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# Galactic Traces of Hydrogen Regeneration

The article discusses direct consequences of hydrogen regeneration mechanisms observed in galaxies when galactic nuclei are active. Previously, these mechanisms have been presented by describing the work of structures that form quasar jets. Based on evaluation of the findings obtained through observation of our Galaxy and intergalactic space, the present article gives direct evidence that the aforementioned processes exist. The adduced evidence is astronomical objects that have come into existence as a result of hydrogen ejected by jets together with plasma and dust. In terms of the Milky Way galaxy, this fact is emphasised by direct astronomical observation of its elements. There are also evidential findings among intergalactic astronomy observational data, whose origin is explained comprehensively in terms of the present approach. However, the provided findings are traditionally regarded from the prevailing Big Bang theory perspective. For instance, according to this theory, huge intergalactic hydrogen clouds are interpreted as residual hydrogen left from the primary explosion. The Milky Way observation results include data indicative of alleged contribution of the given processes to formation of some of its structural elements, including a number of satellite galaxies. There is a criterion whereby it is possible to distinguish galactic gas clouds and star clusters formed of galactic matter itself. This matter containing a great deal of regenerated hydrogen was ejected from a galactic nucleus during the period of its activity. Based on the example of a spiral galaxy, it is assumed that active galactic nuclei are possibly involved in the formation of its morphology. It is concluded that, when being active, a central supermassive object performs its primary function, which is to process waste produced during the life of stars. This process is the final link in the galactic life cycle, which consists of two reciprocal processes. The first one is about hydrogen burning continuously in stars, while the second one is about episodic activity of the galactic nucleus, which results in star waste that contributes to regeneration of hydrogen needed to maintain direct processes within the galaxy. The two specified processes are associated with one more process: stellar electromagnetic radiation energy extended beyond the galaxy partially returns to it. The process is completed due to a fragment of dark matter. The overarching conclusion can be drawn: as a functional system, the Universe is well-organised and self-sufficient to last forever.

***Key words:*** quasar; jets; hydrogen regeneration; clouds of gas and dust; star clusters; satellite galaxies; spiral arms.

## Introduction

A small article published on the website [1] has been revised, completed with additional observational data and interpretation thereof from the perspective applied herein, and re-published, due to the interest therein expressed by specialists.

The article [2] presents a scheme of how stellar baryon waste is processed, which results in most nuclei of chemical elements disintegrating into light fragments whose main component is hydrogen. According to the assumption set forth in the article, jets from central supermassive dark stars (from “black holes”) contain predominantly photons, electrons, protons, and neutrons. Also, jets may contain unprocessed stellar remains, i.e. nuclei of heavy elements (dust and gases). The latter fragments can be drawn into jets from an accretion disk and might partially be captured from the volume of the galaxy as the jets pass through interstellar matter.

Due to the work of the mechanisms described in [2], a number of cosmic objects formed out of matter ejected by jets appear in galaxies and intergalactic space over time, which is borne out with observation data from astronomical and astrophysical databases.

Given the specified mechanisms and using the hypothesis about the origin of the dark matter fragment outlined in [3], the full life cycle of a large galaxy appears to consist of two key phases. The first phase has to do with nuclear fusion constantly observed in stars and associated with hydrogen burning out (which is a direct process, according to the currently accepted perspective). The second phase has to do with periodic activity of a galactic nucleus, which is associated with disintegration of heavy elements obtained during the first process into less complicated elements. In other words, the second phase is a reverse process in relation to stellar nucleosynthesis. During this process, star waste is disposed of, with hydrogen regenerated.

The entire stellar population of a galaxy, with its hydrogen burning out quite slowly, is involved in the direct process. This process leads to accumulation of heavy elements in the galaxy and to partial loss of energy due to electromagnetic radiation leaving the galaxy. Hydrogen can be burning out slowly in the galaxy for many million years.

During the reverse process, the galactic supermassive centre gets involved in order to process spent stellar matter found in the area of its gravitational influence. During the second phase, the galactic nucleus gets extremely active, a tremendous amount of energy is emitted, and the centre of the galaxy turns into the brightest quasar. The quasar phase experienced by nuclei of ordinary galaxies, previously predicted in [2], has already been proven through observations [4,5].

