Diversity of active phenomena created by dark energy

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Abstract

Activity phenomena are widespread at all hierarchical levels of baryonic structures. In the microcosm, they manifest as radioactive decay. In the planetary world, volcanic and seismic activity is observed. Stars exhibit a much greater diversity. But even more types of activity are observed in galaxies. For all activity phenomena, identifying the energy source is crucial. This paper presents a new concept: at all hierarchical levels of the universe, active phenomena utilize dark energy, which a baryonic object acquires through interaction with a dark energy carrier.

Keywords: *Dark energy: carrier, baryon structures, interaction, energy exchange; activity phenomena.*

1. Introduction

The activity of cosmic objects under various names has captured the attention of astronomers since "novae" first appeared in historical records. Sunspots, the largest of which were visible long before the invention of the telescope, can also be added to these phenomena. Naturally, people were well aware of terrestrial activities such as volcanism and earthquakes, which release the most significant amounts of energy. Nevertheless, the true beginning of the study of active phenomena should be considered the discovery of radioactivity by Henri Becquerel in the late 19th century.

The role of various types of activity initially interested researchers less than a detailed description of the processes themselves. However, by the mid-20th century and beyond, elucidating the role of object activity, as well as the physical significance of the various types of activity, already known at all hierarchical levels of our baryonic universe, became more pressing. And then, as far as we know, Ambartsumian was the first to suggest the existence of an evident connection between activity and the evolutionary process of objects (Ambartsumian, 1947, 1958, 1961).

This conclusion arose from studies of the expansion of gaseous nebulae, and then from the dynamics of stellar systems. These studies led him to the idea of an evolutionary path in which objects form not through the condensation of rarefied matter, but through the decay of denser matter. This, on the one hand, was consistent with the observed expansion of the Universe, and on the other hand, it corresponded to the law of increasing entropy. That the process of decay, or radioactivity, forms objects in the microcosm is undeniable. This spontaneous process, an intrinsic property of atomic nuclei, occurs without external influence and increases the relative number of lighter nuclei. The synthesis of heavy nuclei, which resembles the condensation of rarefied matter into a denser state during the formation of gravitationally bound objects, in contrast, requires special conditions. Moreover, this process contradicts the law of increasing entropy.

To be more precise, two main trends can be noted in Ambartsumian's papers of the Byurakan period. The first one we discussed was his unchanged emphasis on the leading role of activity phenomena in the process of formation and evolution of cosmic objects. The second innovation introduced into this old area of research was the concept of the formation of cosmic objects from denser/superdense matter, opposed to the dominant Kant-Laplace hypothesis.

At present, there is no doubt that any active phenomenon observed in the baryonic world is associated with the release of excess energy. Therefore, the origin of this energy has always been the subject of intense debate. Over time, many different mechanisms have been proposed. However, mainstream science ultimately settled on nuclear fusion and accretion, with the latter mechanism proposed as the most efficient energy source at all scales. Despite this, it can now be confidently stated that the discovery of dark energy has

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dramatically changed the situation. Here, we consider the following completely different mechanism. The interaction of a dark energy carrier with baryonic structures continuously pumps a portion of dark energy into baryonic objects. This, in turn, sooner or later transforms them into an unstable or active state, since no object can "peacefully exist" with an excess of internal energy.

2. A new approach to the problem of energetic sources

Activity processes are observed almost everywhere. The variety of active processes is clearly visible at all hierarchical levels of the Universe. One can find a vast diversity of active processes everywhere in our baryonic Universe, ranging from elementary particles and atomic nuclei to clusters of galaxies and the Universe as a whole. By the way, the most evident phenomenon of activity is the accelerating expansion of the Universe.

Two significant issues must be highlighted when one considers the activity phenomena. First, it should be pointed out how the energy released during the activity stage originated. Second, one should explain the physical mechanism that leads the object to the stage of instability. In fact, these two issues are closely related and should be considered jointly. Additionally, it is crucial to utilize only reliable observational facts and established laws of physics when constructing the mechanism of the process. One should refrain from a priori hypotheses if the available data and physical laws allow one to arrive at a reasonable conclusion without them.

In general, the question of activity energy is always extremely complex and depends on many parameters. Therefore, it is not surprising that various physical mechanisms for energy generation in cosmic objects have been employed. As we mentioned in the introduction, in cases of the highest energy release, the accretion mechanism, considered more energetically efficient, is always preferred. Ambartsumian's approach differs radically from the previously used ones. However, when comparing these two concepts, one issue should always be kept in mind: Ambartsumian was well aware of all the proposed energy generation mechanisms before he proposed his own. This means that he proposed a new concept to address the obvious shortcomings of the old ones.

