$$

From the above equations, for electron density n_e=1.2x10^{35}/m^3 the non-relativistic degeneracy pressure (P_{d1}) works out to 6.8x10^{11} GPa and the relativistic degeneracy pressure (P_{d2}) works out to 1.4x10^{12} GPa. The electron degeneracy pressures of this order are supposed to support the White Dwarf stars and solid iron cores of bigger stars against their gravitational collapse.

B. The high-density ensemble of electrons in the hollow sphere is strongly interacting, where each electron experiences strong repulsive force from the adjacent electrons. When the repulsive force between adjacent electrons is $k_e.e^2/L_u^2$, the effective repulsive pressure in the ensemble of electrons is given by,

$$P_r = k_e \frac{e^2}{L_u^4} = k_e e^2 (n_e)^{\frac{4}{3}} \quad (17)$$

For an electron density of $1.2\text{x}10^{35}/\text{m}^3$, with L_u=2 pm, the repulsive pressure P_r comes to $1.4\text{x}10^{10}$ GPa. At this repulsive pressure, the restoring acceleration g_{01} for a small displacement in the position of any electron works out (equation 15) to be of the order of 10^{24} m/s^2. With such extreme restoring acceleration, the electrons can no longer move past one another as free particles. Hence the ensemble of electrons will get grid locked in a lattice structure leading to the solid state of the entire electron ensemble within the container.

Comparison of the two situations considered above shows that it is absolutely wrong to consider the free or Fermi electrons to be non-interacting. Hence, the electron degeneracy pressure derived with following assumptions is fundamentally flawed, erroneous and misleading.

(a) Non-interacting characteristic of electrons, protons and ions.
(b) The HUP imparting high energies to the free electrons.
(c) High speed electrons exchanging their momentum with positive ions through elastic collisions.

Therefore, we may conclude that a simple, harmless looking assumption regarding the non-interacting characteristic of the stellar core constituents, namely the electrons, protons, ions and nucleons, makes a big crucial difference on the resulting physical state of the stellar core. This is a major lacuna in the current models of Gravitational Core Collapse that has mislead Astrophysics into fictitious Black Holes and Neutron Stars.

IV. Final Solid State of all High-density Stellar Cores

Usually, at the end of nuclear fusion stage, a massive star will contain a solid iron core at the centre. When a solid iron core is massive enough, say more than 3 solar masses, current models of stellar core collapse predict that even degeneracy pressure can't prevent the ultimate gravitational collapse of the core into a Black Hole.

We need to consider following three crucial points to highlight the shortcomings of current models of gravitational core collapse and to bring out an alternative sound approach.

I. Kinetic pressure is the pressure exerted through momentum exchange in elastic collisions of high energy non-interacting particles. Basically, all current models of gravitational core collapse regard the kinetic pressure as the only means of providing support against the pull of gravity. Even when thermal pressure dies down, the role of degeneracy pressures is invoked essentially to provide the required kinetic pressure through momentum exchange in elastic collisions among high energy free electrons or neutrons as non-interacting particles.

II. The invocation of electron and neutron degeneracy pressures is an unavoidable prop when there is no other alternative in sight to provide support against gravitational collapse of stellar cores. Actually, neither there is any physical mechanism available for imparting high energies to electrons and neutrons as non-interacting particles, nor they are capable of exchanging their momentum through elastic collusions with other ions. As such the electron and neutron degeneracy pressures cannot provide the required support against gravitational collapse of stellar cores.

III. Unfortunately, the current models never examine the possibility of mutually interacting ensemble of core constituents transforming into a solid state at high densities and developing shear, radial and hoop stresses to support the pull of gravity. As in various arches and dome structures, development of compressive hoop stresses in spherical shells, is the best physical mechanism of supporting the solid stellar cores against gravitational loading.

