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Ionic Gravitation and Ionized Solid Iron Stellar Bodies

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Abstract

A well-known but erroneous notion of electron degeneracy pressure has misled Astrophysics for nearly a century now. Because of their electrostatic interactions, the electrons can never exchange their momentum with positive ions through elastic collisions and hence can never provide the so-called electron degeneracy pressure in stellar cores to counter the effect of gravity. In situations of high core densities, when the mean separation distance between atoms or ions becomes less than the normal size of their parent atoms, their electrostatic repulsion will force them into a lattice gridlock, leading to a solid state. All degenerate stellar cores constitute a solid state and the radial and hoop stresses induced by self-gravitation are proportional to the square of radius (r^2). As the size of a solid iron stellar core grows, its peripheral region will experience extreme compression and will get partially ionized due to the phenomenon of pressure ionization. All so-called Neutron Stars and Black Holes are in fact Ionized Solid Iron Stellar Bodies (ISISB). The presence of ions in the peripheral regions of the ISISB will be associated with the circulation of degenerate electrons around the surface, thereby producing strong magnetic fields. A positive excess of ionic charge in all ISISB becomes a source of Ionic Gravitation through the process of polarization of neutral atoms and molecules in stellar bodies. These ISISB are the primary constituents of AGN and are the source of all non-stellar radiation and Jets of ionized matter.

Keywords

Solid Core, Ionic Gravitation, Hoop Stress, Magnetic Field, Black Holes, AGN

1. Introduction

During last few decades, Astrophysics has made tremendous advancements in the field of observations due to availability of advanced technology. Unfortunately, our old well-established models are unable to explain all new observations without making additional ad-hoc assumptions like existence of Dark Matter, Super Massive Black Holes, gravitational collapse of solid iron stellar cores [1], merger of Black Holes, etc. In this paper, some of the founding assumptions of old well-established models of Astrophysics are critically examined and shown to be invalid. One such assumption is the well-known notion of electron degeneracy pressure and the second one is the extension of hydrodynamic equation of state to check the stability of non-burning high pressure, high density solid stellar cores under self-gravitation [2] [3].

In 1926, R. H. Fowler 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 role in all models of gravitational collapse of massive stellar cores [4]. However, an often-overlooked point is that the Fermi-Dirac statistics 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. When iron stellar core becomes degenerate, the degenerate electrons get freed from their parent atoms leaving behind positive ions. These free electrons are believed to acquire high kinetic energies through the operation of quantum mechanics. When the positive ions start falling towards the center of the core under gravity, the high energy degenerate electrons are supposed to push these ions outwards by their degeneracy pressure to counter the effect of gravity.

However, to impart an outward push to the falling ions, the high energy degenerate electrons will have to exchange their momentum with the falling ions through elastic collisions. Actually, because of their electrostatic interactions, the electrons can never exchange their momentum with positive ions through elastic collisions and hence can never provide the electron degeneracy pressure in stellar cores to counter the effect of gravity. This erroneous assumption of electron degeneracy pressure holding up massive stellar cores from gravitational collapse can be attributed to the following two simple misconceptions.

1) Since the dimension of kinetic energy density $[ML^{-1}T^{-2}]$ is common with the dimension of pressure $[ML^{-1}T^{-2}]$, the energy density of free electrons has been misconceived as electron degeneracy pressure without detailing any mechanism for producing this pressure. As an illustration of such mistakes, we note that the dimensions of energy and torque are common $[ML^{2}T^{-2}]$ but these are entirely different physical quantities. For producing this kinetic pressure, free electrons could have been shown to undergo elastic collisions either with the walls of a container or with an ensemble of identical particles. But they could never be shown to exchange their momentum with protons and other positive ions through elastic collisions for producing the required kinetic pressure.

2) While using hydrodynamic equation of state in stellar interiors, all charged particles like electrons, protons and ions are assumed to be non-interacting. Jus-

tification for doing so is that since the average Coulomb interaction energy per particle is less than their average kinetic energy in stellar interiors, contribution of Coulomb interaction can be neglected while computing the effective pressures. Agreed that the contribution of Coulomb interaction in particular computations could be neglected as too small, but that certainly does not warrant declaration of electrons, protons and ion to be non-interacting. In solid state, it is the Coulomb force, not kinetic or Coulomb interaction energy, that governs the state of relative motion between adjacent particles.

In situations of high core densities, atoms and ions will occupy relatively fixed positions with some thermal vibrations about their mean positions. When under high pressure or gravitational loading, the mean separation distance between atoms or ions becomes less than the normal size of their parent atoms, the electrostatic repulsion between these atoms or 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. Using Equation (15) of [2], we can compute the magnitude of restoring acceleration g_{01}, when a particle is displaced by one percent of the mean separation distance L_u. "*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*". Unlike our normal experience in terrestrial environment, the gravity induced solid state of the core constituents is achieved even at very high temperatures.

The constituents of a solid stellar core do not meet the conditions of kinetic theory of gases and the application of hydrodynamic equation of state in such cases is fundamentally invalid. The mean positions of these solid-state particles constitute a geometric pattern, a lattice structure. When an external force is applied to one or more of these lattice particles, the mutual separation distances between the adjacent particles will slightly change so as to produce additional reaction forces to balance the externally applied force. This small change in separation distances, can be described as an infinitesimal deformation of the lattice structure. If the external force is removed, the deformation in the lattice structure will also get eliminated and this characteristic can be described as elasticity of the solid ensemble of interacting particles. Quantification of the magnitude and direction of the deformation by a displacement vector produces the best characterization of the elastic nature of the solid. The central regions of all non-burning stellar cores physically constitute a solid state. Stresses induced in such solid cores due to self-gravitation can only be analyzed by study of its displacement vector field through equilibrium equations of elasticity and not by hydrostatic equilibrium equations of the kinetic theory.

The equilibrium equations of elasticity for a solid sphere under self-gravitation derived in Section 5.1 of [2], give the following relation between radial stress σ_{rr}, hoop stresses $\sigma_{\theta\theta}$ ($=\sigma_{\varphi\varphi}$) and the gravitation force,

$$\frac{\mathrm{d}\sigma_{rr}}{\mathrm{d}r}+\frac{2}{r}\left(\sigma_{rr}-\sigma_{\theta\theta}\right)=-\frac{4}{3}\pi G\rho^2 r=-\frac{GM\left(r\right)\rho}{r^2} \tag{1.1}$$

where $M(r)$ is the mass contained within radius r, ρ is the density and G the gravitation constant. Solution of this equation, as obtained in [2] is,

$$\sigma_{rr}=-\frac{2\pi G\rho^2}{5}r^2 \quad \text{and} \quad \sigma_{\theta\theta}=\sigma_{\varphi\varphi}=-\frac{2\pi G\rho^2}{15}r^2 \tag{1.2}$$

All stellar cores which are said to be degenerate, where a degeneracy pressure is invoked to prevent their gravitational collapse, are in fact solid stellar cores. The radial and hoop stresses induced by self-gravitation are proportional to the square of radius and are always minimum at the center and maximum at the periphery. As the size of a solid iron stellar core grows, its peripheral region will experience extreme compression due to high radial and hoop stresses and will get strongly ionized. In a strongly ionized state, most of the orbital electrons will get separated from their parent atoms. This stream of degenerate electrons, under the combined field of all positive ions, will start circulating around the surface of the core and give rise to very high magnetic fields in and around the stellar body. The peripheral stresses are expected to be of the order of 10^7 GPa. Under this extreme compression corresponding degree of ionization will lead to complete stripping off of 3rd and 4th shell electrons from iron atoms [3].