These two processes – the direct one and the reverse one – take place simultaneously in galaxies, however, their intensity differs: the first process takes place continuously, with hydrogen burning out slowly, whereas the second one is quite an infrequent process whose short phase is one of the most highly energetic processes in the Universe. Thus, the power of the quasar multiplied by the time of its "operation" is approximately equal to the product of the total power radiated by all the stars in the galaxy multiplied by the time span between two related moments of "switching on" the quasar.

At the stage of no-quasar phase, simultaneity of the reverse process and stellar hydrogen burn-out results from slow preparation of the galactic centre for its forthcoming active phase. Preparation involves gravitational collection of spent stellar matter by the central supermassive object and acceptance of dark matter in the form of extremely light bosons obtained by coupling microwave quanta [3].

When capturing dark matter, a supermassive nucleus receives energy which is used during the active phase to process available baryon waste and eject the processed material into and beyond the galaxy. Relatively slow movement of the dark component into the galaxy is the third process that runs uninterruptedly and brings a part of the used electromagnetic energy back into the galaxy.

Quasar phase activation is completely defined by a degree of readiness of all the ingredients required for it to occur in the nucleus. Estimated conditions required for the galactic centre to get involved in processing stellar matter follow from the very purpose of the reverse process and the quasar model proposed in [6].

The emerged quasar shall "work" as long as supplies of matter and energy both from the central supermassive object and from matter captured by the quasar in the form of an accretion disk are sufficient for it to perform the function it is prescribed by Nature, i.e. to dispose of stellar waste.

## 1. Intergalactic clouds of gas and dust

Outflows of matter – jets – are ejected from an active galactic nucleus. The jets are able to carry matter towards the close proximity of the galactic nucleus as well as towards the halo, and even far beyond it.

According to observational results, velocities in the initial sections of jets coming from large accretion disks of central supermassive objects might not only be close to the speed of light but may also exceed it. This fact is very humbly mentioned by some research groups in their articles and reports such as [7,8].

Effectiveness of matter ejection from the galactic nucleus is due to conditions inside the galactic centre. They include availability of a large accretion disk and achieved "capacity" of structures that jets are primarily made of. As these structures are initially weak, accretion disk matter is ejected into the close proximity of the galactic nucleus in the form of winds blowing out plasma and dust. As the structures build up, gushing-out matter gradually takes the shape of narrowing jets and is ejected into parts of the galaxy that are more remote from the nucleus [6].

With fully shaped structures, the matter they capture can be ejected far into intergalactic space. The fact that this matter is found beyond the galaxy is a direct consequence of extremely high velocities at the bases of jets from supermassive objects with large accretion disks.

The velocity at the jet base may prove to be sufficient for the ejected matter to break off the galaxy completely. In this case, the front of the jet shall move away from its host galaxy, losing its speed due to gravitational slowdown. With a certain value of jet head front's velocity in relation to the host galaxy, the jet might disintegrate and turn into a cloud of gas and dust, which will gradually extend as it moves further, due to its own jet rotation obtained from the accretion disk and, presumably, from the central supermassive object [6].

When large masses of matter are ejected in succession from the galactic centre in the same direction, two extended clouds of gas and dust emerge in intergalactic space. They are symmetrically located in relation to the galactic centre and are drifting away. The structure of withdrawing clouds will be dictated, to a great extent, by initial conditions and dynamics of the processes observed inside the galactic nucleus.

Therefore, ejected clouds may be flocky as the matter is fed unevenly from the accretion disk to jets or they might be rather elongated with no visible traces of rupture. One thing is sure, the clouds are going to withdraw from the host galaxy and, judging by observational data, they can be as long as dozens and hundreds of thousands of light years. However, there might be more compact clouds weighing as much as millions of solar masses, such as those recently discovered hydrogen clouds "drifting" between the Andromeda Galaxy and the Triangulum Galaxy [9].

It seems quite natural that the velocity at the base of the jet leaving the structures of the formation shall be determined by completion of the structures as well as by the characteristics of the accretion disk and the central supermassive object. Therefore, as the amount of accretion disk matter decreases and corresponding changes in the structures arise, the velocity at jet bases shall drop.

With a certain critical value of the velocity at the base of the jet, the mass of matter ejected outside the galaxy will lose its ability to overcome gravitational attraction completely and will not be able to permanently escape from galactic captivity. In this case, one part of ejected matter will withdraw from the galaxy forever, whereas the other part will be hindered by the force of gravity and then start falling back.