In hydrostatic equilibrium of a stellar body, all constituent particles are non-interacting and can freely move past one another. However, in situations of very high core densities, atoms and ions will occupy relatively fixed positions and may experience thermal vibrations about their mean positions. When the mean separation distance between ions is less than the normal mean size of their parent atoms, of the order of Bohr radius or less, the electrostatic repulsion between the ions will force them into a lattice gridlock, leading to a solid state. In a solid state, particles maintain their normal separations through mutual interactions and cannot move past one another. It must however, be kept in mind that this is not a 'naturally' or freely occurring solid state but a 'forced' solid state brought about under extreme gravitational loading in a stellar core.

In a solid state the mutually interacting constituent particles are mostly at rest, apart from some thermal vibrations about their mean positions. The mean positions of these solid-state particles constitute some sort of geometric pattern, a lattice structure. When some external force is applied to one or more of these lattice particles, the mutual separation distances between the adjacent particles in the vicinity will slightly change so as to produce additional reaction forces just to balance the externally applied force. This slight change in separation distances, which implies a slight change in the lattice structure, can be described as slight deformation of the lattice structure. If the externally applied force is now removed, the change or the deformation in the lattice structure will also get eliminated and this characteristic of the lattice structure can be described as elasticity of the solid ensemble of interacting particles. In fact, quantification of the magnitude and direction of the deformation by a displacement vector produces the best characterization of the elastic nature of the solid. Thus, central regions of all stellar cores will physically constitute a solid state. Stresses induced in such cores due to self-gravitation can only be analysed by study of its displacement vector field through equilibrium equations of elasticity and not by hydrostatic equilibrium equations of the kinetic theory.

V. Analysis of Stresses in Solid State Stellar Cores

Theory of elasticity is required to be used for analysing stresses in a solid stellar core under self-gravitation. Radial and hoop stresses in a solid stellar core, under gravitational loading, can be analysed by treating the ensemble of constituent particles as a solid-state continuum. For this we need to first derive the equations of elastic equilibrium for a spherically symmetric solid core under self-gravitation. Thereafter we need to solve the elastic equilibrium equations for displacement vector field under spherically symmetric gravitational loading to obtain radial and hoop strains and stresses. This solution is drastically different from the hydrostatic pressure solution usually obtained from hydrostatic equilibrium equations adopted under kinetic theory of gases.

Let us first designate the displacement vector field **u** for a spherically symmetric solid sphere with centre at point O and maximum radius R. With polar coordinates (r, θ, φ), the components of displacement vector field can be written as, (u_r, u_θ, u_φ). Under spherically symmetric gravitational loading conditions, displacement vector components u_θ and u_φ will be identically zero. The radial displacement component u_r will be independent of θ and φ coordinates and will be a function of radial coordinate r only. The radial and hoop strains induced by the displacement vector u_r are given by,

$$\varepsilon_{rr} = \frac{\partial u_r}{\partial r}; \quad \varepsilon_{\theta\theta} = \frac{u_r}{r}; \quad \varepsilon_{\varphi\varphi} = \frac{u_r}{r} \tag{18}$$

For analysis of stresses under spherically symmetric gravitational loading, we can neglect the Poisson's ratio. Taking the effective modulus of elasticity as E, the corresponding radial and hoop stresses σ_{rr}, $\sigma_{\theta\theta}$ and $\sigma_{\varphi\varphi}$ will be given by,

$$\sigma_{rr} = E\varepsilon_{rr} = E\frac{\partial u_r}{\partial r}; \quad \sigma_{\theta\theta} = E\varepsilon_{\theta\theta} = E\frac{u_r}{r}; \qquad \sigma_{\varphi\varphi} = E\varepsilon_{\varphi\varphi} = E\frac{u_r}{r} \tag{19}$$

