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Trends of Stellar Evolution in Modern Physics[i]

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Abstract In this paper, it examines the trends of stellar evolution reflected in modern physics, identifying the uncertainties present in the established schemes. It explains that during spontaneous contraction of gas clouds the process of heating up cannot be replaced by cooling without qualitative changes in the structure of the clouds. It is shown that the luminous objects can be resistant to decay due to the gravitational interactions, even at low mass; that the outcome of stellar evolution does not yet have a clear description; that spontaneous gravitational contraction of gas clouds in space is largely concluded by the formation of structures resistant to gravitational forces. The recognition of structures resistant to the forces of gravity is a very important element of understanding, which will help in future theoretical research.

Keywords Stellar Evolution, Gas Clouds, Gravitational Interactions, Gravitational Forces, Gravitational Contraction

1. Common Sense and Modern Physics

Historically, the emergence of physics occurred as development of the mechanistic view of the surrounding world, associated with the description of mechanical motion of objects, which are affected by the physical interactions between objects (first, the objects must be identified according to certain rules in the physical system). The physical categories of "force" and "energy" appeared as a consequence of this approach. The mechanistic approach was built on the principle of causality made the perception of the surrounding world conscious and logical. It was based on cognitive mental pictures, which changed over time like a motion picture. The mechanistic interpretation was an indispensable requirement for explaining any new physical phenomenon, because it was subject to "common sense" due to the principle of causality laid down in it. Common sense in physics is a representation of a physical phenomenon using images that allow one to explain the essence of the phenomenon in a simple form.

The first problems with the mechanistic approach arose in Maxwell's attempt to give a physical interpretation to the new concept of "electromagnetic field". Maxwell's equations allow, knowing the charge densities and currents on the one hand and the geometry of the electric and magnetic field strengths at the initial instant of time on the other hand, to determine, as in mechanics, the mechanical state of the charge system at any subsequent time. The introduced concept of "field" was not just a mathematical technique. It was implied that the field is the real distribution of energy in the ether (the electromagnetic field carries energy, meanwhile it was suggested that the energy distribution in the space around the charge should be identified with equipotential surfaces in the elastic ether). This means that the theory of electromagnetism did not develop as an abstract theory, but as a tangible theory, albeit on a figurative level, but with a mechanistic interpretation. However, problems arose. First were Maxwell's attempts to explain the nature of the displacement current, introduced by him. But in fact, the main difficulty that Maxwell faced, which has never been highlighted by anyone as a problem until now, is the mechanistic interpretation of the sequential appearance and disappearance of electric and magnetic fields in the excited electromagnetic wave.

The final blow to the dominance of "common sense" in physics was dealt by the emergence of a new branch of physics – quantum mechanics. It was found that an elementary particle that has mass, somehow, in some unimaginable way, acts in experiments not only as a corpuscle but also as a wave. At the same time, the corpuscular theory is fundamentally incompatible with the wave theory (successive wave and corpuscular theories are mutually exclusive thus it is impossible to create a singular corpuscular-wave theory). For this reason, quantum mechanics needed to allow a free passage from the mathematical apparatus of one theory to another. This decision made it possible to describe and predict many external manifestations of atoms and molecules. However, the world of elementary particles was still beyond understanding. Not only the essence of elementary particle as entity, but the mechanisms of realising the external manifestations described by quantum physics also remained outside the scope of understanding. After numerous attempts to bridge the gaps in understanding of the intrinsic nature of elementary particles (for example, an attempt to present an elementary participle in a form of a wave packet) it was suggested that we accept and recognize that we cannot even roughly guess the essence of the participle, it is beyond our understanding. The quantum theory was based on the theory of probability. However, probability theory cannot carry a physical meaning, it is only a mathematical description of the manifestation of some unknown physics. Therefore, with modern basic knowledge, the microcosm in its interpretation in physical terms is still fundamentally incomprehensible even now. The theory of the quantum field, although it started to directly identify elementary particles, did not solve the indicated problem either. The field functions in the theory of a quantum field have the same indefinite interpretation in physical terms as the standard wave function in quantum mechanics (quantum mechanics is a special case of quantum field theory for low energies in comparison with the rest masses of the particles under consideration).

The crown of disregard for "common sense" was theoretical physics, which separated into an independent branch of physics in the twentieth century, in which the criterion of truth is based on the mathematical proof and the physical interpretation is then accorded with the existing proof. In other words, in the framework of theoretical physics physical models are not built on the basis of the accumulated experimental data, followed by mathematical justification but are made to fit the already existing mathematical structures. This degree of abstraction, which replaces physical models with mathematical ones, has taught modern scientists not to delve into the physical essence of natural phenomena, but to be content with only a mathematical description of the processes being studied.

Thus, a negative tendency of negligence towards describing physical phenomena in physical terms has developed over time in modern physics. Since astronomical sciences are based on physics, the described negative tendency also began to manifest itself in them. For cosmic objects and processes occurring in space many nuances of logical interconnection based on physical concepts began to be overlooked.

2. Common Sense and Astronomical Sciences

The most obvious and unambiguous example of a disparaging attitude in astronomical sciences to a complex analysis in physical categories is the erroneous identification of the cosmic microwave background as the relic presented in [1]. It is only possible to describe the photon gas, the elements of which do not interact with each other with exchanging momentum and energy in terms of thermodynamic laws in the special case when the photon gas is in equilibrium with the substance. A free photon gas that does not interact with matter (that is, photons are isolated in a closed physical system) is not a thermodynamic system and has no right to be described by the laws of thermodynamics. But due to the historical circumstances described in [1], the background microwave radiation detected in space was recognized as a set of photons capable of independently reducing their energy.

Recognition of the microwave background radiation as a relic is, in fact, the basic position in cosmology. Therefore, the scientific directions which are currently developing in modern cosmology are at a stalemate. Particularly the theory of cosmological inflation is based on this recognition and it is only for this reason that it cannot be correct. Moreover, in physical terms, the basis of the theory of cosmological inflation, as demonstrated in work [1], is so contradictory that continuing development of this scientific direction is more surprising.

Another theoretical negligence in the conventional explanations related to the incompatibility of the model of the hot Universe and the Hubble distribution is highlighted in work [2]. But it is the recognition of their interdependence that allowed us to combine the Big Bang model of the Universe and model of the Hot Universe into a generally accepted theory of the "Big Bang", modifying the original understanding of the model with the same name (the accelerated expansion of the Universe was not been discussed at the time). Works [1, 2] together testify to the fallacy of the accepted theory of the birth of the Universe.

Since gravitational forces prevail in space, modern cosmology is based on gravitational effects. Although, as described in [3], there still is no complete understanding of the nature of gravity, however, to understand the observable displays of gravity it is enough to have a description of the gravitational effects in the framework of classical gravity, which is based on Newton's law of gravity in combination with the principle of superposition. The laws of classical gravity, under certain border conditions, must follow from any theory of gravity, regardless of what axioms, associated with the nature of gravity, it is based on.

At first glance, it seems that the laws of classical gravity have been so well studied and understood that it is impossible to find anything new in their description. However, in the same paper [3] based on complex analysis in physical terms, i.e., on the basis of common sense, it was shown that the explanation of the discovered accelerated dispersal of galaxies follows directly from the classical theory of gravitation. This means that it is not necessary to introduce "dark energy" as a new category of science to describe the accelerated expansion of the Universe. A premature introduction of a new entity, a new category into the theory is not permissible according to the principle of the Occam's blade and essentially hinders the development of science. Another conclusion of the study is that the

Universe has a massive halo.

The same conclusion about the existence of the halo of the Universe was reached in [1] although the article started from an independent initial point. Together the arguments in [1-3] allow us to conclude that the basic concept of the appearance of matter from energy in the process of the birth of the Universe is in violation of the principle of symmetry, when antimatter disappears in the process of annihilation and the remaining matter becomes homogenous plasma, is erroneous (see [2]).

All the previous works looked at the fundamental questions which form the basis of astronomical sciences. But, as it turns out, in addition to the problems raised in [1-3], there are still many deep-rooted uncertainties in conventional explanations. It comes down to the poor understanding of the nature of processes that occur in space. Moreover, no matter how absurd it may sound, the main reason is the understanding only the overall effect of classical gravity without considering the nuances of the dynamic processes of gravitational interactions. In other words, ambiguities in the description of cosmic phenomena arise from the negligent attitude to the mechanistic interpretation of the accompanying physical phenomena in physical terms, i.e., in the form of a mental images.

For example, it is obvious that spontaneous gravitational compression of a cosmic cloud leads to the heating of its central zone, and that with increasing average temperature of the cloud, its energy losses to outer space increase. However, the sequence of events is very important here: first, gravitational forces warm up the cloud, and only then, as a result, losses increase (uninsulated physical system). Therefore, in the absence of qualitative changes in the structure of the cloud, the growth of the cloud temperature must continue indefinitely, regardless of the initial mass of the cloud. Use of mathematics for this conclusion is not required. Such logic is perceived by modern scientists as self-evident for heavy space clouds. However, this does not seem to be the case for light clouds. For example, it is obvious that red dwarfs, while thermonuclear fuels are burning, cannot cool down, even when the fuel depletion time is approaching. Likewise, brown dwarfs cannot cool down, unless degeneration of the electron gas has already occurred at the point of time. Even more so they cannot change their initial heat to cooling even lighter self-contracting gas clouds, while they remain gas clouds.