If q is the number of electrons stripped off from each atom, $2r_i$ is the average separation between any two ions and N_u is the resulting ionic density then the electrostatic pressure P_i between adjacent ions will be given by,

$$P_i=\frac{q^2e^2}{4\pi\varepsilon_0\left(2r_i\right)^2}\left(N_u\right)^{2/3}=k_e q^2 e^2\left(N_u\right)^{4/3} \tag{1.3}$$

It is this ionic pressure which supports the radial and hoop stresses given by Equation (1.2). In the grid locked lattice structure of gravitation induced solid state, ionized particles also undergo thermal vibrations about their mean positions. If mean amplitude of ionic oscillations is A then as per Equation (43) of [3], temperature T_i and frequency ν_i corresponding to such ionic thermal vibrations will be given by,

$$T_i=\frac{k_e q^2 e^2 A^2}{k_B\left(r_i^2-A^2\right)r_i} \tag{1.4}$$

$$\nu_i=\frac{1}{2\pi A}\sqrt{\frac{T_i k_B}{m_i}} \tag{1.5}$$

where k_B is the Boltzmann constant and m_i is mass of the vibrating ion. Thermal ionic vibrations at frequency ν_i given by Equation (1.5) will also result in emission of corresponding electromagnetic waves of the same frequency.

Unfortunately, the Astrophysics text books do not cover the theory of elasticity in general or working out stresses in solid bodies in particular. As such the students of Astrophysics are not prepared to handle the solid state of stellar cores or to work out stresses and strains in solid spherical bodies under self-gravitation. That is why Astrophysicists are left with no other alternative but to keep using invalid electron degeneracy pressure and hydrodynamic equation of state for analyzing the stability of non-burning solid stellar cores under self-gravitation. Since current models of core collapse and electron degeneracy pressure are invalid, all stellar compact bodies like White Dwarfs, Neutron Stars and Black Holes [5], are in fact Ionized Solid Core stellar bodies. In the following sections we will present the proposed mechanism of Newtonian gravitational interactions and will introduce a new gravitational interaction between partially ionized solid stellar bodies and other neutral stellar bodies, to be called Ionic Gravitation. With the introduction of Ionized Solid Iron Stellar Bodies (ISISB), we shall attempt to explain most of the unsolved problems in Astrophysics which so far necessitated the assumptions of Dark Matter and Black Holes.

2. Newtonian Theory of Gravitation

Newton's theory of universal gravitation is a physical law describing the gravitational attraction between bodies with mass. As per this law, every particle with mass attracts every other particle with mass by a force pointing along the line joining the centers of both particles. This force is proportional to the product of the two masses m_1, m_2 and inversely proportional to the square of the distance r between the two masses, as

$$F_g = -\frac{G \cdot m_1 \cdot m_2}{r^2} \tag{2.1}$$

where G is the universal gravitational constant. On the other hand, Einstein's General theory of Relativity (GR) is currently accepted as a geometric theory of gravitation which describes gravity as a geometric property of 4-D spacetime. However, in reality 4-D spacetime is not a physical entity and hence GR is not a physical theory of gravitation but just an abstract mathematical model to simulate gravitation [6].

2.1. Similarity between Newtonian Gravitation and Electrostatics

For macroscopic interacting bodies, the gravitational force between them is calculated by summing the contributions of all constituent point masses. It has been shown by shell theorem that an object, with a spherically-symmetric mass distribution, exerts gravitational attraction on external bodies as if all of its mass were concentrated at its center. Gravitational potential energy $V_g(r)$ of two spherically symmetric bodies of masses M and m, separated by distance r between their centers, is given by,

$$V_g(r) = -\frac{G \cdot M \cdot m}{r} \tag{2.2}$$

The gravitational potential energy V_g is an interaction energy released from the intrinsic gravitational field energies of the interacting masses when they are brought from infinite separation to a distance r. Newton's law of gravitation is similar to Coulomb's law of electrostatics, which gives the magnitude of electric-al force between two particles with charges q_1 and q_2 separated by distance r, as

$$F_e = \frac{1}{4\pi\varepsilon_0}\frac{q_1 \cdot q_2}{r^2} = \frac{k_e \cdot q_1 \cdot q_2}{r^2} \tag{2.3}$$

where ε_0 is the permittivity of free space and k_e is the corresponding electrostatic constant. Further, the electrostatic potential energy V_e of two charges q_1 and q_2 separated by distance r, which is also their interaction energy, is given by,

$$V_e(r) = \frac{k_e \cdot q_1 \cdot q_2}{r} \tag{2.4}$$

The similarity between gravitational and electrostatic force equations points to a possibility that the gravitational and electrostatic interactions might have something in common at the most fundamental level. A major theoretical concern of Newtonian Gravitation is that there is no fundamental physical mechanism that could explain the action of one massive body over the other body separated by a large distance through the void or empty space. But a similar theoretical concern also existed for the action of one charged particle over the other charge separated by a large distance through the empty space.

2.2. Mechanism of Electrostatic Interactions

According to elastic space continuum models, the electron and positron consist of a central core of standing strain wave oscillations, with about 65 percent of total mass-energy content of the particle. The electrostatic field of an electron type charge particle consists of phase waves with radially decaying amplitude, propagating inwards from infinity to the core boundary, at the speed of light "c". The electrostatic field of positron type charge particle consists of phase waves with radially decaying amplitude, propagating outwards from the core boundary to infinity, at the speed of light "c". The electrostatic field energy content E_f of electron as well as positron, contained in these radially decaying phase wave type electrostatic fields, is estimated to be about 35 percent of total mass-energy content. That is, about 175 keV energy (E_f) is contained in the electrostatic wave field surrounding the core region of the electron [7].

During the process of interaction of charges, their electrostatic wave fields will get superposed and the total field energy E_{sup} of their superposed combined field will be different from the sum of their individual electrostatic field energies. This difference results in their interaction energy. During electrostatic interaction of two electrons, their interaction energy will be positive, implying thereby that the total field energy E_{sup} of their superposed combined field will be greater than 350 keV. On the other hand, during electrostatic interaction of one electron and one positron or proton, their interaction energy will be negative, implying thereby that the total field energy E_{sup} of their superposed combined field will be less than 350 keV. The negative interaction energy implies that due to the superposition of fields, part of the initial total field energy of the system of interacting charges is released by the system and may get transformed to their kinetic energy or emitted out of the system as radiation. The negative interaction energy of a proton electron pair is also known as their binding energy.

The superposed electrostatic wave field, will no longer be propagating in any one direction (radially inwards or outwards) but will consist of their superposed mixture which may be termed as a *ripple wave field*. This ripple wave field will not behave as an electrostatic phase wave field of a charged particle even though a significant amount of total energy E_{sup} is still contained in this field. As long as the separation distance between a proton electron pair remains greater than 10^{-14} m (10 fm), the total ripple wave field energy E_{sup} in their combined field will be greater than 200 keV, which is quite significant. Even though an electron-proton pair in bound state constitutes a neutral particle, yet their combined ripple wave field energy E_{sup} is primarily of electrostatic origin. This combined ripple wave field energy E_{sup} of a neutral particle is effectively the intrinsic gravitational field energy of the neutral particle.