5.1 Equilibrium Equations of Elasticity for a solid sphere under self-gravitation

Under such gravitational loading, all radial (σ_{rr}) and hoop ($\sigma_{\theta\theta}$= $\sigma_{\varphi\varphi}$) stresses developed within the solid body are expected to be compressive in nature. To derive equilibrium equations of elasticity for the compressive stresses induced by gravitational loading in a solid sphere, let us consider an infinitesimally small solid element in the shape of a truncated cone lying within a spherical shell between radii OA=OB= r and OD=OC= r+Δr. Let O be the apex of the cone with α as the semi-apex angle as shown in figure 3. Let S_1 be the area of inner surface AB of this solid element where compressive radial stress σ_1= σ_{rr} will be acting to produce an outward (+ve) force F_1. Let S_2 be the area of outer surface CD of this solid element where compressive radial stress σ_2 will be acting to produce an inward force (-ve) F_2. Let S_3 be the area of the slanting surface ABCD of this truncated conical element where compressive hoop stress σ_3= $\sigma_{\theta\theta}$ will be acting to produce an outward (+ve) component of force F_3. Sum of these forces, F_1, F_2 and F_3 will balance the gravitational force F_g (per unit volume) acting inwards at point P, the centre of volume V_1 of this element, to produce an equilibrium of forces. Let g be the maximum magnitude of gravitational acceleration at the outer surface (radius R) of the gravitating body of density ρ and let M(r) be the mass of the sphere of radius r. Then,

$$g = \frac{GM}{R^2} = \frac{4}{3}\pi\rho GR \tag{20}$$

And the magnitude of body force F_g per unit volume at radius r is given by,

$$F_g = \frac{GM(r)\rho}{r^2} = \frac{4}{3}\pi G\rho^2 r = \rho g\frac{r}{R} \tag{21}$$

From the geometry of this truncated solid element, we have,

$$S_1 = \pi(r.\alpha)^2 \tag{22}$$

$$\sigma_2 = \sigma_{rr} + \frac{d\sigma_{rr}}{dr}\Delta r$$

$$S_2 = \pi\big((r+\Delta r).\alpha\big)^2 = \pi[(r.\alpha)^2 + 2r.\Delta r.\alpha^2 + (\Delta r.\alpha)^2] \tag{23}$$

$$S_3 = (2\pi r\alpha + \pi\alpha.\Delta r)\Delta r \tag{24}$$

$$V_1 = \frac{\pi\Delta r}{3}\Big[(r\alpha)^2 + \big((r+\Delta r)\alpha\big)^2 + \big((r+\Delta r)\alpha\big)r\alpha\Big]$$

Or,

$$V_1 = \pi\Delta r\alpha^2(r^2 + r.\Delta r) \tag{25}$$

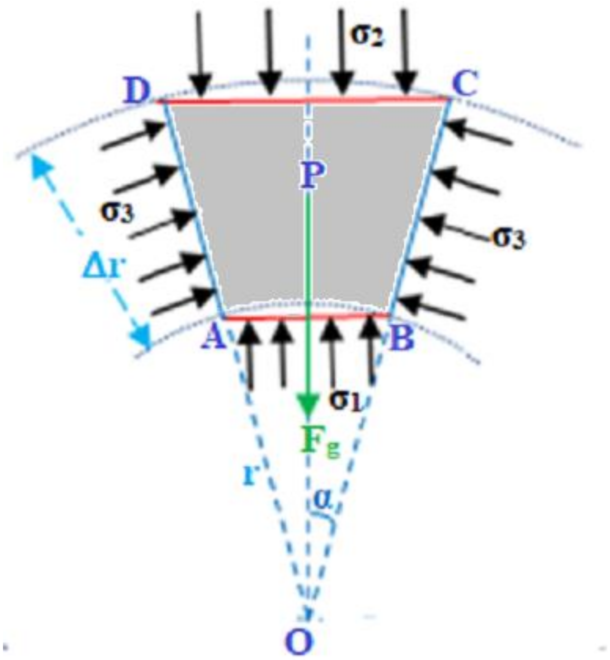

Figure 3. Representation of an infinitesimally small solid element in the shape of a truncated cone ABCD, under the action of radial and hoop stresses along with gravitational body force F_g