Many issues associated with the need to clarify the foundations of cosmology and astrophysics will be discussed in subsequent articles. This work is dedicated to the white spots that remain in the current understanding of stellar evolution. The relevance of this work lies in the fact that the white spots are out of the field of vision of the scientists, it is almost like they do not exist. Accordingly, no attempts have yet been made to give a more in-depth description of the schemes of the relatively obscure stages of stellar evolution, and to understand the principles of the occurring phenomena.

The modern basics of the structure and evolution of stars is discussed in D.K. Prialnik [4].

3. Aims

This paper describes, analytically and in less detail, the accepted theoretical chains of possible direction of stellar evolution. In the course of the analytical review the existing problems are identified. First, an overview of existing base principles in the theory of gravitational compression of gas clouds is presented; then it is explained why it is desirable to deepen the contents of fundamental concepts; and the meaning of the new physical category "absolute stability to gravitational forces" is presented. Incidentally, the principle of forming luminous objects resistant to decay in Earth's environment, which have been recorded in observations, but are not yet amenable to theoretical description, is indicated.

If it is possible to make astronomical observations to trace the final steps of evolution of the spontaneous contraction of heavy gas clouds, then for the spontaneously contracting light gas clouds these observations cannot be carried out in the volume and quality that would be acceptable. The fact is that the heavier clouds in the categories of light spontaneously contracting clouds have a long life and have not yet reached the end of their evolution in the life path of the Universe, and the lighter spontaneously contracting clouds from the category of light clouds are difficult to observe. Therefore, the end of the evolution of the light contracting gas cloud is still only simulated by computers. But in the computer modeling process it should not be forgotten that clouds, contracting as they heat up, cannot achieve a stable condition or convert heating into cooling, regardless of the weight of the considered cloud (cooling gas clouds, if they have ever been in the process of spontaneous contraction and self-heating, cannot exist in principle).

The purpose of this work is to highlight the uncertainties, based on the analysis in terms of physical concepts, that still exist in the modern description of stellar evolution and to provide guidance for theorists to study the patterns of the life stages of stars in more detail.

4. A Visual Interpretation of the Theory of Gravitational Compression of a Gas Cloud

The mathematical model is usually complied with the process of describing any physical phenomenon. Gravitational compression of a gas cloud in outer space is characterized by two oppositely directed processes: compressive forces grow in the process of compression of the cloud (with a reduction in the distances between constituent gas cloud elements), but the released gravitational energy leads to an increase in the gas pressure, which exerts resistance to compression and tends to expand the cloud. The pressure growth for any compression conditions is usually expressed using the polytrophic law: $P = k\rho^\gamma$, where P and ρ are the gas pressure and density, k is a constant and γ is the polytrophic index which depends on the compression properties and the composition of gas. For example, if an ideal gas is compressed with simultaneous heat removal (isothermal compression), then the polytrophic exponent will be equal to one, because the gas pressure will be proportional to its density. When the adiabatic compression of ideal gas occurs with no heat exchange with the surrounding medium, $\gamma = 7/5$. With varying degrees of accuracy, the polytrophic law describes various compression conditions, including those with variations in the composition of the gas. The increase in pressure in terms of power-law dependence during its compression occurs as a result of the release of the gravitational energy that does work and always tends to equal the parallel growth of gravitational forces. It was found that for $\gamma = 4/3$ the gas cloud turns out to be in an indifferent equilibrium between repulsive and compression forces, i.e., when the size of the cloud changes, it does not tend to either compression or expansion. For $\gamma < 4/3$, the gas cloud will be unstable with respect to compression (gravitational forces will dominate over repulsive forces, so the gas cloud will shrink either before the explosion with the scattering of matter, or until a structure stable to gravitational forces is formed). For $\gamma > 4/3$, the gas cloud will be stable with respect to compression, but will tend to expand. These relationships provide a good basis for understanding the occurrence of gravitational collapse, but do not allow us to understand the process of gravitational compression (factors that affect it). In addition, an important factor that significantly affects the dynamics of the processes occurring is the boundary conditions. Therefore, let us consider the process of gravitational compression of a cloud in outer space in terms of a visual interpretation.

According to the law of universal gravitation, the force of gravitational interaction between two particles is proportional to their masses and inversely proportional to the square of the distance between them. Suppose we have a cloud of N particles with the same mass m, which has already taken a spherical shape, the temperature of the cloud is close to absolute zero and the density is approximately the same throughout the volume. Let us choose one element on the outer sphere of the cloud. The gravitational attraction force acting on it from all other (N–1) particles according to the principle of superposition will be proportional to $(N-1)m^2/R^2$, where R is the radius of the cloud. If the length of the path of the particle under consideration before its collision with another particle is denoted by λ, and taking into account that for a large number of elements $(N-1) \approx N$, then the increase in the square of its velocity $\Delta(v^2)$ will be proportional to the following value (from the energy conservation law, the increase in kinetic energy of a peripheral particle is equal to the work done on it by the gravitational forces of all particles of the cloud; meanwhile the work is equal to the product of the force acting on the accelerated peripheral particle and the distance traveled):

$$\Delta(v^2) \sim Nm\lambda.$$

If the momentum of the peripheral particle created by gravitational forces was transmitted through perfectly elastic collisions of internal particles towards a diametrically opposite particle, then the cloud would have a maximum compression velocity under the influence of gravitational forces. This would happen because the transmitted pulses from the oppositely-interacting particles would have extinguished each other in the central zone of the cloud. But in fact, the impulses of peripheral particles created by gravity are not transmitted in the radial directions, but create and increase the chaotic motion of the cloud particles in the processes of perfectly elastic collisions at different impact distances and different directions of motion of the cloud elements.

Undeniably, the forces of attraction towards the center of mass of the cloud act on all particles of the cloud. For a visual interpretation, it is permissible to accept that the gravitational effect is produced only on peripheral particles. However, this does not mean that the work done by the forces of gravity consists of portions of energy spent on accelerating the peripheral particles for their passage over smaller and shorter distances of their range λ_i, until the initial length of the cloud radius is exhausted. Distance traveled by the peripheral particles is not equivalent to decreasing the radius of the cloud: while work is done on the peripheral particles before they collide with the "inner barrier of the cloud," they are replaced by other particles from the inner zone of the cloud that in turn become peripheral particles. Conditionally, at the moment of collision of external particles with internal particles, the gravitational forces from internal particles cease to act on the former peripheral particles, except for their gravitational interactions with newly formed peripheral particles. Therefore, it is almost like the gravitational acceleration of peripheral particles towards the center of mass of the system is repeated many times, but the received pulses are not extinguished in the inner zones of the cloud and are not reflected back to the original peripheral particles, thus compensating for the work of gravitational forces, but accumulate in the inner zone. A randomness appears, in which collisions of particles are similar, perfectly elastic and, consequently, undamped. These interactions of particles with each other tend to redistribute their individual kinetic energies in such a way that for each unit volume of the gas cloud the total kinetic energies of all particles of each unit volume are equal.

If the described distribution of the kinetic energies of elements occurs in a multielement system with undamped interactions, it comes to equilibrium and becomes a thermodynamic system for which the laws of statistics are applicable and which can be characterized by statistical parameters, such as temperature, pressure, entropy, enthalpy, etc. Small perturbations of the thermodynamic system disturb it and force it to move towards a new state of equilibrium. Strictly speaking, in transitional periods the system ceases to be thermodynamic and cannot be characterized by statistical parameters. But if the system reaches a new equilibrium, then, under certain assumptions, the state of the system in transient processes can also be characterized by statistical parameters.

Gravitationally self-contracting gas cloud does not reach a new equilibrium state, but constantly tends towards it. Therefore, it is possible to characterize it by thermodynamic parameters. The increase in pressure of the gas cloud essentially impedes the process of gravitational compression, pushing the peripheral particles back to the periphery and causing the system to strive for equilibrium. However, some internal particles do not encounter gravitationally attracted external particles, and take their place on the periphery, allowing the system to do work on its new peripheral elements. Meanwhile, the peripheral particles initially accelerated by gravitational attraction did not yet have time to distribute the energy they acquired between all other elements of the system. It is for this reason that the gas cloud cannot reach the state of equilibrium, it only constantly strives for it. Moreover, the equilibrium point is continuously shifting. This, in turn, means that for a gravitationally self-contracting gas cloud, a theoretical inevitability of unlimited self-heating arises. The internal forces of gravity, while the cloud continues to be in a gaseous form, always do work, remaining active forces and not turning into potential forces.

Thus, in the absence of losses, the forces of gravity purposefully increase the kinetic energy of the elements of the gas cloud in their chaotic motion, increasing the pressure and temperature of the cloud. At the same time, the growing pressure in the cloud cannot counteract the forces of gravity and stop compression due to following the statistical laws that violate symmetry and prevent the extinction of the effects of gravitational compression. In fact, statistical laws allow the forces of gravity to do work, transforming the negative potential energy of the gravitational internal field into positive internal energy of the cloud for perpetually long time while the laws of statistics for the gas are operational. To be more precise, we are considering a closed isolated system, so the internal energy of the cloud should remain constant. However, the term "internal energy" is not rigidly defined in physics, and the constituent parts of internal energy can vary depending on the problem under consideration. In statistical physics, the movement of the elements within a system is usually included in the composition of internal energy. Therefore, with the total energy of a closed isolated system unchanged, its internal energy can change.