Accretion energy is nothing more than the transformation of the potential energy of matter, generated by a hypothetical grand explosion, into other forms of energy. In other words, in this case, it is assumed that the energy of the initial, so-called Big Bang, is used as the source of the energy released during instability phenomena. Ambartsumyan, however, insisted on a mechanism for energy production within objects, which consequently become unstable. A crucial question then arises: which mechanism is correct, and where can we find evidence of the underlying mechanism? Moreover, the comparison must be made while maintaining the self-consistency of the underlying physical laws.

Ambartsumyan's concept of the activity of cosmic objects matured after he had demonstrated the expansion of stellar shells and the instability of stellar associations. This became possible thanks to his new approach, based on alternative thinking, which allowed him to notice nuances invisible to others. This enabled him to find all the necessary and sufficient arguments to prove his case while avoiding the inertia of human thought. This line of thinking, in this case, led him to the conclusion that all objects are formed through the decay of ultra-dense pre-stellar matter. However, the laws of modern physics, which preclude the existence of very massive clusters of ultra-dense matter, became a stumbling block for his concept. This insoluble problem effectively removed Ambartsumyan's concept from active consideration, ascribing it only historical value.

Those familiar with Ambartsumian's research know how meticulously he approaches observational data and theoretical calculations. Therefore, it seems strange that his calculations and conclusions have led to a stalemate, where an impeccable chain of logic predicts a situation unsupported by theory. There are two possible explanations: either Ambartsumian was mistaken, which seems highly unlikely when his arguments are verified, or the theory is missing something. The first step is to clarify whether the situation has changed significantly since then.

Undoubtedly, the most significant change in our understanding of energy resources since the introduction of Ambartsumian's concept is the introduction of the idea of dark energy (Perlmutter et al. (1999), Riess et al. (1998)). Dark energy, which (according to generally accepted estimates) comprises approximately 70 percent of all mass/energy, was unknown and could never be harnessed. This represented the greatest energy reserve, completely unknown, and therefore never taken into account. But what's surprising is that even now, when the physical picture of dark energy is more or less known and estimates of its quantity exist,

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no one considers it a viable source of energy that could be transferred to baryonic objects.

A detailed examination of the situation should begin with the very discovery of dark energy. It was introduced into the arsenal of modern physics as a consequence and explanation for the acceleration of the expansion of the baryonic universe. The most important thing in this situation is that the scientific community wasn't looking for acceleration; rather, it was attempting to estimate the expected (as a consequence of the simple Big Bang model) deceleration of the universe's expansion. Observational evidence for energy transfer to galaxies proved obvious; therefore, the need arose to introduce a new type of energy with an unknown carrier that constantly interacts with the structures of the baryonic universe. This means that the very reason dark energy was introduced into the arsenal of physics was the presumed interaction between its carrier, whatever it may be, and baryonic structures.

The first conclusion we arrive at using only observational data is that the carrier of dark energy, whatever it appears to be, certainly interacts with baryonic matter. This unknown carrier of energy, interacting with baryonic objects, comprises at least 70 percent of all mass/energy, while the entire baryonic universe contains less than 5 percent. In this case, a not very strange question arises: could dark energy serve as a storehouse of energy resources for all the unstable phenomena that we observe everywhere? After all, the energy required for all observed instability phenomena is only a tiny fraction of the dark energy reserves.

Based on the above, any discussion must take into account that the dark energy carrier, whatever it is, interacts with all baryonic structures. Any interaction between different substances is a natural means of redistributing energy between the interacting entities. In this case, an unknown energy carrier, containing at least 70 percent of the total mass/energy, is in continuous energy exchange with the structures of the baryonic universe, which contain less than 5 percent of the mass/energy. A reasonable question then arises: could dark energy serve as an energy reservoir for the unstable phenomena we observe everywhere? After all, the energy required for these phenomena constitutes only a tiny fraction of the dark energy reserves.

Interactions between different systems must occur in strict accordance with the known laws of thermodynamics. It is also known that the energy balance of the interaction process is governed by the second law of thermodynamics, which determines the direction of energy flow between substances with different energies. It states that energy flows from a system with a higher energy level to a system with a lower energy level.

Furthermore, it is known that all baryonic structures possess negative total energy, meaning they exist as such due to the absence of the energy required for their decay. Dark energy, on the other hand, is strictly positive, as it constantly performs physical work, accelerating the expansion of the Universe. Thus, there is no doubt that, thanks to interactions between the baryonic world and the carrier of dark energy, it is the baryonic structures that continuously receive energy. The amount of energy transferred per unit of time is unimportant for a qualitative analysis of the process, as energy is a cumulative quantity and continually increases as the process proceeds. Moreover, if the current idea that dark energy uniformly fills all space is correct, then the accumulation of energy in cosmic objects continues at all hierarchical levels of the baryonic matter of the Universe.