For equilibrium of the solid element under consideration, the sum of all forces or component of forces along the radial line passing through this element must be zero. Component of forces along the transverse direction to the radial line are inherently balanced because hoop stresses $\sigma_{\theta\theta}$ and $\sigma_{\varphi\varphi}$ are equal. Now, resolving the force components due to compressive stresses and gravitational body forces along the radial line through the element, we get,

$$\sigma_1.S_1 + \sigma_3.S_3.\alpha - \sigma_2.S_2 - F_g.V_1 = 0 \tag{26}$$

Or, $$\sigma_{rr}.\pi(r.\alpha)^2 + \sigma_{\theta\theta}.(2\pi r\alpha + \pi\alpha.\Delta r)\Delta r.\alpha - \left(\sigma_{rr} + \frac{d\sigma_{rr}}{dr}\Delta r\right).\pi[(r.\alpha)^2 + 2r.\Delta r.\alpha^2]$$
$$-\frac{\rho g r}{R}.\pi\Delta r\alpha^2(r^2 + r.\Delta r) = 0$$

Or, dividing by α^2 throughout and simplifying, we get,

$$\sigma_{\theta\theta}.(2\pi r + \pi.\Delta r)\Delta r - \left[\sigma_{rr}2\pi r.\Delta r + \frac{d\sigma_{rr}}{dr}\Delta r.\pi\{r^2 + 2r.\Delta r\}\right] - \frac{\rho g r}{R}.\pi\Delta r(r^2 + r.\Delta r) = 0$$

Removing the common factor $\pi\Delta r$ from all terms, we get,

$$\sigma_{\theta\theta}.(2r + \Delta r) - \left[\sigma_{rr}2r + \frac{d\sigma_{rr}}{dr}\{r^2 + 2r.\Delta r\}\right] - \frac{\rho g r}{R}.(r^2 + r.\Delta r) = 0 \tag{27}$$

Dividing by r^2 throughout and re-arranging the terms after neglecting infinitesimal terms $\Delta r/r$ we get,

$$-\frac{d\sigma_{rr}}{dr} - \frac{2}{r}(\sigma_{rr} - \sigma_{\theta\theta}) - \frac{\rho g r}{R} = 0 \tag{28}$$

This equation can be re-written as a standard equilibrium equation for compressive stresses in a self-gravitating elastic solid sphere.

$$\frac{d\sigma_{rr}}{dr} + \frac{2}{r}(\sigma_{rr} - \sigma_{\theta\theta}) = -\frac{\rho g r}{R} = -\frac{4}{3}\pi G\rho^2 r \tag{29}$$

If instead of an elastic solid, the gravitating sphere consisted of a uniform fluid (liquid or gas) of density ρ then under spherically symmetric gravitational loading, no hoop stresses can develop in the fluid body and there could only be radially varying pressure stresses. That is, in the gravitating fluid body the radial and hoop stresses of the solid body will get replaced with fluid pressure p. Replacing σ_{rr} and $\sigma_{\theta\theta}$ with p in equation (29), we get,

$$\frac{dp}{dr} = -\frac{4}{3}\pi G\rho^2 r = -\frac{GM(r)\rho}{r^2} \tag{30}$$

which is the standard equation of hydrostatic equilibrium.

Replacing the radial and hoop stress terms in equation (29) with corresponding strain terms from equation (19), we get the standard equilibrium equations of elasticity, for the solid sphere under self-gravitation, as a second order differential equation in displacement vector component u_r as,

$$E\frac{d^2u_r}{dr^2} + \frac{2E}{r}\left(\frac{du_r}{dr} - \frac{u_r}{r}\right) = -\frac{4}{3}\pi G\rho^2 r$$

Or, $$\frac{d^2u_r}{dr^2} + \frac{2}{r}\frac{du_r}{dr} - \frac{2}{r^2}u_r = -\frac{4\pi G\rho^2}{3E}r \tag{31}$$

5.2 Solution of equilibrium equations for a solid sphere under self-gravitation

The solution of second order non-homogeneous differential equation (31) for radial displacement component u_r will consist of two parts. First part will be the solution of the characteristic equation, which is the homogeneous part of equation (31) as,

$$\frac{d^2u_r}{dr^2} + \frac{2}{r}\frac{du_r}{dr} - \frac{2}{r^2}u_r = 0 \tag{32}$$