So, on the one hand, the laws of physics make it possible for the gravitational forces to be realized, but, on the other hand, they constantly slow down the compression process, by trying to expand the cloud. Moreover, the increase in the energy of resistance to compression (increase in internal energy) always loses to the released gravitational energy, because it is a consequence of gravitational compression. Therefore, the geometric dimensions of the cloud inevitably decrease. The average free path continually decreases with a decrease in the size of the cloud and a constant number of its constituent particles. The limit of compression for a closed and isolated system is a singular point with infinitely high pressure and temperature. However, considering that temperature and pressure cannot be infinitely large simultaneously, in practice certain effects that prevent the realization of a singular state must inevitably arise.

It is interesting to note that there might in, a statistical distribution, be particles with velocities greater than the second cosmic velocity, which will be able to leave the cloud. Then an evaporation process will appear, and the system will no longer be closed. If there were no losses from electromagnetic radiation, the processes of evaporation would have become essential for a self-contracting gas cloud under the influence of internal gravitational forces. But this topic is beyond the scope of this analysis.

In an isolated system, the gravitational acceleration of particles in the system increases the average kinetic energy of the cloud particles, directly increasing its temperature. The increase in temperature leads to an increase in internal pressure, which characterizes the emerging resistance to gravitational compression (the forces of pressure are inclined to balance the gravitational forces). Based on the principle of energy balance, the increase in pressure must be such as to balance the process of gravitational contraction, i.e., the compression process should stop. However, in this case, the system reaches a state of an unstable equilibrium. Since the increase in pressure is a consequence of the release of gravitational energy, the system, as mentioned above, does not reach a stable equilibrium state: the equilibrium point is constantly shifting. It turns out that although the laws of statistics are inherently always aimed at the unprompted achievement of the equilibrium of the system (this is their nature), in the case of gravitational interaction, these same statistical laws unexpectedly begin to interfere with the establishment of equilibrium. If we change the initial conditions by first supplying the isolated, closed system with a small portion of external energy at a speed which is needed for the gravitational forces to do work on a particular cloud without supplying energy, the portion of the supplied energy will cause the cloud to expand. However, the forces of gravity will resist this expansion. In this situation, it is not the pressure of the cloud that will exert resistance to the forces of gravity, but the forces of gravity will fight against the pressure. Therefore, the same initial cloud, with the changed initial conditions around the equilibrium point, will no longer be continuously compressing, but continuously expanding (the expansion will occur with a decrease in the average kinetic energy of the elements of the cloud, i.e., with its cooling). This is what is meant by instability of the equilibrium point for the considered closed system.

The existence of losses with electromagnetic radiation the self-contracting cloud, under the influence of internal forces of gravitation, changes the dynamics of a non-isolated system in comparison with an isolated one. The outflow of energy from the system does not allow gravity to raise the temperature of the shrinking cloud to the same extent as in the absence of losses. For greater clarity, we agreed to consider a cloud with initial temperature close to zero. And this means that the losses from the cloud with electromagnetic radiation were close to zero. During an arbitrarily chosen initial time interval, the cloud will heat up due to gravitational compression. With an increase of temperature there must be losses. The resulting energy losses, according to the law of conservation of energy, cannot exceed the produced heating. Moreover, first the temperature rises, and only after that, the losses that depend on temperature increase. For this reason, the temperature of the cloud must rise, regardless of the type and mode of implementation of spontaneous losses. However, the rate of growth will be less than in the absence of losses. And this means that it becomes more difficult for the gas cloud to reach the point of an unstable equilibrium, since the rate of growth of the resistance to compression decreases.

When analyzing the process of gravitational compression of a cloud, one must consider that the internal pressure of a gas cloud depends not only on its temperature, but also on density. Therefore, the presence of radiation losses allows the gravitational forces to compress the cloud more effectively per unit temperature increment. The active growth of the density of a gas cloud with a moderate increase in its temperature in the end leads to degeneracy of the electron gas, i.e., to a qualitative change: the system ceases to be a gas cloud and to be an "ideal" thermodynamic system (the laws of statistics always lead to an equalization of specific internal energy content occupied by the system around the volume, which for the "ideal" thermodynamic system is inevitably accompanied by processes of mass transfer). Furthermore, it is obvious that the process of degeneration is inevitable not only for heavy clouds, but also for light ones, if conditions that allow the process of spontaneous compression under the influence of internal forces of gravity apply. This is a new conclusion. Although it was obtained without a mathematical justification, but it follows from "common sense", from the logic of cause-effect relationships in physical terms, thus, must be true. The goal of this paper is not to create models, but to identify problems and formulate the requirements for the solution.

Unstable equilibrium is not a theoretical assumption, it can be encountered in practice and takes part in the evolution of all stars when thermonuclear reactions are ignited at a specific stage of gravitational compression of a gas cloud, compensating for losses from a cloud with electromagnetic radiation (strictly speaking, all types of energy losses are compensated, but this is irrelevant in the case of schematic arguments). By engaging internal sources of energy, which is simultaneously an external source for the considered physical system (total of the elements of the gas cloud), of the cloud, the uninsulated system becomes isolated, because the outflow and inflow of energy from and to the system become equal. Moreover, the process of cloud compression stops completely, and the stability of the unstable equilibrium point of the system is monitored by automatic regulation of the intensity of the energy source.

Based on the pattern described above (the law of proportionality between the increase in the square of the velocity of the gravitationally accelerated peripheral particle and the mass of the cloud Nm), it follows that the larger the initial cloud (N), the more effective the acceleration of the peripheral particles of the cloud by gravitational forces. However, since the increment of the pulse obtained by the peripheral particle during the gravitational action on it is ultimately distributed between a large numbers of particles, it is impossible to draw a conclusion about the vigorous heating of the cloud in the process of gravitational compression in a heavy cloud. Such a conclusion is possible only for strict, and not for simplified analysis.

Individual conclusions can, nevertheless, be drawn in the framework of a simplified analysis. For example, it can be seen from general consideration that for certain acts of cloud perturbations, like local excretions of portions of external energy, the effect of disturbances on a large cloud is distributed to a larger number of its elements and becomes less influential on the cloud as a whole. This important but obvious fact will help, henceforth, to understand the cause of the appearance of various directions in the evolution of self-contracting gas clouds, depending on their initial masses.

Another example of schematic reasoning could be that the temperature of the compressing gas cloud rises towards the central zone, and the radiation losses under certain conditions can be determined only by the temperature of the outer layers. Therefore, it is possible to assume that there are cases when the extreme level of self-heating of a heavy cloud proves to be higher in comparison with the self-heating of a light cloud.

If two arbitrarily light particles are placed in an empty space next to each other, then however arbitrarily small will the gravitational forces be, they will certainly manifest themselves and cause the particles to spontaneously move towards each other. Under Earth conditions, the gravitational field of the planet inside the vacuous installation can be considered homogeneous and stationary, i.e., not interfering with the presence of mutual gravity of two adjacent particles. However, the arising gravitational forces are so small that it is impossible to ensure the purity of the experiment in practice. However, if the volume with a rarefied gas is strongly compressed in a vacuum and the compressing shell is removed, then the gravitational field of the compressed particles can be sufficient for their retention in the gravitational interaction with each other. Then, compressed by an external force, the gas will continue its compression already unprompted, having turned into a plasma clot, after a certain time. The pressure inside the plasma clot can be sufficient for its exit from the vacuum chamber into the environment with atmospheric pressure, so that a "phase boundary" of the cluster is formed.

It is possible that the unexplored luminous objects, found in Earth's atmosphere, are connected with these types of plasma objects (often observed in the troposphere of Earth: in the upper layers during ionospheric disturbances, geomagnetic storms, auroras; in near-surface layers over the cracks in Earth's crust or during earthquakes – in these cases the luminous objects seem to float straight out of the earth; sometimes tornadoes and, in extremely rare cases, thunderstorms). But in Earth conditions these objects interact with matter that surrounds them, that is why they do not reach their evolutionary completion and destruct before their natural death or stabilization. If a light gas cloud contracts in outer space, it is not yet known to science how its evolution cycle will end. It isn't known, simply, because nobody has asked the question until now. But, as follows from the above analysis, the final stage of evolution of any self-contracting light gas cloud is the same: the degeneracy of the electron gas.

5. General Assumptions in the Theory of Stellar Evolution and the Existing Problems

The evolution of stars is associated with self-contracting clouds, which are mostly made up of hydrogen gas. The presence of other chemical elements and dust, created by earlier stars, in the cloud, the principles of origin of the stars and their evolution, discussed below, do not change dramatically. The particles of a gas cloud do not unite for the reason that there are forces of repulsion, leading to elastic repulsion of particles. Precisely due to the forces of repulsion the notion of "the internal energy of a thermodynamic system" appears. The nature of the appearing forces of repulsion is always connected with electromagnetic interaction. In astronomical sciences, the term "gas clouds" should be understood as any cloud that obeys the statistical laws of the gaseous medium, including ionized, but taking into account the characteristic features for each particular case under consideration.

The process of compression of a hydrogen cloud in outer space, if we consider the compression conditions to be ideal and undisturbed by processes of turbulence, primarily depends on the initial mass of the self-contracting cloud Due to various physical effects, the principle is realized in space: the heavier the initial mass of the cloud, the higher the maximum temperature reached as a result of the self-heating of the cloud.