Thus, observed facts and known physical laws do not rule out the possibility of dark energy transfer to baryonic objects. This is a key question in the search for an energy source for various instability phenomena. Since this mechanism of energy transfer and accumulation is universal, it can be applied to all cosmic objects at all hierarchical levels. However, it should be noted that any baryonic structure interacts with a dark energy carrier spatially located within the volume of this structure. Moreover, even if the baryonic structure initially satisfies the virial theorem

$$W = 2T + U = 0, \tag{1}$$

where T and U are the kinetic and potential energies, respectively, interaction will change the situation. After some time, the virial value will become positive:

$$W > 0. \tag{2}$$

On the other hand, a positive value of the virial indicates an expansion of the given barionic structure.

3. Changes in the micro world

At all hierarchical levels, the baryonic world is structured by a single principle: any baryonic structure as such exists due to negative energy. Atomic nuclei exist as the fundamental objects of our world solely due to their unique property—the mass defect. A mass defect is the mass deficit of a nucleus compared to the same

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number of protons and neutrons in a free state. This is one of the most important properties of baryonic matter, observable only in the microcosm, but responsible for the existence of the entire baryonic world. This property is a universal mechanism for converting mass into energy and vice versa, which ensures the diversity of atomic nuclei. The second key manifestation of this property is that the mass defect per baryon changes when moving from one nucleus to another. This feature is crucial and of non-trivial significance for the existence of our world. Its true significance is much broader than might seem at first glance. It means that baryons can change their mass depending on the physical conditions in which they appear; they can adapt to suit physical conditions if the latter change for one reason or another.

Physically, the energy equivalent to the mass defect is the nuclear binding energy. This is the energy that can split a nucleus into individual baryons if it is somehow injected into the nucleus and completely absorbed. One natural way for energy to be injected into a nucleus is through interactions between atomic nuclei and the dark energy carrier. This can be argued in the same way as in the previous paragraph. This means that through constant interaction with the dark energy carrier, some non-zero energy is continually injected into the nucleus. This leads to both the binding energy and the nuclear mass defect continuously decreasing. This process is extremely slow (Harutyunian, 2024), but it inevitably gradually destabilizes atomic nuclei due to an increase in their mass and a decrease in their binding energy.

Thus, if we accept the existence of dark energy that can be transferred to baryonic objects, this inevitably leads to the destabilization of all objects, including atomic nuclei and baryons themselves, changing the entire known physical picture. This process cannot be described as anything other than the evolution of atomic nuclei. We conclude that, as a result of interaction with the carrier of dark energy, the atomic nuclei and baryons themselves inevitably evolve, which in this context means an increase in their mass and a decrease in their stability.

We've always been taught that all atomic nuclei heavier than hydrogen and helium are formed deep within stars through nuclear fusion (which, figuratively speaking, is the equivalent of fusion and accretion in the microcosm). However, for energetic reasons, such reactions are only possible up to the iron nucleus. For nuclei heavier than iron, the specific binding energy decreases, and therefore, the formation of heavier nuclei by this mechanism becomes energetically unfavorable. The existence of heavy radioactive nuclei seems even stranger if their formation also occurred through a clever method of neutron capture. Nature would hardly expend great effort to create nuclei destined to decay in one way or another. In the paradigm we're considering, all processes proceed in one direction: the gradual destabilization of heavier nuclei and the formation of lighter ones through the decay of radioactive ones. Radioactive nuclei are those that have already transitioned from a stable to an unstable state.

We conclude that evolutionary changes in nuclei lead to their gradual destabilization, resulting in stable nuclei becoming radioactive. Radioactivity is a form of activity in which an atomic nucleus decays or releases a particle/energy due to excess internal energy. Physicists have always known this and have described this process with considerable confidence. Here, we add only that the excess energy that destroys an atomic nucleus accumulates as a result of the interaction of these nuclei with a carrier of dark energy.

Within the framework of the considered paradigm of the universal evolution of baryonic matter, all atomic nuclei are subject to the evolutionary changes described above. Any large cosmic object (a star, a galactic nucleus), in turn, consists of a huge number of atoms whose nuclei are evolving. It is therefore clear that at any given moment, a certain fraction of the heaviest nuclei within a given structure are in a radioactive state and are already releasing the absorbed dark energy. This occurs through the ejection of particles and/or the emission of radiative energy. Both of these mechanisms increase the internal energy of the macrostructure itself.

4. Systems of cosmic objects

Our conclusion is transparent and natural. All baryonic structures in all hierarchical structures of the universe continuously receive energy from the carrier of dark energy. In the microworld, this energy gradually compensates for the mass defect. Therefore, it reduces the binding energy of the atomic nucleus and baryons. As a result, the mass of atomic nuclei and individual baryons increases, the temperature (kinetic energy) of matter rises, and electromagnetic radiation is generated. Macroscopic objects, which consist of atoms, cannot infinitely increase their internal energy. Therefore, they release it through various means. The simplest mechanism is the emission of electromagnetic waves. If this mechanism is insufficient to release excess energy, matter ejection occurs. This can take the form of stellar wind, and with a more intense mass

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increase, large clumps of matter can also be ejected.