Standard solution of this characteristic equation involves two arbitrary constants which are required to be fixed by the boundary conditions alone and do not depend upon the gravitational body force represented by the right-hand side of equation (31). This characteristic solution is,

$$u_r = A_1 r + A_2 \frac{1}{r^2} \tag{33}$$

Due to spherical symmetry the displacement vector vanishes at the origin. Hence an essential boundary condition for the solution of characteristic equation (32) is that u_r must be zero at r=0. With this boundary condition the constant A_2 in equation (33) reduces to zero, and the resulting radial and hoop compressive stresses will be given by the constant A_1E. That is the integration constant A_1 will get fixed by a constant uniform pressure P_0, if acting on the outer surface of the solid sphere under consideration. Therefore, $A_1 = -P_0/E$.

Second part of the solution will consist of a Particular Integral or particular solution of equation (31) in terms of a function of radial coordinate r that uniquely satisfies this equation. This particular solution is,

$$u_r = B_1 r^3 + B_2 r^2 \tag{34}$$

Substituting this value of u_r from equation (34) into equation (31), we get,

$$B_1 = -\frac{2\pi G\rho^2}{15E} \quad \text{and} \quad B_2 = 0$$

Therefore, superposing the characteristic and particular solutions from equations (33) and (34) we get the final solution for the displacement vector component u_r as,

$$u_r = -\frac{2\pi G\rho^2}{15E} r^3 - \frac{P_0}{E} r \tag{35}$$

Using equation (19) we can now compute the radial and hoop stresses induced by self-gravitation and external pressure P_0 on the solid sphere under consideration.

$$\sigma_{rr} = E\frac{\partial u_r}{\partial r} = -\frac{2\pi G\rho^2}{5} r^2 - P_0 \tag{36}$$

$$\sigma_{\theta\theta} = \sigma_{\varphi\varphi} = E\frac{u_r}{r} = -\frac{2\pi G\rho^2}{15} r^2 - P_0 \tag{37}$$

That means if we neglect the external pressure term P_0, the radial and hoop stresses induced by self-gravitation alone are given by,

$$\sigma_{rr} = -\frac{2\pi G\rho^2}{5} r^2 \tag{38}$$

$$\sigma_{\theta\theta} = \sigma_{\varphi\varphi} = -\frac{2\pi G\rho^2}{15} r^2 \tag{39}$$

The most remarkable feature of these self-gravitation induced radial and hoop compressive stresses is that they are maximum at the periphery and zero at the centre of the solid stellar core. In contrast the hydrostatic pressure and density are always maximum at the centre when the contents of the self-gravitating stellar core are assumed to be in fluid state – whether liquid or gaseous. The most common stellar cores consist of solid iron spherical bodies with extreme compression in their outer peripheral regions.

VI. Stars Finally End up in Solid Core Stellar Bodies

From the foregoing discussions, we may summarise that the electron degeneracy pressure, derived with invalid assumptions, is erroneous and misleading. Hence, all stellar cores which are said to be degenerate, where some sort of degeneracy pressure is invoked to prevent their gravitational collapse under hydrostatic equilibrium conditions, are in fact solid stellar cores which acquire their stability through equilibrium equations of elasticity. For the stability of a solid iron core under self-gravitation, neither do we need to assume non-interacting characteristic of the core constituents for applying hydrostatic equilibrium equations, nor do we need to invoke the fictitious electron degeneracy pressure. All we need is to apply equilibrium equations of elasticity for working out the radial and hoop stresses in spherically symmetric solid body under self-gravitation. It is found that the radial and hoop stresses in a solid stellar body are always minimum at the centre and maximum at the periphery. This shows that solid stellar cores can never collapse under self-gravitation.