All neutral atoms consist of a large number of proton-electron pairs and neutrons held together in bound states. The ripple wave fields of different proton-electron pairs in an atom or molecule will further get superposed to yield a combined superposed ripple wave field of the neutral particle. We may refer to this combined superposed ripple wave field of neutral atoms, molecules and neutrons as a neutral ripple wave field, with each neutron counted as one electron-proton pair in closely bound state. If certain neutral particle consists of n electron-proton pairs, then taking m_u to be the mass of each electron-proton pair, mass m of such a neutral particle will be $m = n \times m_u$. If E_b is total binding energy of all constituents, then the total ripple wave field energy E_{rwf} of such a neutral particle of mass m will be,

$$E_{rwf} = \left(n \times 350 - E_b\right)\text{keV} \tag{2.5}$$

Since mass m and total ripple wave field energy E_{rwf} of such neutral particles are both proportional to the number of effective electron-proton pairs n, we can roughly state that the total ripple wave field energy of neutral particles directly depends on their mass.

2.3. Mechanism of Newtonian Gravitational Interactions

Let us consider gravitational interaction of two neutral particles, each of mass m and separated by distance r. During the process of gravitational interaction between two neutral particles, their neutral ripple wave fields, or intrinsic gravitational fields will get superposed and the total gravitational field energy E_{fg} of their combined field will be less than the sum of their individual ripple wave field energies ($2E_{rwf}$). This difference ($E_{fg} - 2E_{rwf}$) results in the gravitational interaction energy V_g as given by Equation (2.2). Hence the mechanism of gravitational interaction between two neutral particles, is quite similar to the mechanism of electrostatic interaction between a pair of oppositely charged particles.

Next, consider a large body of mass M consisting of N number of identical neutral particles, each of mass m and ripple wave field energy E_{rwf}. If V_g (in keV) is the total gravitational binding energy of N neutral particles then the total intrinsic gravitational field energy E_{fg} of that body will be given by an equation similar to Equation (2.5) as,

$$E_{fg} = \left(N \times E_{rwf} - V_g \right) \text{keV} \tag{2.6}$$

Here, V_g is the usual gravitational potential energy or the gravitational binding energy of the associated N neutral particles, whereas E_{fg} is the total field energy of the combined ripple wave field or the intrinsic gravitational field of the N particles. There is an important distinction between the interaction energy V_g and the combined field energy E_{fg}. Whereas the field energy E_{fg} is spatially spread out, both inside and outside of the body of mass M, the interaction energy V_g manifests itself partly as kinetic energy of constituent particles and partly as energy emitted out as radiation. Specifically, the interaction energy V_g is not a field energy and the field energy E_{fg} is the field component of the total mass M of the body.

Hence, an excellent physical mechanism for explaining the gravitational interaction is provided by the interaction between two or more neutral matter particles through superposition of their neutral ripple wave fields. As such, the fundamental basis of gravitational interaction can be traced to the electrostatic phase wave field of charged particles. This intrinsic electrostatic field is characterized by unidirectional propagation of phase waves with radially decaying amplitude. However, the fundamental unit cell for gravitational interaction is the neutral pair of two opposite charges surrounded by a superposed ripple wave field that constitutes the intrinsic gravitational field of the neutral particle.

2.4. Domain of Newtonian Gravitation

1) Newtonian Gravity primarily describes the phenomenon of gravitational attraction between two or more neutral matter particles. It is fundamentally distinct from electrostatic attraction between two or more opposite charges governed by the Coulomb's law.

2) Newtonian Gravity does not propound gravitational attraction between any form of energy or momentum, other than between neutral matter particles.

3) Newtonian gravitational attraction between two or more neutral matter particles is basically a macroscopic phenomenon which cannot be extended to microscopic or quantum processes.

4) Newtonian equations of gravitation basically represent a static phenomenon where time involved in making significant configuration changes between gravitating bodies is much greater than the time taken by the propagation of intrinsic gravitational influences between them at the speed of light.

3. Ionic Gravitation

3.1. Polarization of a Dielectric Sphere Placed in Uniform Electric Field E_0

Under the influence of electric field, the positive and negative bound charges of an atom or molecule get displaced in opposite directions along the field. The net effect is to pull the opposite charges apart, *i.e.*, to polarize the molecule. If q is the total charge carried by the orbiting cloud of electrons and d is the distance by which its center gets displaced from center of the nucleus then the induced dipole moment $\boldsymbol{m}$ of the polarized atom or molecule, in a direction from negative to positive charges, is given by,

$$\boldsymbol{m} = q \cdot d \tag{3.1}$$

The electric polarization $P(r)$ is defined as the dipole moment per unit volume. A dielectric material placed in an external electric field becomes polarized, which means that neutral atoms and molecules of the material acquire dipole moments. Let us consider a dielectric sphere of radius "a" placed in an external uniform electric field E_0. The state of polarization of this sphere is represented by the electric polarization P, which is defined as the dipole moment per unit volume. In an isotropic medium, the polarization P induced by an electric field E will be proportional and parallel to the field.

$$P = \varepsilon_0 \chi_e E \tag{3.2}$$

where χ_e is the electric susceptibility of the medium.

Polarization of the medium produces an effective polarization charge consisting of volume charge density ρ_p and surface charge density σ_p given by,

$$\rho_p(r) = -\nabla \cdot P(r) \tag{3.3}$$

$$\sigma_p(r) = P(r) \cdot n \tag{3.4}$$

where n is the unit vector normal to the surface. Further, due to the polarization P given by Equation (3.2), effective electric permittivity of the medium gets increased to,

$$\varepsilon = \varepsilon_0 (1 + \chi_e) \tag{3.5}$$

The ratio $\varepsilon/\varepsilon_0$ is known as relative electric permittivity ε_r or dielectric constant of the medium. As a result of polarization of the dielectric sphere, the electric field within the sphere remains parallel to the external applied field E_0, but gets reduced in magnitude as,

$$E_{in} = \frac{3}{2 + \varepsilon_r} E_0 \tag{3.6}$$

An equivalent electric dipole at the center of the sphere with a dipole moment p_{eq} oriented in the direction of the applied field, is given by,

$$p_{eq} = 4\pi a^3 \cdot \frac{\varepsilon_r - 1}{2 + \varepsilon_r} \varepsilon_0 E_0 \tag{3.7}$$

The equivalent dipole moment p_{eq} can be interpreted as the volume integral of polarization P. Hence the polarization P, which is constant throughout the sphere, is given by,

$$P = (\varepsilon - \varepsilon_0) E_{in} = 3 \frac{\varepsilon_r - 1}{2 + \varepsilon_r} \varepsilon_0 E_0 \tag{3.8}$$

The polarization surface charge density σ_p is given by,

$$\sigma_p = P \cdot n = 3\frac{\varepsilon_r - 1}{2+\varepsilon_r}\varepsilon_0 E_0 \cos(\theta) \tag{3.9}$$

where, θ is the angle which the radial position vector makes with the external field direction. This surface charge density can be considered as producing an internal field inside the sphere, directed oppositely to the applied field, thereby reducing the field inside the sphere to its value given by Equation (3.6).