Traditional cosmology and cosmogony hold an opposed view, since they see the reverse process, the fusion of objects, as the formation scenario of all baryonic structures. Such mechanisms, which are essentially modifications of the Kant-Laplace hypothesis, include merging galaxies, accretion at various scales, and the synthesis of heavy atomic nuclei. All of them contradict the law of entropy increase, considered one of the "supreme" laws of physics (Eddington, 1929).

The prevailing concept of the formation of baryonic objects and structures often gives rise to paradoxes. The reason lies in two a priori assumptions. The first is the hypothesis that all baryonic structures formed through the gravitational compression of gas clouds. To account for the compression, the second hypothesis adds that the virial of these clouds was negative. These two assumptions rule out the possibility that the structures formed in this way could be expanding entities. Examples include both galaxies and galaxy clusters. To reconcile the enormous velocity dispersions in galaxy clusters with the traditional mechanism of their formation, a free parameter in the form of dark matter was introduced (Zwicky, 1933, 1937). This parameter subsequently became a lifeline in interpreting the rotation curves of spiral galaxies. This is because the expansion of these systems cannot be taken into account. This is why the clearly observed Hubble expansions in the Solar System (Dickey et al., 1994, Lainey et al., 2020), for example, are attempted to be explained by tidal effects and the transfer of angular momentum from the central object to the outgoing one.

It seemed that the discovery of dark energy should have changed the situation, but mainstream science continues to obey the dictates of the hypothesis mentioned above. However, the history of the emergence of the concepts of the two dark substances deserves a closer look. While dark matter was introduced to reconcile observational data with an a priori accepted hypothesis, dark energy is a transparent statement of the observational data. Therefore, there is no doubt that if a choice between the two arises, the second has a clear advantage.

We want to emphasize once again that a self-consistent application of the laws of physics inevitably leads us to the conclusion that the total energy of all cosmic objects and their systems gradually increases over time. In this case, the rate of energy transfer is irrelevant. What matters is that the energy is transferred in one direction—from the carrier of dark energy to baryonic objects. Since energy is cumulative, it accumulates in these objects and their systems over time. This means that the energy balance is changing, and the baryon structure must release its excess energy. The release occurs through the expansion of any system of gravitational objects, releasing energy in the form of clumps of matter or excess radiation. This is what constitutes activity or instability.

Furthermore, this is an evolutionary stage for any object, and it presumably should exhibit repetitive behavior. Indeed, if an object accumulates so much energy over a certain period of time that it threatens its existence, then it must release this energy. This is precisely when the activity phenomena discussed here occur. The release of accumulated energy is a more fleeting process than its accumulation. Once the amount of accumulated energy no longer poses a threat to the existence of a given object, the emission processes cease. However, the accumulation process continues, and after some time, the active phase may recur.

5. Concluding remarks.

A detailed study exhibits that as a result of the interaction between baryonic matter and a dark energy carrier, the latter transfers part of its energy to baryonic objects. We have already mentioned that the discovery of dark energy itself was due to this energy transfer, which accelerates the Universe's expansion. It was the discovery of acceleration that suggested the existence of dark energy and its transfer to baryonic structures. On the other hand, this interaction may be the mechanism that provides energy for various active or unstable phenomena. It is also clear that if this mechanism is the source of energy for active phenomena, then the amount of energy released during various instability processes can be considered insignificant compared to the total supply of dark energy.

Within the framework of the paradigm we consider here, instability phenomena are easily explained by the mechanism of dark energy conversion into the energy of baryonic objects. Moreover, the self-consistent application of this mechanism makes it obvious that introducing the ideas of black holes and dark matter into science is unnecessary. These hypothetical objects and substances, in our view, entered science and became established as coherent free parameters, nothing more. It happened because the scenarios of cosmology and cosmogony, used to describe the formation of baryonic structures, were dictated by unrealistic a priori

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hypotheses. This is reminiscent of the use of the geocentric system in the Middle Ages.

This approach and the mechanism for energy transfer to baryonic objects based on it appear more natural and physically defensible. True, it differs sharply from what is used in mainstream science, but it is based solely on observational facts and well-established physical laws. It is even possible to carefully conceive and implement a method for solving the inverse problem, in which the amount of energy released during unstable phenomena is used as input to determine the rate of energy transfer to various objects. Clearly, this is far from a trivial task. However, on the other hand, it does not seem completely hopeless and could lead to interesting results.

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