6.1 Extreme compression in solid iron stellar cores

Since self-gravitation induced radial and hoop compressive stresses are found to be maximum at the periphery of the solid iron stellar cores, we need to examine the physical state of the solid core under extreme compression. Let us consider an ensemble of atoms in a spherically symmetric solid iron core, subjected to extreme radial compression. Depending upon the level of compression the orbiting electrons of adjoining atoms will get pushed out resulting in partial or full ionization [4]. This phenomenon is also known as 'pressure ionisation'. Under conditions of high density, when most of the orbiting electrons get separated from their parent atoms, the ensemble of positive ions will experience extreme repulsive forces and get grid-locked into a gravity induced solid state. The apparently free stream of electrons will start circulating on the surface of the core and give rise to high magnetic fields in and around the core body.

In a typical solid iron stellar core under high-stress, the degree of ionization may vary across the core. When the fusion reactions stop and the core gets cooled, degree of ionization may reduce to a minimum at the centre and maximum at the surface due to high radial stress. With ion density N_u, the electrostatic pressure between adjacent ions, separated by $(1/N_u)^{1/3}$ distance, will be given by the electrostatic force divided by unit cell area $(1/N_u)^{2/3}$ as,

$$P_i = k_e q^2 e^2 (N_u)^{4/3} \tag{40}$$

A massive stellar iron core will experience extreme compression at its periphery due to gravitation induced radial and hoop stresses. The peripheral stresses are expected to be of the order of 10^6 to 10^7 GPa. Therefore, as discussed in detail in [4], at this extreme compression, degree of ionization will correspond to the complete stripping off of 3rd and 4th shell electrons from iron atoms with corresponding ionic pressure of 10^7 GPa. The stress-free central zone of the stellar iron core is expected to contain normal iron atoms. Therefore, even for massive solid iron stellar cores the extreme radial stresses occur at their peripheral zones and are supported by the extreme ionic repulsive pressures, with the central zones remaining stress free. As such there is absolutely no chance of the gravitational collapse of massive stellar cores in solid state.

6.2 Final Solid Core Stellar Bodies

Current theories of stellar structure project three final end states for a star, namely Black Holes, Neutron Stars and White Dwarfs. A vast majority of more than 90% of all stars, including our sun, are expected to finally evolve into White Dwarfs. Less than 10% of all stars finally end up in the so-called Neutron Stars, mostly through the process of Super Novae explosions. Extremely high densities are believed to prevail in the central cores of both White Dwarfs and Neutron Stars, essentially to invoke the degeneracy pressures for providing support against gravitational collapse. That is, the extremely high core densities in White Dwarfs and Neutron Stars are not directly measured or observed quantities but indirectly inferred from the current core collapse models. Since current models of core collapse and degeneracy pressure are found to be invalid, we are led to the conclusion that the White Dwarfs and so-called Neutron Stars are in fact Solid Core stellar bodies.

The solid core of white dwarfs mainly consists of Oxygen and Carbon atoms which are mostly in ionised state in the outer periphery regions. The spectra emitted by white dwarf atmospheres show hydrogen lines in majority of cases. In other cases, spectral lines of neutral helium are observed. It implies that the solid cores of white dwarfs are surrounded by burning shells of helium and hydrogen. The presence of ions in the peripheral regions of the solid core will be associated with the circulation of degenerate electrons on the surface, thereby producing strong magnetic fields around white dwarfs. On the other hand, a 'Neutron Star' mainly consists of a massive solid iron core, which is extensively ionised in the outer regions. This ionised solid iron core will be accompanied by circulation of degenerate electrons on the surface, thereby producing very strong electric and magnetic fields. These solid iron core stellar bodies, which are the remnants of Super Nova explosions of massive stars, may get surrounded with burning shells of hydrogen and helium. Specifically, very strong magnetic fields in these stellar bodies are not caused by the physical rotation of the solid iron cores but attributed to the strong circulation of degenerate electrons on the surface. Peculiar pulsar type effects of these stellar bodies may be attributed to complex interaction between: mechanical vibrations in the solid core, oscillations in the trajectory plane of circulating electrons, precession of very strong magnetic field vector and presence of highly stressed ions on the periphery of rotating solid iron core.