At a certain stage of the gravitational compression of the cosmic cloud, due to the increase in the density and temperature of plasma in the cloud thermonuclear reactions are triggered, which release energy (thermonuclear reactions are threshold reactions). The energy released in thermonuclear reactions tends to expand the cloud. In heavy clouds, the forces of gravity are so strong that they are able to support the conversion of hydrogen into helium using carbon, nitrogen and oxygen isotopes as catalysts. With a decrease in the initial mass of the cloud, a proton-proton chain reaction is realized in which helium is generated at a lower effective temperature. Such a transition is not at threshold, and a decrease in the temperature of the cloud with a decrease in its initial mass is not stepped, but occurs smoothly.

The lower the initial mass of the cloud, the more sensitive it is to individual acts of thermonuclear fusion, which begin to noticeably inhibit the gravitational compression of the cloud. The inhibition of the rate of decrease in the radius of the contracting cloud leads to a deceleration of the growth of the density of the cloud, which the probability of occurrence of individual acts of thermonuclear fusion is subject on. Therefore, with a certain level of reduction in the initial mass of the cloud, the energy released from the thermonuclear reactions of protons with cloud impurities (lithium and deuterium), for which the lower initial energies of the colliding nuclei are allowed, it is sufficient to delay the gravitational compression of the cloud, and the proton-proton helium generation cycle ceases to take place at all. Here, it is important to understand that the reason for the end of compression and the increase in temperature of a light cloud is not the insufficiency of gravitational forces to further heat the compressed gas, but the abundance of the energy released through combustion of impurities to stop compression.

But for most theorists, due to the abolition of the tradition of producing cause-effect analysis in physical terms, the dependence of the energy release of a compressing gas cloud on its initial mass (the initial mass function) began to be perceived as a characteristic of the ability of cosmic clouds of various masses to self-heating caused by the very nature of gravity: the larger the initial mass of the cloud, the higher the potential capacity of the forces of gravity to warm the cloud. Moreover, it is forgotten that under continuous gravitational compression the temperature of the self-contracting cloud would increase unrestrictedly for any gas cloud with any initial mass, if some of the compression-inhibiting factors were not included in the work. The restrictions on the degree of compression and self-heating do not appear due to the weakness of the gravitational forces of the light clouds, but because of the existence of factors constraining the gravitational compression, dependent on the initial mass of the cloud and affecting the dynamics of compression.

It is useful to note that regardless of the types and schemes of the thermonuclear reactions that arise in the course of gravitational compression, including the burning of cloud impurities without the occurrence of a proton-proton cycle, the Lawson principle, which states that for the stable maintenance of thermonuclear reactions, it is necessary to fulfill the energy balance: the volume of energy released in thermonuclear reactions should be equal to the withdrawn energy from each unit of volume, is always realized. It is the energy balance that allows the gravitational forces and thermonuclear reactions to self-balance (the resulting thermonuclear reactions seem to be controllable). Of course, we should not forget that when determining the plasma confinement time, one must consider not only radiation losses, but also energy losses with mass.

Thus, if the self-contracting gaseous cloud is self-heating and is in a vacuum (i.e., is a non-insulated system because of the inevitable losses due to electromagnetic radiation), then it cannot stop its compression, while it is still in gaseous form, regardless of the changes in chemical composition of its constituent gases, and has to continue to heat up continuously, regardless of the weight of the cloud and its current temperature. No other options exist. There are only cases of a slow rise in temperature. However, this provision is often contradicted in literature.

The need to take into account the principle of the inevitable growth of the average temperature of a self-contracting gas cloud can be illustrated by the following example. With the depletion of hydrogen reserves of any ordinary star, like the Sun, the forces of gravity inevitably take over and renew the process of star compression. At this point, the nucleus of the star is almost entirely composed of helium. At the beginning, with the attenuation of thermonuclear reactions in the core of the star, the peripheral layers of hydrogen ignite. This result in the temperature increase of helium accumulated in the central zone. After some time, thermonuclear reactions are initiated in helium. The increasing pressure in the center of the star inflates it, and it turns into a red giant. Transformation into a red giant is possible only for a star with a certain remaining minimum mass by the time of hydrogen burnout, because the forces of gravity must be able to support thermonuclear reactions with helium, counteracting the energy released in these reactions. The effective temperature of the red giant inevitably drops because enlarged outer layers of the star cool due to an increase in the surface area of radiation. However, the energy loss from the star, as long as it remains gas, cannot decrease. For this reason, the overall luminosity of the red giant is about the same as the luminosity of the star that generated it. Therefore, the term "cooling of the star" in this case is erroneous and conventional.

Another possibility of hindering the self-contraction, accompanied by self-heating is the emergence of a qualitative leap that would change the considered model of self-compression of gas cloud. To date, only two options for initializing a qualitative jump in a self-contracting gas space cloud are known: the degeneracy of the electron or neutron gas.

For the reasons outlined above, the first stage of spontaneous contraction of a cosmic cloud the so-called Kelvin contraction takes place, which constantly heats up the cloud. Meanwhile, the average density of a gas cloud increases, the distance between the gas particles, on which the forces of gravitation depend in squared terms, decreases, and the work of gravitational forces required to increase the internal energy of the central zone of the cloud grows. At the same time, the average pressure and temperature of the gas cloud increase, as do the losses due to electromagnetic radiation.

From a specific point of time the Kelvin contraction with its mechanism of resisting contraction, scarce per se, and more so because of the existing losses with radiation, for big gas clouds is supplemented by the mechanism of compensation of the losses into the environment connected with the reactions of thermonuclear synthesis, that is, a star is born. Today it is customary to call cosmic objects, in which thermonuclear reactions occurred even briefly, stars.

The start of the thermonuclear reactions changes the dynamics of a contracting gas cloud in the following way: if the energy of the thermonuclear reaction is not sufficient for compensation of losses with electromagnetic radiation, the contraction will continue but will be less intense; if the losses and energy-release are equal in thermonuclear synthesis the cloud will be fixed in its size; with excesses in energy-release of the thermonuclear synthesis the cloud will expand. But the stars ignite controlled thermonuclear reactions: excess contraction leads to excess energy-release in thermonuclear reactions, and the cloud begins to expand, but the thermonuclear reactions become weaker as the cloud expands. As a result, the energy of thermonuclear reactions does not work against the gravitational forces, and only compensates for the losses due to radiation in doses. That’s why the internal pressure begins to fully and sustainably compensate for the gravitational forces, the dynamics of the processes of the star stabilize, neither contraction, nor expansion of a gas cloud taking place, the star, as long as the fuel burns, becomes stable, the gravitational forces do not do any work. If we ignore the complex processes associated with heat-mass transfer of a star that are connected with losses of mass and with the inversion of the temperature gradient and so on (formation of photosphere, chromosphere and corona, convection, shock waves, photon pressure bearing in mind the Doppler effect, etc.), then after the exhaustion of the stock of the thermonuclear energy, the active process of contraction will inevitably start again. This is a very important point that is always considered in all existing models of stellar evolution, if we ignore certain statements, like that red and brown dwarfs gradually cool down as the stocks of thermonuclear fuel deplete (stars can become dim, but not cool down). And in some models, without proper reasoning, it is even considered as a matter of fact, and as not requiring special attention that it is possible to change the self-contraction into dispersion (especially for the lightest gas clouds).

However, any fuel, even a high-energy thermonuclear fuel will eventually run out. As the forces of gravity in the cloud act constantly, for the process of contraction to end either an appearance of a structure resistant to gravitational forces is needed or a complete dispersion of the matter is required. If there are no questions about the dispersion of substance in theory and observations, there is a lot of uncertainty about structures resistant to gravitational forces.

Firstly, we know that the electromagnetic forces of the elements of a substance, in its solid state, which determines its permanent spatial form, fully compensate for the forces of gravitational compression, i.e., gravitational forces do not do any mechanical work and are unable to raise the temperature of the object, even though the gravitational field remains spatially distributed within the structure of the object as a potential field. This includes the fact that the gravitational forces are unable to raise the temperature of the multiphase incompressible objects such as planets, and maintain higher temperatures in their central areas. Therefore, if conditions are created for insignificant losses of energy into the environment from the formed stable structure, in comparison with its internal energy, the formed structure, characterized by the parameter "temperature" will definitely, gradually and unprompted become isothermal. Any convective processes, if they do not create favorable conditions for the release of energy from the limited supplies of a particular type of fuel can only equalize the temperature in their physical nature. However, for unknown reasons, this fact is ignored by astrophysicists (this problem will be discussed in a separate paper).

Secondly, for some reason it is forgotten that even in the theory of stellar evolution the structures resistant to compression do occur, they are "degenerate" structures and their density is independent of temperature. But at the same time, it is believed that such structures cool down, i.e., they can be characterized by the "temperature" parameter and allows its decline. If in the first case we are talking about the fact that the temperature of the object cannot increase due to forces of gravity, because, in fact, the forces of gravity do not perform any mechanical work, i.e., negligence present in one form or another in almost all modern astrophysical models of the evolution of planets, then, in this case, a rather important fundamental physical question has been raised: why the approach to the theoretical description of degenerate systems is the same as the description of thermodynamic systems when a degenerate system ceases to exist as thermodynamic one? Even if no current data is available to help understand the physical nature of the new form of matter, it does not mean that the new physical object should continue to be described in terms of "pressure" and "temperature", which are fundamentally inapplicable to it.

6. Absolute Resistance to the Forces of Gravity

The concept of resistance to gravitational forces in the theory of gravitational contraction does not exist, but it would be desirable to introduce it for the following reasons.