3.2. Force on a Dielectric Sphere Placed in the Field of a Point Charge *Q*

Integrating the polarization surface charge density σ_p given by Equation (3.9) over surface of the sphere of radius a, we get total positive surface charge Q_p on one half of the sphere and total negative surface charge of magnitude Q_p on the opposite half of the sphere.

$$Q_p = \pi a^2 \frac{3(\varepsilon_r - 1)}{\varepsilon_r + 2}\varepsilon_0 E_0 \tag{3.10}$$

In the external uniform electric field E_0, force acting on positive and negative charges Q_p will be equal and opposite. Hence the total force acting on the polarized sphere placed in a uniform electric field will be zero. That is, a dielectric sphere will not experience any force in a uniform electric field. However, that is not the case when the same sphere is placed in a radially decaying field of a strong point charge. Let us consider a positive point charge Q placed at the origin O of a polar coordinate system. Let the center A of a dielectric sphere of radius "a" be positioned at a distance R from the origin. The electric field E_0 at the center A of the sphere, caused by charge Q at the origin is given by,

$$E_0 = \frac{1}{4\pi\varepsilon_0}\frac{Q}{R^2} = \frac{k_e \cdot Q}{R^2} \tag{3.11}$$

Assuming $R \gg a$, the field at the center of the sphere can be regarded as an average field acting at all atoms and molecules of the sphere. Under the influence of this field, the dielectric material, with relative electric permittivity ε_r, will get polarized. The polarization P will be given by Equation (3.8) and polarization surface charge density σ_p given by Equation (3.9). As a result of this polarization, negative surface charge of magnitude Q_p will get induced on the hemispherical surface of the sphere nearest to charge Q and a positive surface charge of magnitude Q_p will get induced on the hemispherical surface farthest to charge Q. If d_e is the separation between the effective centers of opposite surface charges, then the equivalent electric dipole moment p_{eq} at the center, given by Equation (3.7) can be written as,

$$p_{eq} = Q_p \cdot d_e = 4\pi a^3 \cdot \frac{\varepsilon_r - 1}{2+\varepsilon_r}\varepsilon_0 \cdot \frac{k_e \cdot Q}{R^2} \tag{3.12}$$

However, the electric field of charge Q is not uniform or constant but decays radially. As such, the field strength is higher at the center of negative surface charge and lower at the center of positive surface charge. Let the difference in field strength between these two points be ΔE. Hence, the magnitude of field strength at the center of negative surface charge will be $E_0 + \Delta E/2$ and the magnitude of field strength at the center of positive surface charge will be $E_0 - \Delta E/2$. Therefore, Coulomb force acting on the negative surface charge Q_p will be $-Q_p(E_0 + \Delta E/2)$ and Coulomb force acting on the positive surface charge Q_p will be $+Q_p(E_0 - \Delta E/2)$. Summing up these two components, we get a net force F_{ig} acting on all polarization surface charges as,

$$F_{ig} = -Q_p\left(E_0 + \frac{\Delta E}{2}\right) + Q_p\left(E_0 - \frac{\Delta E}{2}\right) = -Q_p \cdot \Delta E \tag{3.13}$$

Here, we are taking ΔE as the magnitude of change in electric field strength. Since d_e is the separation between the effective centers of opposite surface charges, we can compute ΔE from radial derivative of E_0 given by Equation (3.11) as,

$$\Delta E = \left|\frac{\partial E_0}{\partial R} \cdot d_e\right| = \frac{2k_e Q}{R^3} \cdot d_e \tag{3.14}$$

Combining Equations (3.12), (3.13) and (3.14), we get net force F_{ig} as,

$$F_{ig} = -Q_p \cdot \frac{2k_e Q}{R^3} \cdot d_e = -p_{eq} \cdot \frac{2k_e Q}{R^3} = -8\pi a^3 \cdot \frac{\varepsilon_r - 1}{\varepsilon_r + 2} \varepsilon_0 \cdot \frac{(k_e \cdot Q)^2}{R^5} \tag{3.15}$$

Replacing $4\pi\varepsilon_0$ with $1/k_e$ Equation (3.15) can be written as,

$$F_{ig} = -2a^3 \cdot \frac{\varepsilon_r - 1}{\varepsilon_r + 2} \cdot \frac{k_e \cdot Q^2}{R^5} \text{ Newtons} \tag{3.16}$$

where a and R are in meters, Q in Coulombs and F_{ig} is in Newtons. This net force F_{ig} is an attractive force and remains attractive for both positive and negative external charges Q. Therefore, this force of attraction between an external charge of any sign and a body of neutral matter, may be called force of Ionic Gravitation F_{ig} as given by Equation (3.16). If mass density of the sphere is ρ_s and radius a then the Mass M_s of the sphere is given by the usual relation as,

$$M_s = \frac{4\pi}{3} a^3 \rho_s \text{ kg} \tag{3.17}$$

Dividing the ionic gravitation force F_{ig} in Equation (3.16) by the total mass M_s of the sphere, we obtain the charge induced ionic gravitational acceleration A_{ig} of the sphere as,

$$A_{ig} = -\frac{3}{2\pi\rho_s} \cdot \frac{\varepsilon_r - 1}{\varepsilon_r + 2} \cdot \frac{k_e \cdot Q^2}{R^5} \quad \text{m/s}^2 \text{ or N/kg} \tag{3.18}$$

This parameter A_{ig}, depicts an ionic gravitational acceleration field (m/s^2) or a force field giving force per unit mass (N/kg), induced by an external charge Q in the neutral matter solid sphere of density ρ_s.

3.3. Gravitational Influence of a Strongly Ionized Solid Body

As per the shell theorem of electrostatics, field outside a uniform shell of charge is the same as that of a point charge with the same total charge as that in the shell. Therefore, if the total external charge Q of Equation (3.18) is uniformly spread over the surface of a large stellar solid body it will produce the same ionic gravitational field on surrounding neutral matter bodies of density ρ_s as that given by Equation (3.18). This ionic gravitational attraction will be over and above the Newtonian gravitational interaction between neutral matter bodies. However, the influence of ionic gravitation field may not extend as far out in space as that of Newtonian gravitation because of its $1/R^5$ decay. On the other hand, the influence of ionic gravitation field in the nearby vicinity of a charged or ionized solid stellar body may be much stronger than that of Newtonian gravitation field. We shall discuss the existence of such strongly ionized solid stellar bodies in compact stellar objects, in following sections.

4. Core-Shell-Envelope Stellar Structure

4.1. Multiple Shell Structure of Massive Stars

Let us consider a massive star of say more than $25M_\odot$, with a partly filled iron core and multiple fusion shells as illustrated in **Figure 1**. Let us assume that the radius R_0 of the partly filled central iron core is about 10,000 km. Immediately surrounding the iron core is the Silicon zone, consisting of an inner Silicon fusion shell S_1 (Si → Fe) surrounded by Silicon envelope E_1 (Si) with its radius R_1. Similarly, surrounding the Silicon zone there are Oxygen, Carbon, Helium and Hydrogen zones with their respective fusion shells and envelopes as shown in **Figure 1**. If P_1, T_1 are the pressure and temperature of the Silicon shell S_1 and (P_2, T_2), (P_3, T_3), (P_4, T_4) and (P_5, T_5) are the pressure and temperature of the outer shells S_2 (O → Si), S_3 (C → O), S_4 (He → C) and S_5 (H → He) respectively, then it is well known that $P_1 > P_2 > P_3 > P_4 > P_5$ and $T_1 > T_2 > T_3 > T_4 > T_5$. Further, let R_2, R_3, and R_4 be the radii of envelopes E_2 (O), E_3 (C), and E_4 (He) respectively.