6.3Solid Core Super Novae Explosions (SCSNe)

We have not yet achieved a final breakthrough in our full understanding of how supernova explosions work. It is generally believed that supernova explosions are always associated with iron core collapse phenomenon occurring in the terminal stage of the life of large stars. However, since a solid iron core can never collapse under self-gravitation, supernova explosions may be taking place on the surface of such a solid iron core. While iron nuclei are being produced through silicon fusion reactions with release of energy, a small fraction of fissionable nuclei may also get produced with absorption of a part of the released energy. As the central iron core keeps growing steadily, the nuclei with higher ionic charge may keep getting diffused to the outer surface of the core. By the time mass of the solid iron core grows to about a solar mass or so, the concentration of fissionable nuclei on surface of the solid iron core may become critical to trigger a fission reaction, a Super Nova explosion. On the other hand, transient fusion reaction instabilities in any of the burning shells surrounding a solid iron core may also trigger a thermonuclear Super Nova explosion.

Various types of super nova explosions may also be related to the size and composition of central solid core on the one hand and to the size and composition of the surrounding burning shells on the other hand. For example, most of the nova explosions may only be associated with the solid cores of white dwarf stellar bodies and most of the super nova explosions may be associated with the formation of solid iron core stellar bodies which are currently being recognised as neutron stars. Considerable further research is needed firstly to study the nuclear fusion reaction instabilities in thin shells surrounding the central solid cores and secondly to understand the process of formation and accumulation of fissionable nuclei on the outer periphery of the solid iron core much before the Super Novae explosions get triggered.

VII. Summary and Conclusion

During the main sequence stage, all active stars are being powered by internal fusion reactions. The pressure, temperature, density and composition in different regions of these stars can be analysed by using hydrostatic equilibrium equations of kinetic theory by assuming all constituent particles to be non-interacting. But in high-density stellar cores, where the mean separation between constituent particles is less than Bohr radius or about 50 pm, the constituent particles can no longer be assumed to be non-interacting. Under the kinetic theory, all constituents of the gas are assumed to be non-interacting and exchange their momentum through elastic collisions. As such only the particle momentum and kinetic energy account for all pressure and temperature effects. However, mutual electrostatic interactions among highly dense and ionized core constituents, strongly govern the evolution of physical state of the core under self-gravitation.

In the absence of thermal pressure, gravity will accelerate the heavy ions radially inwards and the high-speed degenerate electrons will be required to push these ions radially outwards by exchanging their momentum through elastic collisions. However, electrons cannot exchange momentum with heavy positive ions due to their electrostatic interaction. That is why the much-acclaimed model of electron degeneracy pressure, founded on the wrong assumption of non-interacting nature of electrons, protons and ions, is invalid and misleading.

Since all ions will experience a strong electrostatic repulsion from their adjacent ions, when any ion is slightly displaced from its mean position it will be subjected to a restoring acceleration of the order of 10^{18} m/s^2. This high restoring acceleration ensures that such ions will get grid locked in a lattice structure leading to the gravity induced solid state of the core constituents. However, when we assume the non-interacting characteristic of electrons and ions, the restoring acceleration of individual ions will be reduced to zero, thereby converting the solid state of the stellar core to a high-density fluid state. Therefore, we may conclude that a simple, harmless looking assumption regarding the non-interacting characteristic of the stellar core constituents, makes a big crucial difference on the resulting physical state of the stellar core.