Firstly, not only can a proton and an electron be absolutely stable, that is, existing for an indefinitely long time without changing their characteristics in vacuum, but also a complex system can. Including systems related to space objects. At the same time the infinitely existing, without changing its internal state, space object or space system, eventually represents the final step of the evolutionary chain of various astrophysical processes.

Secondly, due to the shielding effect of electric fields and the large masses of space objects, forces of gravity prevail in cosmology, it becomes unacceptable to disregard them. The evolution of stars and other celestial objects is determined by gravity. When it comes to structures that are resistant to gravity, the paramount importance is given to the unalterable nature of the geometry of these objects. But it is only possible to say that an object is definitely stable when it retains its geometry until the completion of all the transient processes, i.e., when it achieves equilibrium, with its internal parameters which do not change over time. Naturally, the energy balance of the inflow and outflow to and from the object, when determining its resistance under specific environmental conditions, must be zero. Resistance to the forces of gravity is a special case of stability in the general sense.

Thirdly, there are structures that exist in the scale of space but are absent in Earth conditions. They are degenerate structures "neutron and electron gas". The question of resistance of these structures to the internal forces of gravity is not as trivial as it seems at first glance. There is the traditional approach: there are four types of fundamental interactions, one needs to compare the contribution of each in the case of their joint presence. But the degenerate systems may violate this approach. A suitable analogy: the absence of electromagnetic radiation from an orbital electron of an atom. It is only possible to explain the observed effect after expanding current fundamental knowledge. This situation is similar to what happens to the degenerate structures: it is possible that they stop being any form of aggregate material, and move into a new category of their existence, similar to the forms of "elementary particle" and "molecule". Perhaps not, but, in any case, it is a subject for future research, the need for which should already be recognized today.

There are two possible options of stability of any real substance or combined substantial objects. Absolute resistance of the closed but not isolated, located in an infinite empty space, system that completes the evolutionary path of any previously known form of existence through unprompted processes, as well as the simple resistance, which occurs when the artificial creation or spontaneous formation of certain boundary conditions exist. In other words, the discussion about absolute stability can take place only when the specific system is located in a vacuum with no other objects in and external radiation in its vicinity, and in all other cases we can talk about simple stability.

In general, it is quite possible to allow for a completely sustainable system to absorb external energy. If the system has a single equilibrium state, then, after it receives a portion of the energy, it must spontaneously return it to the environment (to the vacuum), by returning to its original state of absolute stability. Prior to achieving stability, when the losses to the environment stop, the system should be considered as being in an excited state. Often the process of returning the excess energy to the environment takes place discretely and with a time delay. But in any case, a return of excess energy occurs, and does so spontaneously. Determination of the excited state of the system has traditionally been related to such cases. The process of simple approaching of the stable state in the continuous process of energy expulsion is usually not related to the excited state of the system, though it is inherently linked to "excitement" of the system, rather than the accumulation of "internal energy" in the system that, under certain conditions, can be lost.

The internal energy should be classified as energy which can be absorbed or released by a closed system without changing its external energy characteristics. This definition is blurred when you try to divide the internal energy into components: separate types of energies can appear or disappear for different situations, which are accounted for as components of internal energy. However, it is this definition that allows us to qualify internal energy to the physical "function of state" category.

If a closed system reaches a state of equilibrium, then we can only talk about isolated systems. Thus, isolated system should be understood not only as a lack of energy exchange with the environment, but also as a case when there is a flow of incoming and outgoing energy, but their balance is zero.

A specific internal energy of the system corresponds to a specific equilibrium state of the system. For non-isolated system in outer space, the equilibrium state can only be related to a zero value of its internal energy (an absolutely stable condition can arise only when the observed system does not have even small losses of energy into a vacuous environment). To be more precise, not the value of absolute zero of the internal energy but the point of reference associated with the zero value. Within the framework of thermodynamics it is considered that in the vicinity of absolute zero the thermodynamic energy of the system is constant, non-zero and independent from temperature. At the same time, quantum effects appear, which establish discrete energy levels close to the absolute zero, allowing the entropy to approach zero. But the aim of this paper is not to discuss thermodynamics, but only to emphasize that energy exchange of a closed system with the environment tends to the value of zero, as temperature tends to zero. Therefore, absolutely resistant states for non-isolated objects, characterized by the term "temperature" and located in a vacuum, can occur only at absolute zero.

When considering absolute resistance, i.e., stability in vacuum, the excitation energy of the system, counted from its absolute stable state, can be related to the internal energy of the closed non-isolated system. The excitation energy in the overall context is the unprompted energy given a vacuum until it reaches a system in absolute equilibrium. Accordingly, the thermal energy lost by space objects can be attributed to excitation energy.

We can talk about the absolute resistance to the forces of gravity, which is a special case of absolute resistance as such, when gravitational forces played a critical role in the preceding absolute resistance, even if they stop their influence afterwards (in a hypothetical case, related to the lack of gravitational interaction between elements inside the degenerate system; the possibility of such a case is not alleged, but simply outlined for a more in-depth analysis in future scientific developments).

Protons and electrons are absolutely stable formations in absolute emptiness, they are elementary particles. They do not intake any form of energy. An atomic nucleus is already a stable structure. But it is a "degenerate system", representing by its nature a composite "elementary particle". It cannot be cooled down or warmed up, and neutron capture (adding a new element into a close system, i.e., turning a closed system into an open one) leads either to a formation of a new isotope, or to an unstable structure, but not to warming up of a nucleus.

On the one hand, it is known that an elementary particle has some form of energy linked to its existence, which can conditionally be attributed to the internal energy of the particle (today, this form of energy is identified with the rest mass). The atomic nucleus also has a form of energy (mass defect), which hypothetically could be attributed to the internal energy. The elementary particle or an atomic nucleus committed to the closed system cannot change its mass or mass defect. If the particle and atomic nucleus do not disintegrate, i.e., remain stable, they exhibit the absolute stability property. But on the other hand, in spite of the need for energy costs to create these structures, the elementary particle and the atomic nucleus are not able to absorb and radiate from any form of energy. This means that they do not have internal energy. Therefore, for such objects the link of absolute stability with zero internal energy seems self-evident, despite the release of energy from the decay of unstable elementary particles and isotopes.

It is meaningless to talk about the absolute resistance of elementary particles to the forces of gravity because we know nothing about the existence of gravitational forces within the elementary particles: the gravitational forces are absent in the Standard Model. Furthermore, it is also pointless to talk about the absolute resistance of an atomic nucleus to gravitational forces. Experimental data shows that, even if the forces of gravity are present inside the atomic nucleus, their value is negligible in comparison with the forces of close interaction. However, one alarming fact is: the average "density" of an atomic nucleus does not depend on its size, the volume of the nucleus of a chemical element is proportional to its atomic weight: $r_n \approx 1{,}2A^{1/3}$, where r_n is the radius of the nucleus in Fermi [$1\ F = 10^{-15}$ m] and A is the atomic weight of a chemical element. Indirectly, this indicates that the nucleus is a distinctive form of existence of matter, rather than a set of aggregate state nucleons. More details on the subject are given in the next chapter.

It now makes sense to talk about the resistance of a large population atomic nuclei to the forces of gravity (this case refers to space objects composed of matter in different states of aggregation, because electrically same charged atomic nuclei would not self-assemble in groups). Moreover, it is important to remember that it is necessary to take into account the radioactive isotopes in this case. But the unstable isotopes should only be seen as fuel, temporarily changing the momentary balance of energy.

An atom, isolated in absolute emptiness, is also a stable system: it does not radiate electromagnetic energy, the movements of electrons on its orbits do not undergo any changes for an infinitely long period of time, and the atom does not "freeze". However, an atom represents an elementary, but still a multi-unit system. That is why it can receive external energy without changing its kinetic energy, remaining an atom. But the atom has one stable condition that is why, while it absorbs electromagnetic radiation, it becomes excited and, after throwing away the excess energy with a quantum of electromagnetic radiation, the atom returns to its absolutely stable state.

A molecule is also a stable configuration of matter in absolute emptiness, i.e., it shows the absolute resistance property. It becomes even easier to excite the "molecule" system. A molecule can receive external energy and remain a molecule without changing its kinetic energy, and the energy absorbed will turn into a rotatory movement of a molecule as a whole and/or into internal fluctuations of atoms inside the molecule.

The kinetic energy of an elementary particle, an atom and a molecule can be changed only with the help of external, relative to them, energy (due to external influences). If these particles are considered as the ones being observed, then the kinetic energy will be an external parameter for them, not related to their internal conditions.

The aggregate kinetic energy of individual elementary particles, atoms and molecules, which constitute a closed system, is calculated in the center-of-mass system and should be attributed to the internal energy of the system, because the energy of the movement of elements of the system has the ability to change due to external influences without breaching the system and changing its external energy characteristics, when the whole system is considered as a single object. In addition, at multiplicity of elements, the internal energy of the system will include the potential interaction occurring between the elements and the excitation energy of the elements themselves. The same can be said about the multi-element systems whose elements are arbitrary real objects (subsystems).

Ideal gas, the monatomic molecules sizes of which in comparison with the distances between them, can be neglected, there are no forces of attraction or repulsion between the gas molecules, and while colliding, an absolutely resilient interchange of impulses takes place without energy loss for the excitation of molecules, is an ideal thermodynamic system, in which laws of statistics work. That is why kinetic energy of molecules of ideal gas (although there are no forces of potential interactions between them) should be related to internal energy. This is the kind of energy that can bring in or take away from the system without changing its external energy indicators.