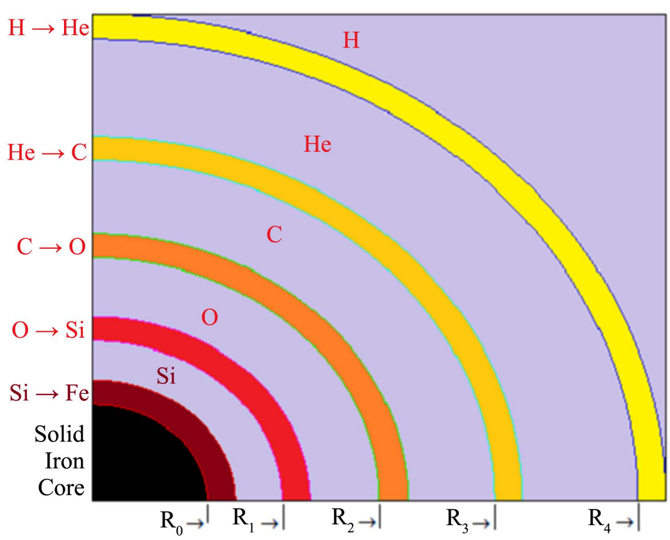

Figure 1. Illustration of multiple fusion shells and envelopes surrounding the central iron core.

If we represent magnitude of gravitational field at radius R as g ($=GM_r/R^2$), where M_r is the mass contained within radius R, then obviously $g_1 > g_2 > g_3 > g_4$. Let ρ_1, ρ_2, ρ_3 and ρ_4 be average densities of the envelopes E_1, E_2, E_3 and E_4 respectively. The pressure gradient $|dP/dR|$ in any envelope will be given by $g \cdot \rho$ under hydrostatic equilibrium conditions.

4.2. Characteristics of Core-Shell-Envelope Structure

Salient characteristics of the Core-Shell-Envelope structure of a massive star are outlined below.

1) ***Stress loading on the central solid core***. There are two types of loading on the solid core. First is the self-gravitational loading which is dependent on the mass of the core and second is the external pressure loading due to the hydrostatic pressure P_1 of the surrounding fusion shell. The radial and hoop stresses generated in the solid core due to this loading are minimum at the center and maximum at the outer surface region of the core. Due to extreme compression, the outer region of the core gets pressure ionized.

2) ***Build-up of central core radius leads to expansion of the massive star.*** With the growth of central core radius, all fusion shells and associated envelopes will keep getting pushed outwards to higher radii with corresponding reduced gravitational field g. That means the pressure gradients $|dP/dR|$ of all envelopes will keep getting reduced, as a result of which the envelopes will keep expanding while shifting outwards. Since most of the envelopes are convective, some fraction of hot gases in the outermost envelope will cross the escape velocity in that region and get lost from the star.

3) ***Effect of Silicon burn out in shell 1.*** Since the rate of fusion reaction in S_1 is much faster than the rate of fusion in S_2, S_3 etc., it is perfectly logical to consider the possibility that the Silicon fuel in envelope E_1 and shell S_1 may get exhausted while the fusion reactions in outer shells S_2 onwards are still going on. Therefore, when the radial thickness of shell S_1 and envelope E_1 gradually shrinks to zero, the shell S_2 and envelope E_2 will shift inwards to take the place of S_1 and E_1 respectively. That is, all outer shells and envelopes will shift inwards whereby their gravitational fields and pressure gradients will correspondingly increase leading to overall shrinking of the massive star. However, since the shell pressure P_2 is much less than pressure P_1 of the old Silicon shell S_1, the pressure loading on the central solid core will reduce accordingly.

4.3. Reignition of Silicon Shell after Fresh Accumulation

Even after termination of Silicon fusion in S_1, production of fresh Silicon in fusion shell S_2 continues unabated. In due course of time, sufficient amount of Silicon will get accumulated in the envelope E_1 such that reignition of Silicon in reborn shell S_1 could become possible. This reignition of Silicon in S_1 will release a sudden burst of enormous thermal energy resulting in following significant effects on the whole core-shell-envelope structure.

1) Shock wave triggered fusion instabilities. Sudden rise in temperature and pressure in new shell S_1 will trigger a shock wave through all surrounding shells and envelopes. Such a shock wave may initiate pressure, temperature fluctuations in most of the shells and may even trigger fusion reaction instabilities or run-away fusion in some shells leading to Nova explosions.

2) Production of fissionable nuclei in shell S_1. Pressure loading on the central solid iron core will get enhanced, leading to higher degree of ionization in the iron core. Silicon fusion reactions in S_1 in the immediate vicinity of ionized iron core will suddenly shoot up resulting in the production of higher atomic mass nuclei, even heavier than iron nucleus, that may include fissionable nuclei.

3) Stellar mass loss from outer regions. Creation of envelope E_1 coupled with the shock wave initiated from S_1 will lead to expansion of the whole star. Not only expansion, the pressure and temperature fluctuations in most of the shells, as well as Nova explosions triggered by the shock wave, will lead to extensive mass loss from outer regions of the star.

4.4. Silicon Fusion Termination and Reignition Cycles

In massive stars silicon fusion termination, fresh accumulation and reignition of silicon fusion in S_1, may lead to another cycle of fusion termination, fresh accumulation and reignition in S_1. As such, there could be a number of cycles of silicon fusion termination and reignition. Each cycle of silicon fusion termination and reignition will result in fresh shock waves, expansion and extensive mass loss from outer regions of massive stars. Finally, when the central solid iron core is built up to a radius of about 50,000 km, excessive ionization on the surface of the core coupled with excessive accumulation of fissionable heavy nuclei, may lead to Supernova explosion either due to run-away fusion reaction in S_1 or due to fission of heavy fissionable nuclei.

Contrary to the current perception, as described under Core Collapse Supernova explosion models [1] [4], the stress loading on central solid iron core does not increase with extinction of fusion reaction in Si shell S_1. While the stresses induced in the solid core due to self-gravitation remain unaffected by the termination of Si burning, the stresses induced by external pressure loading will in fact reduce with extinction of shell S_1. Therefore, it is wrong to suggest that the extinction of Si fusion in massive stars will lead to gravitational collapse of central solid iron core.

5. Ionized Solid Stellar Bodies

5.1. Nature of Compact Stellar Objects

The evolution cycle of all stars reaches a dead end when their nuclear fusion reactions get terminated either due to exhaustion of fuel around the burning shells or due to excessive loss of material blown away by Nova or Supernova explosions. What is left behind as a stellar remnant, is invariably the central solid core which is highly ionized in outer regions and surrounded by a nearly spherical shell of circulating degenerate electrons. In a gravity induced solid state, such stellar remnants will normally sustain high temperatures as given by Equation (1.4). From the radial stress calculations in the peripheral regions (Equation (1.2)) and the corresponding degree of ionization, the radius of a fully developed solid core is estimated to be of the order of 40,000 km to 60,000 km with its mass around a solar mass. These ionized, solid core stellar remnants are currently known as Compact Stellar Objects.

From the degree of ionization in peripheral regions [3], maximum positive charge accumulation in ionized solid core is estimated to be of the order of 10^{37} Coulombs. Ideally speaking the total charge of circulating degenerate electrons should also be of the same order. However, when bulk of the star material surrounding the central solid core gets blown away in Nova or Supernova explosions, a very small fraction of the circulating electrons may also get blown away. Assuming that about 0.01 percent of the circulating electrons get blown away in such terminating explosions, the remnant ionized solid core with circulating electrons will be left with an excess of positive charge of the order of 10^{33} Coulombs. This positive excess of ionic charge in all solid stellar remnants becomes a source of Ionic Gravity and plays a significant role in evolution of Galactic structures. The shell of degenerate electrons circulating around the ionized stellar body will create a strong magnetic field.