Mutually interacting ensemble of positive ions in stellar cores, transforms into a solid state under self-gravitation and develop shear, radial and hoop stresses to support the pull of gravity. Development of compressive hoop stresses in spherical shells, is the best physical mechanism of supporting the solid stellar cores against gravitational loading. Central regions of all high-density stellar cores, when not undergoing nuclear fusion reactions, will physically constitute a solid state. Stresses induced in such cores due to self-gravitation can only be analysed through equilibrium equations of elasticity and not by hydrostatic equilibrium equations of the kinetic theory. The solution of equilibrium equations of elasticity for a spherically symmetric solid sphere yields the radial and hoop stresses induced by self-gravitation to be proportional to the square of radius (r^2). The most remarkable feature of the self-gravitation induced radial and hoop compressive stresses is that they are maximum at the periphery and zero at the centre of the solid stellar core. This makes it impossible for the stellar core to collapse under self-gravitation. In contrast, by assuming the contents of a self-gravitating stellar core to be non-interacting, we transform the actual solid state to hypothetical fluid state where the hydrostatic pressure is always maximum at the centre. Hence it is concluded that the current models of Stellar Core Collapse, founded on the invalid assumption of non-interacting core constituents, are erroneous and have misled Astrophysics into the realm of fictitious Black Holes. We also conclude that all stars finally end up in Solid Core Stellar bodies like 'White Dwarfs' and 'Neutron Stars' and that the Super Novae explosions are the nuclear or thermonuclear explosions occurring on the surface of solid iron stellar cores.

References

[1] Hix W. R., Lentz E. J., Endeve E., et al. 2014, *Essential ingredients in core-collapse supernovae. AIP Advances, 4(4), 041013*. https://doi.org/10.1063/1.4870009

[2] Couch, S. M. 2017, *The mechanism(s) of core-collapse supernovae.* Phil. Trans. R. Soc. A. 375: 2016 0271 https://doi.org/10.1098/rsta.2016.0271

[3] Rodrigues Almeida, C. 2020, *Stellar equilibrium vs. gravitational collapse.* EPJ H 45, 25–48 (2020). https://doi.org/10.1140/epjh/e2019-100045-x

[4] Sandhu G. S. 2019, *Black Holes are a Mathematical Fantasy, not a Physical Reality*. Applied Physics Research; 11(4), p16 https://doi.org/10.5539/apr.v11n4p16

[5] Sandhu, G. S. 2011, *Demystification of the spacetime model of relativity.* Physics Essays, 24(1), 85-94. http://dx.doi.org/10.4006/1.3543877

[6] Einstein, A. 1939, *On a Stationary System with Spherical Symmetry consisting of Many Gravitating Masses*. Annals of Mathematics, 40(4), pp922 http://www.jstor.org/stable/1968902

[7] Bonolis, L. 2017, *Stellar structure and compact objects before 1940: Towards relativistic astrophysics.* Eur. Phys. J. H 42, 311–393 (2017) https://doi.org/10.1140/epjh/e2017-80014-4

[8] Janka H.-Th., Langanke, K., Marek A., et al. (2007), *Theory of core-collapse supernovae.* Physics Reports Volume 442, Issues 1–6, 38-74 https://doi.org/10.1016/j.physrep.2007.02.002

[9] Coughlin, E. R. 2017, *Spherically Symmetric, Cold Collapse: The Exact Solutions and a Comparison with Self-Similar Solutions.* Astrophys. J., 835, 40. https://doi.org/10.3847/1538-4357/835/1/40

[10] Koester, D. & Chanmugam, G. 1990, *Physics of white dwarf stars.* Reports on Progress in Physics, Vol 53, No.7, 837-915. https://iopscience.iop.org/article/10.1088/0034-4885/53/7/001/pdf

[11] Haensel, P. 2003, *Equation of state of dense matter and maximum mass of neutron stars.* arXiv: astro-ph/0301073v1. https://arxiv.org/abs/astro-ph/0301073v1

[12] Lattimer, J. M. 2012, *The Nuclear Equation of State and Neutron Star Masses.* Annual Review of Nuclear and Particle Science, 62, 485-515. https://doi.org/10.1146/annurev-nucl-102711-095018

[13] Sandhu, G. S. 2018, *Wrong Potential Energy Term in Schrödinger's Equation for Hydrogen Atom.*Journal of Modern Physics, 9, 607-619. https://doi.org/10.4236/jmp.2018.94042

Gurcharn S. Sandhu. "Stellar Core Collapse Models are Erroneous and Misleading." *IOSR Journal of Applied Physics (IOSR-JAP)*, 12(6), 2020, pp. 09-21.