In connection with the fact, that molecules of a real gas can receive energy for changing rotatory movement of whole molecules and inner fluctuations of atoms inside the molecules, the increase in the average kinetic energy of molecules at a certain magnitude requires more energy than for ideal gas, i.e., the imperfections of the gas influence its internal energy. Moreover, there are forces of potential interaction between molecules of a real gas, which also influence internal gas energy. For thermodynamic systems the criteria of "temperature", "pressure", "enthalpy" etc. become applicable.

The solid bodies arising in certain branches of evolution of matter in space can also be characterized by thermodynamic parameters. Therefore, many space objects achieve absolute stability by reducing their temperatures to absolute zero. Cosmic gas clouds can strive to absolute zero, but only if they there were not in the process of unprompted contraction before that.

But, as will be seen from further analytical review of stellar evolution, absolutely resistant to the forces of gravity structures can form in space as a result of gravitation, for which the thermodynamic parameters do not apply. In some cases, these structures will be able to be excited like atoms and molecules and in other cases – only form new, stable "isotopes", as is the case with atomic nuclei.

Thus, the process of gravitational self-contraction of clouds of matter in space ends with the formation of a structure resistant to gravitational forces, that either expels the excess energy in order to achieve an unexcited neutral state, if the formed structure was previously excited, or cools to absolute zero, if the stable structure is such as that term "temperature" is applicable to it, and it becomes absolutely stable after the discharge of excess energy and the exhaustion of the external substance of accretion processes, turns into hidden mass.

7. Atomic Nuclei and Neutron Gas

One of the possible endings of stellar evolution is a formation of a neutron star. Although the neutron star has been predicted theoretically, even before its discovery through observations, there is no accurate description of its structure yet. In essence, a neutron star is a structure in which degenerate neutron gas equalizes the forces of gravity. At the same time, the distance between the particles that make up the neutron star is comparable with the De Broglie wavelength, and its stability is related to strong interactions. An atomic nucleus is also united into a whole by strong interactions.

Atomic nuclei are composed of protons and neutrons, which behave the same way inside the atomic nucleus, uphold the principle of isotopic invariance and are called "nucleons" (neutron and proton are different charged states of the same particle). When electrically charged nucleons (protons) approach each other significant forces of electric repulsion occur, when neutral nucleons (neutrons) approach no repulsion takes place. But regardless of the type of nucleons that approach each other (including the proton and neutron) at distances of about 10^{-15} m and less the forces of mutual attraction become apparently suddenly in stepwise leap (in quantum field theory – the interaction radius), which are greater than the forces of electrical repulsion, if available (in the case of convergence of similar charges). These are the emerging forces which characterize the strong interaction. They are short-range forces (abruptly ceasing to operate at distances greater than the specified) and have the largest coupling constant among the fundamental forces.

But on further convergence of nucleons, close interaction forces must either change their sign or new forces of a different nature should arise, creating repulsion. Furthermore, the forces of inertia, often used to describe the equilibrium of complex systems (for example, to describe the stability of the metal structure consisting of positive ions in the lattice sites and electronic "gas" clouds), in this case, cannot act as repulsive forces at extremely short distances between nucleons.

It is important to note that no well-defined approach to the description of the strong interaction exists yet. It is assumed that the short-range forces are, by nature, from the quantum field theory, in which forces of attraction appear at a threshold distance between the converging interacting objects, changing their sign in the case of further convergence of objects. This happens due to the redistribution of influence of virtual particles of the quantum field involved in a close interaction, depending on the distance between the objects. The fact that at infinitesimally small distances the forces of attraction of the strong interaction become repulsive forces, explains the integrity and mutual impenetrability of nucleons. The effect of the nucleon repulsion at extremely small distances is inevitably taken into account not only in the theory of the atomic nucleus, but also in models of neutron stars.

In the framework of quantum field theory, it was possible to create a model of the symmetric meson theory. But the main difficulties are associated with large sizes of the interaction forces, with the complex dependence of the energy potential on the distance, measured from the nucleon, with the dependence of the interaction forces on the nucleon spin, and even from the orbital angular momentum of the nucleon (if we assume that it exists).

Since the potential of the strong interaction, depending on the distance, has a potential well in which the attractive forces change into repulsive forces, then, in the theory of nucleon-meson mechanism, pions are responsible for the relatively remote forces of attraction and heavy mesons are responsible for the short-range repulsion (various models of soft and hard repulsive cores). At the same time, the field theory faces fundamental difficulties, for example, those related to the inapplicability of the perturbation theory (due to the high value of the dimensionless constant of the force interaction).

Though historically the term "strong interaction" arose from the need to describe the strength of the intra-nuclear interaction, which was impossible to describe using only the forces of gravity and electromagnetism, today it is already used in the description of inter-quark interactions in the framework of quantum chromodynamics, which is carried out because of gluons (dimensionless constant of the strong interaction α depends on energy and is expressed in decimals at short distances and is close to 1 at large distances). At the same time, nucleons are "colorless" combinations of quarks held together by collective excitations of the gluon cloud and a sea of quark-antiquark pairs, which can be interpreted as pions (the existence of the pion was predicted by Yukawa from the standpoint of quantum field theory, in which pions are the exchanged particles of strong interaction between nucleons in the atomic nucleus). In other words, the intra-nuclear strong interaction did not become true strong interaction, but a form of its expression. But the transition to a lower micro-level did not improve, but worsened the situation with the uniqueness of the accepted picture of close interaction.

Today, on the one hand, it is agreed that the strong interaction inside the atomic nucleus must be accompanied by an exchange of pions between nucleons with interconversion of protons and neutrons into each other. On the other hand, it is argued that the neutrons become stable (in the framework of the nuclear shell model) and that there is no interconversion. In general, all the individual problems can be solved one way or another, but the overall picture is still seriously blurred. And this fuzziness is linked also to complex external displays of the properties of the atomic nucleus as a whole.

The external displays, indicating the form of certain intrinsic properties of the atomic nucleus, are rather contradictory. On the one hand, practice shows that the theory of the atomic nucleus is well described by the statistical approach: the atomic nucleus is a sphere filled with individually distinct particles (nucleons), with kinetic energy (using the Fermi gas model the velocities of nucleons in the nucleus are almost relativistic). However, the statistical approach does not describe the motion of individual nucleons, but their joint motion and the outcome of the statistics of their interactions. Therefore, a statistical approach cannot explain the formation of the spin and nuclear magnetic moment, the effects of parity and disparity of protons and neutrons, which affect the stability of the nucleus.

On the other hand, all these problems can be solved by the nuclear shell model of the nucleus, but it is not compatible with the statistical model. The nuclear shell model also includes individual distinctiveness of the particles (nucleons). Moreover, this model makes a description of each nucleon, individually, taking into account its quantum properties and compatibility of the Pauli principle. The nucleons are distributed to the quantized energy levels in a spherically symmetric field based on their potential and kinetic energy. All these procedures are done quite artificially, but a positive result is achieved, nonetheless (for example, to describe a compound nucleus, when a statistical approach becomes difficult to apply), i.e., the nuclear shell model really works.

But there is one additional important fundamental difficulty: the two models are essentially incompatible with each other and contrary to the nucleon-pion model of interaction, which almost deprives the nucleons of their individuality. But, at the same time, the existence of the atomic nucleus itself is determined, in fact, by strong interaction based on the nucleon-pion model.

Thus, no complete description of the strong interaction has yet been created. Therefore, the expectation of seeing a strict model of a neutron star is premature. It is always important to remember this and not to see the currently accepted views in developing areas of science as a dogma. Establishing analogies between space and terrestrial objects is not a compilation of speculative models but an accumulation of useful information, which will first facilitate the formation of the ultimate views on the fundamental physical positions, and only then will it be possible to develop the a complete model in astrophysics.

It is useful to note that the atomic nuclear theory does not in any form take into account the ability to change the energy of the one or more nucleons and the entire core as a whole through an external action. This cannot be done theoretically. Experimental observations confirm this. A variety of nuclear reactions in a variety of flow conditions also point to constant internal energy of the atomic nucleus, determined by the mass defect. Therefore, the constant internal energy of the atomic nucleus should be taken as a starting point, i.e., for zero internal energy. It seems that there is also no reason to expect a possibility of alteration in the internal energy of the neutron star when subjected to external electric and gravitational fields of arbitrarily high intensity. A neutron star must manifest itself in the same way as an atomic nucleus. This is not a complete but a fundamental similarity. For example, we know about the positive electric charge of the atomic nucleus, but that does not mean that the elements of the theory of the shell model will be useless with respect to the neutron star.

At the moment it seems that the short-range forces (of strong as well as weak interaction) are not accidentally discarded from the consideration of the strength of gravitational and electrical interactions. It is possible that the gravitational interaction at short distances between the nucleons is modified into close interaction. However, this point is outside the scope of this paper and will need further in-depth discussion. At the moment, it is only obvious that short-range action does not only stabilize the accumulation of nucleons, but converts them into a new form of matter, transforming the cluster of the nucleons into a single undivided elementary particle, which is no longer a thermodynamic system. Perhaps, understanding the neutron star as the composite elementary particle helps us focus on some problems of fundamental physics. In turn, deepening the foundation of physics will allow us to better understand the existing problems in astronomical sciences. For example, nothing forbids the nuclei of planets, which form magnetic fields around planets, to exist in a degenerate state (the questions of proto-nucleus formation of the planets are still the most poorly worked out elements of the theory of planetary evolution). But this is a complex question, closely intertwined with the general theory of the evolution of the stellar system as a whole, which it is too early to interpret in the proposed angle.