As per our current understanding, where the erroneous concept of electron degeneracy pressure is still dominant, compact stellar objects are believed to be stellar remnants known as white dwarfs, neutron stars, and black holes. Since all stellar remnants are actually ionized solid stellar bodies, these are neither as small nor as dense as required for sustaining the notion of electron degeneracy pressure. The compact stellar objects known as black holes and neutron stars are all Ionized Solid Iron Stellar Bodies (ISISB) with excess of positive charge and strong magnetic field produced by circulating electrons. On the other hand, the compact stellar objects known as white dwarfs are all partially ionized solid carbon/helium stellar bodies with some excess positive charge and medium magnetic field produced by circulating electrons. All of these compact stellar objects will produce ionic gravitation due to their excess positive charge and will be accompanied by strong magnetic fields. These objects may be surrounded by a shell of accreting matter consisting of gases, dust or inter stellar matter. As and when the accreting matter falls on the surface of these compact stellar objects, it will get instantly ionized and produce strong non-stellar radiation [8]. Very high surface temperatures sustained in some ISISB may also give rise to continuum X-ray emissions.

In situations where the Supernova explosion takes place much before the central solid iron core could grow to its full or ionized stage, the resulting stellar remnant will consist of a non-ionized solid iron core with surrounding rocky solids. Such stellar remnants ultimately form all rocky and earth like planets, exoplanets and rogue planets.

5.2. Electromagnetic Interactions of Ionized Solid Stellar Bodies

Maximum size of all ionized solid stellar bodies will become self-limiting due to repulsive action of highly ionized boundary surface in preventing further gravitational in-fall of more positive ions. However, gravitational or electrostatic in-fall of all inter stellar matter, especially the electrons, on highly ionized boundary surface of these bodies will trigger strong nuclear reactions and produce gamma rays and other non-stellar radiation. When a small percentage of degenerate electrons get blown out with Supernova or Nova explosions and are lost from the ionized solid stellar remnants, they spread out in the interstellar space. These excess electrons, in due course, get caught on some interstellar bodies or active star envelopes, through ionic gravitation, to impart net negative charge to these entities [9].

Ionic gravitation due to excess positive charge is one of the most dominant electromagnetic interactions between ionized solid stellar bodies and neutral stellar bodies. The mechanism of ionic gravitation, as discussed above, is through polarization of neutral atoms and molecules by any strong external charge. Since this interaction always produces an attractive force irrespective of the sign of the charge, it can be categorized as a gravitational interaction. Second most dominant electromagnetic interaction is between ionized solid stellar bodies and stellar bodies that have acquired excess of negative charge through capture of Nova or Supernova blown out electrons. This will be purely an electrostatic attraction between net positive charge on ionized solid stellar body and net negative charge on the second stellar body.

Next dominant electromagnetic interaction of ionized solid stellar bodies is the production of strong magnetic field and the associated magnetic interaction with accreting neutral matter that is falling-in towards the surface of such bodies. As the gravitationally in-falling matter passes through the circulating electron shell it tends to get dragged along through polarizing action. By the time it reaches ionized solid surface, it gets highly ionized and experience Lorentz force. Under the action of Lorentz forces, the accreting ionized matter will experience extreme compression and hence will get pushed towards the polar regions to produce Jets of ionized matter. Another electromagnetic interaction of ionized solid stellar bodies is the production of strong gamma ray bursts when accreting matter or electrons crash onto the ionized solid surface of such stellar bodies.

6. Galactic Rotation Curves and Assumption of Dark Matter

Let us consider Milky Way galaxy for illustration of the issue of unexpectedly constant observed circular velocities of most stellar bodies on spiral arms. The radially decaying galactic central force field is normally expected to produce a radially decreasing pattern of circular velocities in the galactic disc. In the galactic plane, for the disc radius extending from about 4 kpc to 20 kpc, the observed circular velocities form a nearly flat curve, with velocities in the range of about 200 km/s to 220 km/s [10]. Let a stellar object with circular velocity V_c and radial velocity V_r, be located within a spiral arm at a radial distance R from the galactic center. Let M_r be the total baryonic mass within a sphere of radius R. Assuming approximate validity of the shell theorem for the galactic disc region and also assuming that the stellar object under consideration is moving solely under the influence of central force field of the galaxy, radial acceleration $\mathrm{d}V_r/\mathrm{d}t$ of the object will be given by,

$$\frac{\mathrm{d}V_r}{\mathrm{d}t} = -\frac{GM_r}{R^2} + \frac{V_c^2}{R} \tag{6.1}$$

Normally, the radial acceleration of any stellar object moving solely under the influence of central force field of the galaxy will be negative. Taking M_r to be about $2 \times 10^{11} M_\odot$ at $R = 4$ kpc, with $V_c = 220$ km/s the central gravitational acceleration $(-GM_r/R^2)$ works out to be -1.75×10^{-9} m/s^2 whereas the corresponding centrifugal acceleration (V_c^2/R) works out to be 3.9×10^{-10} m/s^2. That is, the radial acceleration $(\mathrm{d}V_r/\mathrm{d}t)$ at $R = 4$ kpc is estimated at about -1.36×10^{-9} m/s^2. Now taking M_r to be about $2.5 \times 10^{11} M_\odot$ at $R = 20$ kpc, with $V_c = 200$ km/s the gravitational acceleration $(-\mathrm{GM_r/R^2})$ works out to be -8.7×10^{-11} m/s^2 whereas the corresponding centrifugal acceleration (V_c^2/R) works out to be about 2.1×10^{-11} m/s^2. That is, the radial acceleration $(\mathrm{d}V_r/\mathrm{d}t)$ at $R = 20$ kpc is estimated at about -6.6×10^{-11} m/s^2. This explains the inward curving of spiral arms at lower radial distances.

However, while justifying the necessity of dark matter, the radial acceleration $\mathrm{d}V_r/\mathrm{d}t$ is assumed to be zero and all trajectories of stellar objects are implicitly assumed to be circular, disregarding the fact that a central force field can only generate radial acceleration and cannot produce circular velocities of its own. The circular or tangential velocities of stellar bodies are not directly produced by the radial acceleration field of the galaxy but depend on the initial angular momentum of the accreting matter with respect to the gravitating body. Conservation of angular momentum will ensure increase in circular velocity of stellar bodies as their distance from central gravitating body keeps decreasing. However, this increase in circular velocity V_c with decreasing R does not depend on the strength of central gravitation field or magnitude of M_r, but is solely governed by the conservation of angular momentum. Hence it is fundamentally wrong to assume the existence of fictitious Dark Matter for explaining the pattern of circular velocities of stellar objects in spiral arms.

In reality stellar objects in spiral arms do not move solely under the influence of central gravitation field of the galaxy, their motion is also influenced by the local gravitation fields within the spiral arms. There are localized gravitating bodies existing within the spiral arms, which produce their own gravitation field in addition to the gravitational field of the central gravitating body. For example, the circular velocity of a star within a globular cluster will be governed by its initial angular momentum with respect to the cluster and not with respect to the parent galaxy. As such circular velocity of any stellar body within a globular cluster cannot be explained by using only the central gravitation field of the parent galaxy. The galactic spiral arms can be regarded as independent localized gravitating bodies, just like globular clusters that are in the process of being accreted to the central galaxy.