8. Analytical Review of Accepted Interpretations of Existing Trends of Stellar Evolution

As is already clear from the above material, stars are spontaneously contracting, under the influence of gravitational forces, hydrogen clouds in space, generally containing impurities and dust; described by the laws of thermodynamics for a gas cloud and which ignite, even for a short time, not random but continuous and often occurring thermonuclear reactions. The evolutionary direction of the nascent star primarily depends on the initial mass of the cosmic cloud.

The lightest hydrogen clouds with masses less than a hundredth of the mass of the Sun ($M < 0.01\ M_{\Theta}$, where M is the mass of the hydrogen cloud, M_{Θ} is the solar mass) are unable to ignite a multitude of thermonuclear reactions that increase the luminosity of the cloud. These light clouds do not form stars and are hardly ever observable. The final stage of evolution of the gravitational compression of such clouds is not discussed in the literature and is not even modeled on computers. It is usually assumed that such clouds can only cool down, and very light clouds in the category under consideration even begin to disperse after a certain time interval, replacing the initial compression by expansion. From the material presented above it becomes clear that the accepted disregard for the fate of very light clouds is erroneous. It is most likely that their evolution ends with the degeneration of the electron gas and the formation of a hidden mass.

Thermonuclear reactions can be triggered by heavier clouds, but without the hydrogen-helium cycle, which is possible only for clouds with the initial mass larger than the Kumar limit. Although the intensity of thermonuclear reactions of clouds under consideration is low, the luminosity of clouds increases so much that they are already referred to as stars and are called brown dwarfs. The masses of brown dwarfs are $0.01\ M_{\Theta} < M < 0.07\ M_{\Theta}$. Brown dwarfs are characterized by convection, they burn out the lithium and deuterium impurities quite quickly and their luminosity is very low. It is believed that brown dwarfs gradually cooldown and fade, throughout their life cycle as they exhaust the impurities involved in thermonuclear reactions. After the exhaustion of the impurities brown dwarfs quickly cool down and turn into objects with a degenerate electron gas, which in turn continue to cool. But at this stage of analytical review it is already becoming clear that arguments that permit the cooling of the cloud during the stage of thermonuclear burning of its impurities are not just wrong, but formed from gross violations of the laws of physics. The topic of whether structures with a degenerate electrons or neutron gas are able to cool down has been discussed above and will be discussed further in the paper.

For the unprompted launch of thermonuclear reactions in gaseous hydrogen, with the maintenance of the hydrogen-helium cycle, in which the proton-proton reactions produce an accumulation of helium, the initial mass of the cloud must not be less than 0.07 solar masses. If the original masses of clouds are in the range $0.07\ M_{\Theta} < M < 0.8\ M_{\Theta}$, stars light up, which are parts of a group of red dwarves. The largest number of the observed stars in spherical subsystems of galaxies is red dwarves, with a mass of about $0.5\ M_{\Theta}$. Their evolutionary path is very long both at the stage of Kelvin contraction (about one billion years) and at the "star" stage (about tens of billion years, the duration is highly dependent on mass).

Nobody has yet asked the question of what the kind of end of the evolutionary cycle does a red dwarf have, as the "red dwarf" itself is considered to be the final stage of evolution of light stars. But stars are stable only for the period when thermonuclear fuel burns in them. When the stock of thermonuclear fuel has been exhausted, the process of gravitational contraction is inevitably renewed both for big and small stars. That is why the contraction of a red dwarf will inevitably continue, and the image of the final stage of evolution of the red dwarf still needs to be uncovered.

If the initial cloud was such that as the result of Kelvin contraction the star was born, close to the main sequence of Hertzsprung-Russell diagram, the stage of a "star", as opposed to Kelvin contraction, will certainly be accompanied by the process of mass decrease: the contracting cloud discards the matter and loses mass, and the bigger the star, the more intensive the process. But the processes of stellar wind and discarding of shells do not lead to complete dispersing of matter in space: the matter in central zones remains in gravitational interaction.

The stars of the main sequence and red giants with masses, close to the solar mass M_{Θ} and up to six solar masses $6\ M_{\Theta}$, after exhausting their thermonuclear fuel turn into white dwarves by discarding their shells, accompanied by formation of planetary nebula; the mass of a white dwarf, at this time, is less than $M < 1.4\ M_{\Theta}$. If this condition of a nucleus mass is different, then stellar evolution will have a path that deviates from that of a white dwarf.

A white dwarf has a structure of "a giant molecule", in which electrons become generalizations for all atomic nuclei, i.e., electrons turn into degenerate electron gas. The process of contracting of white dwarves slows down abruptly. Further, two variants are possible. The first variant is that, as long as the white dwarf remains luminous, the process of contraction continues, and the forces of gravitation continue doing work. In this variant, the star cannot cool down and will either have to change its structure from degenerate electron gas into some yet unknown stable structure; it will, possibly, turn into a "small" neutron star, or explode. Nevertheless, the theory of a white dwarf presents evidence in favor of the fact that the structure with degenerate electron gas is resistant to gravitational forces. At the same time, the white dwarf cannot be resistant to the forces of gravity, like an asteroid or planet: it is not a thermodynamic system and is not able to cool down (as the molecule cannot heat up or cool down, it is only able to be excited or to lose stimulus). The glow of the white dwarf is due to its transition to a completely stable state. In addition, it is important to take into account that the resulting white dwarf, in practice, is always an open system (it interacts with the substance that drops on it). Therefore, the second option the competition of the evolution of these stars is related to their tendency to become a completely stable structure.

Thus, it is most likely that the process of contraction of a star with a mass $M \approx (0.8\ldots6)\ M_{\Theta}$ (the heavier the star, the larger the amount of mass that it loses due to stellar wind by the moment of formation of a white dwarf), stops, after forming a white dwarf. A white dwarf is a structure resistant to gravitational forces, it does not have temperature, but it is in an excited state. After the cessation of all transient processes a white dwarf will turn into a hidden mass. What will actually happen to a white dwarf at the end is not yet known.

It is likely that the red dwarfs can expect a similar end: after the thermonuclear fuel runs out a degenerate Fermi gas (electron gas will degenerate) will form in them. Electron gas degeneration process is recognized for brown dwarfs, and it can be considered common. It can be expected that clouds that are even lighter, for which no thermonuclear reaction is not excited due to unprompted contraction, and also turn into a degenerate "giant molecule" system (but this situation is not commonly recognized). Thus, the final stage of the evolution of the spontaneous gravitational contraction of light gas clouds and light stars is likely the same and is connected to the formation of hidden mass.

Heavier stars with masses up to about 50 M_{Θ} after exhausting the thermonuclear fuel transform into neutron stars with masses up to 2.5 M_{Θ} also as the result of discarding their shells, which is accompanied by an explosion and is observed as a "supernova". It is possible that explosions of supernovas with masses (6-8) M_{Θ} can lead to absolute dispersing of matter in space, and heavier stars leave neutron stars at the place of the explosion.

Like in the case of a white dwarf, the destiny of a neutron star is unknown. Theoretically contraction can continue. However, neutron gas is almost incompressible and the rate of change of the size of the star is very low. In this case, further compression must lead to a new qualitative leap: a neutron star will have to transform into something new, not yet known. Therefore, it is more correct to assume that the neutron star is a structure resistant to the forces of gravity. And since it is not a thermodynamic system, it cannot cool down. Moreover, as the atomic nucleus does not have internal energy, the neutron star can also not be an excited system, i.e., dump energy into the surrounding vacuum. Emission of matter and energy can take place solely for an open system interacting with the matter surrounding a neutron star.

Current models of neutron stars predict that the maximum level of thermal radiation of the neutron star falls inside the soft X-ray band frequency. Taking into consideration the fact that the emissions of a neutron star is different from the thermal spectrum and that a neutron star does not radiate ultraviolet or X-rays (except in the case of double stars, when a neutron star draws in the gas of an ordinary neighboring star), and the pulses are conditioned by the imposition of electron rotations around the star and the star's own rotation, then the possibility that a neutron star is a structure completely resistant to gravitational forces and not characterized by temperature, seems more attractive. In this case a neutron star will, in time, become a hidden mass after accretion of matter is ceased.

One should not expect the structure of the neutron star to be what it is assumed to be, built on the principle of the structuring of the elementary particles in their own cluster due to fundamental interactions. It is most likely that a neutron star will not be an aggregation of elementary particles, but a single composite elementary particle without a hard shell and different phases inside the shell, i.e., it would be similar to an atomic nucleus.

The necessary condition for discarding the shell of a contracting star after the thermonuclear fuel had been exhausted is connected with the fact that the process of formation of a structure with degenerate electron gas or with degenerate neutron gas is momentary, that is why, as the result of a sudden "solidification" of the nucleus, shock waves are formed (they appear due to a collision of a "not solidified" shell, moving towards the center, with a suddenly "solidified" nucleus), initiating a thermonuclear explosion of one intensity or another.

This is the common explanation. However, it is useful to note that the phenomenon of "changing the aggregate state of matter" is in no way connected with the critical state of the system as a whole. In physics, there is no requirement that the phase transition must be instantaneous for each elementary volume of the considered batch of matter. On the contrary, in practice, a phase transition never occurs simultaneously over the entire volume of matter. This is a characteristic feature of any thermodynamic system. However, the requirement of instantaneity is mandatory for explosions of stars generated in shock waves. Therefore, the explosions of stars clearly indicate the fallacy of the concept of a degenerate state of matter as a kind of "phase state", i.e., in a state, which is determined by certain links between the elements in the system. The instantaneous transition (its contemporaneity) sufficiently reliably testifies to the qualitative leap: the elements composing the cloud momentarily cease to be its elements; lose their individuality.

An explosion of a supernova gives rise to a synthesis of nuclei of heavy chemical elements. It is useful to note here that, in addition to the generally accepted scheme for generating heavy elements with neutron capture, another mechanism of synthesis is also possible. In massive gas clouds, as soon as the star loses stability, endothermic thermonuclear reactions can be triggered, which activate the process of gravitational compression in the case of thermonuclear fuel burning in exothermic reactions, thereby activating the collapse of the star.

Formation of black holes is considered the final stage of evolution of heavier stars with masses more than 50 M_{Θ}. The bigger the mass of the object, the less average matter density is required for achieving its gravitational radius. Consequently, potentially a black hole can be formed before the neutronization of matter occurs. But in fact, gravitational potentials distribute the matter in space in such a way that the gravitational radius is not achieved. For example, the size of a supergiant exceeds its gravitational radius by the order of two. Two mechanisms of formation of a black hole are possible. In the first option an ultra-massive gas cloud already becomes unresisting towards contraction at Kelvin stage and begins collapsing before the nucleus reactions begin (the practical application of this option is limited by the lower mass limit of a supergiant). In the second option, it is assumed that a neutron nucleus can appear with a mass more than 2.5 M_{Θ} inside the supergiant, with the appearance of which the neutron gas will become unstable, and its further contraction under the influence of gravitational forces will lead to formation of a black hole.

But, firstly, the neutronization of matter happens once certain critical parameters have been reached, and it is improbable to expect the formation of larger neutron clusters for both supposed variants of the black hole formation. Secondly, a neutron star reveals itself as a composite elementary particle, therefore, is the term "critical mass" applicable for the question is unclear. Thirdly, the fact of the existence of a black hole as a whole is still too ambiguous, even though most astronomers already tend to consider their existence authentic when comparing certain properties of space objects with expected appearances of black holes.

So, the ending of the evolution of gravitating gas clouds, primarily, depends on their initial mass, and on their initial chemical composition. "Gas" cloud is a cloud, the particles of which do not unite when they collide with each other.

9. A Few Words about Black Holes

The general theory of relativity gives a geometrical explanation to gravitational forces, interpreting them as a contortion of a four-dimensional space-time. The notion of a "black hole" itself is a consequence of this interpretation. But more and more physicists tend to give a field interpretation to gravity with particles carriers of the force interaction (different options of building of quantum gravity are possible), in which the interpretation of the blocking gravitational effect for massless photons, trying to move away from a heavy material object with the speed of light is somewhat difficult. Besides, both common approaches to explaining the nature of gravity (the general relativity theory and quantum gravity) are fundamentally incompatible with each other.

But the main difficulty in describing black holes is associated not so much with understanding the nature of the emerging effect or with the explanation of the mechanism of the formation of black holes, but rather in the physical interpretation of the object itself, which is capable of manifesting itself as a black hole. The structure of a black hole is essentially impossible to describe through the known fundamental forces. Its structure is not only unknown at present, but is inconceivable in principle (if more new categories are not introduced into science). It is incorrect to say that a singularity is located at the center of the black hole, because the physical nature of a singularity is far beyond our understanding. A fortiori, the characteristics of a black hole are defined by a singularity, and it is essentially impossible to understand what the difference between the singularities needs to be for the size and mass of black holes to be different.

Today astronomers know of 24 objects that can be identified as black holes, formed as the result of stellar evolution. The masses of these objects lie in the range of (3-29) M_{Θ}. They do not act as primary radio pulsars, x-ray pulsars or x-ray bursters. At the same time, neutron stars that do not have strong magnetic fields might act this way. But, it is believed that, the probability of this is very low. However, in view of the above, this option should be given a higher degree of probability. In addition, the option that such objects are structures, formed by neutron stars seems quite believable. But modern knowledge is not yet sufficient to describe such structures. Nevertheless, introducing the notion of "black hole", which does not have a physical interpretation, into the theory of massive cosmic objects is not just premature, but even unscientific. The possible outcome of contraction of massive gas clouds with the formation of an evaporating or non-evaporating black hole should only be considered as a hypothesis, and, most likely, aspiring to be the truth with very low probability.

We should also not compare heavy non-luminous debris from the hypernova explosion with a black hole (the mass of the exploding star is more than 100 M_{Θ}). Accretion disks and rays of the dispelled matter with the created gamma-ray bursts are more logically and more simply explained by a massive structure, similar to a neutron star, than by a model of a black hole, which requires inventing a lot of criteria, connected with critical speed of the absorption of matter and the realized physical mechanisms for discarding the excess tightened matter while exceeding the critical absorption speed.

However, objects that have a claim to be called "black hole" are formed not only as a result of the evolution of heavy stars, but also as a result of the evolution of galaxies. The presence of massive objects with no electromagnetic radiation in the centers of galaxies can, nowadays, be considered a fact (the number of these objects, discovered by astronomers, is in the thousands). However, these objects should also not be compared to black holes yet. Further development of science will definitely give us a clue to their physical nature.

In conclusion of the topic of black holes, it is important to mention a relatively recent high-profile event: on September 14, 2015, the LIGO collaboration recorded a gravitational wave burst whose shape coincided with the predicted theoretically in the developed model of the fusion of two black holes (this burst is interpreted as the merging of two black holes with masses of 29 and 36 solar masses, as a result of which a single black hole with a mass of 62

M_{Θ} was formed, without generation of electromagnetic waves, that is, the energy used to form the gravitational waves was equivalent to 3 M_{Θ}). After this, several other similar events were recorded. The ongoing improvement of the ways of overcoming noise will allow us to observe several events a month in the near future and even more often at a later time in the future.

The detection of gravitational waves confirmed the general theory of relativity (accordingly, the quantum theory of the gravitational field is then incorrect). However, even in spite of this discovery, massive space objects should not be categorically identified with black holes. The history of physics has numerous examples where the same phenomenon is described by mutually exclusive models (for example, one can be the above-mentioned mutually exclusive models of the atomic nucleus). It is hypothetically possible to describe the emergence of gravitational waves as a result of the fusion of massive objects using other theories. But the available knowledge about the fundamental properties of the universe does not yet allow us to raise this issue in scientific articles. This is the business of the future.

10. Conclusions

The presented analytical review of the existing approaches and theoretical principles laid into the description of stellar evolution reveals a blur and uncertainty in the actual fate of the stars. We know very little about the final stages of stars evolution, as strange as this might sound.

To change this situation, it is necessary, first, to recognize the existence of structures resistant to the forces of gravity. This is a very important element of understanding, which will help in future theoretical research. After all, we are not talking only about the cooling of an asteroid or planet to absolute zero, but also about "degenerate" structures, which can probably be considered as "elementary systems", consisting of one element. The question of whether there are forces of gravity which act inside an atomic nucleus or neutron star is for the future, today this question cannot be answered due to a lack of essential knowledge on the subject. After all, the assumption of lack of resistance of massive neutron stars to gravitational collapse is not obvious. It is a very important step in theoretical understanding to assume that the "degenerate" structures do not simply cease to be thermodynamic systems, but can be absolutely stable.

Secondly, one should be wary of false expectations, which do not turn into debatable principles but into conscious concealment of suggestions, which ostensibly can be ignored. A striking example of this is the fate of the brown dwarfs, described above, for which it is assumed that they cool down, even before the formation of a degenerate structure. And the fate of the lighter gas clouds is not analyzed at all. But it is so obvious an error that it does not even need to be subjected to special analysis. It is possible that future work on the analysis of the fate of self-contracting light gas clouds in space can aid solve the mystery of the luminous objects that occur on Earth.

Thirdly, it is necessary to avoid hypothesis based on the fundamentally incomprehensible. This primarily relates to the inclusion in all modern cosmological models of the concept of a "black hole", not just as a passive element as of yet unknown to physics intrinsic properties, but as a fully active functional object with theoretically false principles of its existence and models of work. Scientific creativity and going beyond conventional solutions to emerging scientific problems are useful and even necessary. But it should no longer be acceptable to refer to scientific creativity when talking about the assumptions based on the fundamentally incomprehensible.

REFERENCES

[1] A. S. Belyaev. Photon gas, Universal Journal of Physics and Application, Horizon Research Publishing (HRPUB), Vol.10, No.1, 11-15, 2016. Online available from http://www.hrpub.org/download/20160229/UJPA3-18406008.pdf.

[2] A. S. Belyaev, A new model of the birth of the Universe. Universal Journal of Physics and Application, Horizon Research Publishing (HRPUB), vol. 11, No 5, 182-189, 2017. Online available from http://www.hrpub.org/download/20170930/UJPA7-18410201.pdf.

[3] A. S. Belyaev. Gravitational Contraction of a Dust Cloud in Space, Universal Journal of Physics and Application, Horizon Research Publishing (HRPUB), Vol.10, No.1, 22-30, 2016. Online available from http://www.hrpub.org/download/20160331/UJPA5-18406009.pdf.

[4] D K Prialnik. An Introduction to the Theory of Stellar Structure and Evolution, Second Edition, Cambridge University Press, 2010.

[i] This is my own work made out of some kind of project.