Thus, the circular velocities of stellar bodies within the spiral arms of a galaxy are produced by the combined effect of their angular momentum with respect to the local spiral arm structure as well as with respect to the central galaxy structure. Therefore, the flatness of circular velocities of stellar bodies in the spiral arms, has to be explained by the shape, size and structure of the spiral arms and their localized gravitational field in addition to the centralized gravitational field of the galaxy. It is quite possible that the localized gravitational field of galactic spiral arms may get significantly enhanced by the presence of Ionized Solid Stellar Bodies and their associated ionic gravitation field. But there is absolutely no scope for assuming the presence of fictitious Dark Matter anywhere within or outside of the galaxy.

Specifically, a spiral arm of a galaxy may be regarded as an interconnected or gravitationally coupled large collection of star clusters that constitute their own local gravitation field distinct from the central gravitation field of the parent galaxy. Let us consider a large star cluster of about hundred light years in diameter, moving under the central gravitational field of a galaxy. Just as all constituents of this star cluster will move with same common circular velocity in the central field, all constituents of the gravitationally bound galactic spiral arm may also move in the central field with almost same common circular velocity. Due to tidal forces of the central gravitation field, the gravitationally coupled collection of star clusters will experience a stretching or pulling effect along the axial line of the spiral arm. This stretching or pulling effect keeps getting stronger with the decrease in radial distance from the center of the galaxy. Ultimately, within the central galactic bulge, the tidal forces become so strong that individual star clusters and even individual stars get ripped apart from the local gravitation field of the spiral arm.

7. Constituents of Active Galactic Nuclei

7.1. Flaws in Current Models of AGN

As per currently accepted cosmological models, an Active Galactic Nuclei (AGN) is believed to be a compact region at the center of a galaxy that produces very high non-stellar emissions [8]. Super Massive Black Holes (SMBH) are believed to be located at the center of all galaxies and the non-stellar emissions from AGN are supposed to be resulting from accretion of matter onto these central Black Holes. However, the general model of matter accreting toward a central SMBH and then ejected from its vicinity through relativistic jets by the action of strong magnetic fields associated with accretion discs, is not supported by any physical mechanisms. Physically, it is impossible for the matter accreting toward a central SMBH to account for observed AGN properties due to following reasons.

1) Strong magnetic fields cannot be produced by the in-falling particles in the accretion discs unless such particles are only electrons or only ions. In a mix of particles, only heterogeneous localized magnetic fields can be produced.

2) Charged particles moving through a magnetic field only experience a Lorentz force at right angles to their velocity vector and hence can never get linearly accelerated to high velocities by the action of such magnetic fields.

3) The accreting particles in the accretion disc are only accelerated by the gravitational force of the central compact body. Being a motion in central force field, the in-falling motion of the accreting particles is always constrained by maintaining their Angular Momentum constant.

4) Let us assume that a certain fraction of mass of the accreting particles with a total radially inward momentum P_{in}, is somehow ejected radially outward in the form of a jet, with a total outward momentum of P_{out}. Then it is obvious from Newton's laws of motion that the central compact body will need to apply a sort of reaction force amounting to imparting an outward total momentum of sum of $P_{in} + P_{out}$ to these accreting particles for enabling the ejection of jets. However, such a reaction force can never be provided by any Black Hole since these jets are assumed to be produced from the accretion disc just outside of the Event Horizon, and not from the physical surface of the gravitating body.

5) Further it is well known that gamma radiation can only be produced by nuclear reactions or nuclear interactions. As such Gamma radiation, which is a part of intense non-stellar radiation from AGN, can never be produced from gravitational thermal energy in the accretion disc.

It may therefore be concluded that observed AGN properties cannot be explained by assuming the compact body at the center of AGN to be the fictitious SMBH.

7.2. Primary Constituents of AGN

The primary constituents of AGN are the highly Ionized Solid Iron Stellar Bodies (ISISB) which are the remnant cores of massive stars after their outer envelopes get blown off by Nova or Supernova explosions. Mass of such ISISB is estimated to be of the order of one solar mass and the total positive charge accumulated in outer regions of these ionized solid bodies is estimated to be of the order of 10^{37} Coulombs. In a spherically symmetric solid body under self-gravitation, the magnitude of radial and hoop stress (Equation (1.2)) keeps increasing in proportion to square of radius. Due to extreme stress induced compression, degree of ionization in outer regions also keep increasing with radius until ionic repulsion on the surface prevents any further increase in radius as well as mass of such ISISB. On these considerations, maximum radius of an ISISB is estimated to be of the order of about 50,000 km. Most ISISBs are likely to sustain high surface temperatures (Equation (1.4)) which may produce intense continuum X-ray emissions.

The degenerate electrons freed from ionized atoms of the solid body will start circulating around the solid body under the combined electrostatic field of the ionized solid body. Even though total negative charge of circulating electrons is expected to be of the same order as the total positive charge of the ionized solid body, yet due to various environmental factors, a very small percentage of circulating electrons may get lost from the ISISB. As such, the ionized solid body may be left with a net positive charge of the order of 10^{33} Coulombs. The remaining circulating electrons will produce a strong primary magnetic field all around the ionized solid body. The net positive charge of ISISB will give rise to the significant effect of Ionic Gravitation in the neutral matter spread around in its vicinity.

Due to Newtonian and Ionic gravitation, inter-stellar matter and stellar bodies in the surrounding space will get attracted towards an ISISB and tend to crash on to its ionized solid surface through the accretion process. While approaching the ionized solid surface, the neutral accreting matter will get ionized under the influence of circulating electrons and electrostatic field of ionized solid surface. When the flux of electrons in the ionized accreting matter crashes on to the ionized solid surface of an ISISB, it will result in production of burst of X-rays and Gamma-rays. Bombardment of the ionized solid surface of an ISISB by high energy electrons in the accretion process is the primary source of galactic Gamma ray bursts. Production of electromagnetic radiation in jets of ionized matter, created by strong magnetic fields of ISISB, is the secondary source of X-rays and Gamma-rays. Thus, all non-stellar radiation of AGN primarily originates in ISISB.

7.3. Production of Ionic Jets from the Magnetic Field of ISISB

A strong magnetic field in ISISB is created by the collective circulating motion of all degenerate electrons moving in the electrostatic field of ionized solid stellar body. A weak magnetic field may also be created by the rotational motion, if any, of ionized solid stellar body about its axis. In Cartesian coordinates, if Z-axis is along the axis of spherical solid body, then the stream of electrons circulates around this axis just above the ionized solid surface. The magnetic field lines from the strong magnetic field will follow the longitudinal lines in the vicinity of ionized solid surface. If the angular velocity vector of the circulating electrons points towards +ve Z-axis, then the associated strong magnetic field will point towards −ve Z-axis in the vicinity of the ionized solid surface.

A thin shell between solid ionized surface and the inner boundary surface of circulating electrons may be termed as Magnetic Interaction Shell (MIS). If any positive ion gets into this MIS and is moving along the direction of nearby circulating electrons, then by the action of Lorentz force it will get magnetically compressed towards the ionized solid surface. On the other hand, if any negative ion or electron gets into this MIS and is moving along the direction of nearby circulating electrons, then by the action of Lorentz force it will get magnetically compressed towards the circulating stream of electrons. That is, the magnetic Lorentz force acting on the inner layer of circulating electrons will counter the inward pulling force of solid surface ions as well as radially compress the stream of circulating electrons.

As the gravitationally in-falling matter passes through the circulating electron shell it tends to get dragged along through polarizing action. By the time it reaches MIS, it gets highly ionized and experience Lorentz forces in the MIS. Under the action of strong magnetic field, accreting positive ions will experience radially inward Lorentz force, thereby strongly compressing or squeezing the positive ions against the ionized solid surface. Thus, positive ions from the accreting matter entering the MIS zone will get pushed, or squeezed out under extreme compression, towards the polar regions to produce strong Jet of ionized matter flowing outwards along the magnetic field axis. If the ISISB is also undergoing rotational motion about its axis then quite often the magnetic field axis may not exactly align with the rotational axis and thus produce a sort of precessional motion of the ejected Jet.

However, under the action of strong magnetic field, accreting negative ions or electrons will experience radially outward Lorentz force, thereby strongly compressing the negative ions or electrons against the circulating stream of electrons. Thus, negative ions or electrons from the accreting matter entering the MIS zone will get pushed towards the polar regions, while still circulating around the inner flow of positive ions, to produce strong Jet of electrons flowing outwards on helical paths along the Jet of positive ions.

7.4. Magnetically Coupled Group of ISISB Located at the Galactic Center

An ISISB is characterized by its size, mass, ionic charge, temperature, magnetic field and the net positive charge. Due to its net positive charge, two or more ISISB cannot get merged together under any circumstances. Two or more ISISB can only get coupled through their magnetic fields when their gravitational, electrostatic and magnetic forces get balanced under equilibrium conditions. The magnetic coupling of two or more ISISB will be somewhat akin to the coupling of two or more bar magnets. The magnetic fields of two or more axially coupled ISISB will be parallel and will be anti-parallel for transversely coupled ISISBs. This way, a magnetically coupled group of ISISB will constitute a cubic lattice grid structure. The magnetic coupling of two or more ISISB can be compared with mutual coupling of two or more nucleons within an atomic nucleus. Two or more nucleons can never merge into one under any circumstances but they get mutually coupled into a stable configuration within a nucleus. That is why the name Galactic Nucleus is most appropriate for a magnetically coupled group of ISISB. Such a coupled group of ISISB will function as one composite entity, just like the atomic nucleus, for all gravitational, electrostatic and magnetic interactions with the surrounding interstellar matter and stellar bodies. It replaces the currently assumed hypothetical SMBH that are supposed to be located at the center of all galaxies.

7.5. Electrostatic Attraction between ISISB and Negatively Charged Stellar Bodies

Due to high concentration of ISISB in the central regions of all galaxies, there is a dominant electrostatic interaction between positive ionized solid stellar bodies and other stellar bodies that have acquired excess of negative charge. This will be an electrostatic attraction between net positive charge on groups of ISISB in the Galactic Nucleus and net negative charge on the other stellar body. From the observed motions of stars near the center of a galaxy the mass of the central body, inferred on the basis of Newtonian gravitation, is estimated to be of the order of $4 \times 10^6 M_{\odot}$. As such this central body is assumed to be the hypothetical SMBH with a mass $M_{gc} = 4 \times 10^6 M_{\odot}$. If a typical star, of about one solar mass M_s, is moving in the neighborhood at a distance R from this galactic center, then the magnitude of gravitational force between the hypothetical SMBH and the star in question will be given by,

$$F_{ng} = \frac{GM_{gc}M_s}{R^2} = \frac{6.67 \times 10^{-11} \times 4 \times 10^6 \times 2 \times 10^{30} \times 2 \times 10^{30}}{R^2} \tag{6.1}$$

If an equivalent force is to be produced by an electrostatic interaction between the AGN with net positive charge of Q_{gc} and the moving star with net acquired negative charge of q_s, then

$$F_{es} = \frac{k_e Q_{gc} q_s}{R^2} = \frac{9 \times 10^9 \times Q_{gc} \times q_s}{R^2} \tag{6.2}$$

where k_e is the electric constant $1/4\pi\varepsilon_0$. Equating F_{ng} with F_{es} from the above two equations, we get the product of Q_{gc} and q_s to be equal to about 1.2×10^{47} C^2. Assuming the net positive charge Q_{gc} on the central group of ISISB to be of the order of 10^{35} Coulomb, the net acquired negative charge of q_s on the moving star is required to be of the order of 10^{12} Coulomb.

Hence, it appears quite likely that the high-speed motions of stars in the vicinity of a Galactic Centre are governed by the electrostatic attraction forces between net positive charge of the Galactic Nucleus and net negative charge acquired by the orbiting stars. Even though electrostatic forces between ISISB and other stellar bodies are much more dominant than the gravitational forces, yet the acquisition of excess negative charge by stellar bodies through ionic gravitation, appears to be quite uncommon. As such the role of electrostatic forces on stellar bodies appears to be significant mainly in the central core regions of galaxies in comparison to outer regions.

8. Summary and Conclusion

As a founding assumption of Astrophysics, the well-known notion of electron degeneracy pressure has been shown to be wrong and invalid. Secondly, the use of hydrodynamic equation of state has been wrongly extended to check the stability of non-burning high pressure, high density solid stellar cores under self-gravitation. In situations of high core densities, atoms and ions will occupy relatively fixed positions and when the mean separation distance between atoms or ions becomes less than the normal size of their parent atoms, their electrostatic repulsion will force them into a lattice gridlock, leading to a solid state. All stellar compact bodies like White Dwarfs, Neutron Stars and Black Holes, are in fact Ionized Solid Core stellar bodies. The presence of ions in the peripheral regions of the solid core will be associated with the circulation of degenerate electrons around the surface, thereby producing strong magnetic fields in and around all such compact stellar bodies.

The mechanism of Newtonian gravitation is found to be quite similar to the mechanism of electrostatic interaction between a pair of opposite charges. However, the fundamental unit cell for gravitational interaction is the neutral pair of two opposite charges surrounded by intrinsic gravitational field of the neutral particle. Newtonian gravitational attraction between two or more neutral matter particles is basically a macroscopic phenomenon which cannot be extended to microscopic or quantum processes.

At the end of evolution cycle, stellar remnant of a star is invariably the central solid core which is highly ionized in outer regions and surrounded by a nearly spherical shell of circulating degenerate electrons. When bulk of the star material surrounding the central solid core gets blown away in shell explosions, a very small fraction of the circulating electrons may also get blown away. The remnant ionized solid core with circulating electrons will be left with an excess of positive charge. This positive excess of ionic charge in all solid stellar remnants becomes a source of Ionic Gravitation through the process of polarization of neutral atoms and molecules in stellar bodies. When some part of blown away electrons get caught in star envelopes, it becomes a source of electrostatic attraction between ionized stellar remnants and the stars with excess negative charge.

The compact stellar objects currently known as Neutron stars and Black Holes have been identified with ISISB. These ISISB are the primary constituents of AGN and are the source of all non-stellar radiation and Jets of ionized matter. Just like the nucleons in atomic nucleus, AGN constituent ISISBs, with excess positive charge and strong magnetic fields, can never merge into one another and keep getting accumulated in central regions of all galaxies. A group of ISISB can even get magnetically coupled to form the central Galactic Nucleus. Hopefully, all galactic gravitational anomalies and weird AGN properties can be explained by the special characteristics of ISISB, including Ionic gravitation, electrostatic interaction, Jet formation and non-stellar radiation.

Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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