As a rule, masses of matter successively ejected outside the galaxy will have different velocities. Velocity of the head front of the ejected mass permanently withdrawing from the galaxy might turn out to be far from maximal as the structures it is made of may not be fully shaped but capable of ejecting matter at a high speed sufficient to let it separate from the galaxy. In this case, fully shaped structures will give the highest speed to new fragments of matter able to catch up with the first ejections and cause gases to blend with each other, generating a big and extending cloud of gas.

The velocity of jet matter permanently withdrawing from the galaxy shall decrease as physical and energetic capabilities of the accretion disk and the central object to support the process of treating stellar matter and ejecting it at a high speed decrease, too. Hence, matter permanently withdrawing from the galaxy shall have a velocity decreasing at the “tail” of the cloud.

Travelling across the universe, a loose and extended cloud of gas and dust shall occasionally elongate further and sometimes contract due to disparity in velocities of its parts. Weak forces of gravity in the cloud cannot always resist its extension in particular spots. This is only one of the possible formation scenarios for elongated intergalactic clouds with high hydrogen concentration and relative motion of its own parts.

Despite disintegration of heavy nuclei in internal parts of accretion disks and in jets, such clouds shall be characterized by their special composition of elements. It shall be a pale imitation of the composition of accumulated matter as heavy nuclei of the latter shall mainly be destroyed by a quasar operating at its full capacity. All these intergalactic clouds have one thing in common – high hydrogen concentration and, unlike original galaxies, lower concentrations of heavy elements – “metals”.

Although their full composition of elements, structure, and velocity depend on certain galactic conditions at the points when matter is ejected by jets, what these clouds have in common is their common purpose prescribed by Nature – to supply hydrogen to intergalactic space. This is the main channel contributing to formation of intergalactic clouds with high content of the main element – hydrogen – in the universe.

Clouds separated from the galaxy can travel across the universe for many millions of years, changing their trajectory when affected by gravitational fields of the galaxies they encounter and clusters thereof and interacting with clouds of gas they come across. Some of the clouds may be captured by galaxies and integrated into their own galactic structures. Some of the clouds can withdraw from their source at relatively low speeds and can even stay in its vicinity and form large coronas around host galaxies [10].

If a cloud is sufficiently extended in space and its trajectory parameters are appropriate in relation to a large galaxy it is approaching, the cloud might capture the galaxy in a ring-like manner. Apart from available initial elongation of the cloud of gas and dust, its additional gravitational extension by the galaxy to be captured shall contribute to this.

Over time, formation of stars shall begin in such a ring-shaped cloud. It is possible that stars were being formed inside the cloud at an earlier stage when it was travelling across intergalactic space for a long time, provided that conditions inside the cloud were conducive to this process and its velocity gradient was partially suppressed by its own gravity. In this case, a galaxy the cloud has encountered might obtain a ring made of gas and dust and containing new stars, i.e. a polar-ring galaxy is born (Hoag's Object).

As a rule, the chemical composition and relative content of heavy elements of the principal galaxy and those of its ring-shaped part shall differ. For the foregoing reasons, the content of heavy elements in the ring-shaped part, in percentage terms, is expected to be lower than in the galaxy, i.e. a significantly greater deal of hydrogen is expected to be found in the ring.

Based on the polar-ring galaxy organisation mechanism, it can be assumed that a rarer type of a polar-ring galaxy might exist. This rarer type shall contain two rings of different diameters, with their planes rotating almost perpendicularly against each other and against the plane of the principal galaxy. Note that the rings shall be formed out of different clouds emerged from ejected matter from different galaxies, which can be reflected in different chemical compositions of their gases and in differences in the age of stars. In this case, with the first ring already available, an outer ring might be formed under conditions where the weight of the disc galaxy is relatively big compared to the weight of the inner polar ring.

If it is a disc galaxy, it is quite possible that such a ring might be formed directly in its disc part since everything is defined by initial parameters observed when the galaxy and the extended cloud of gas and stars are approaching each other. Besides, the ring may rotate in the plane that is not necessarily aligned with the plane of the galaxy. Moreover, it can rotate in the opposite direction compared to rotation of the disc of the original galaxy, with the ring centre and the galactic centre aligned.

However, a question arises in this case: how long can such a combination of a stream of gas and dust with stars survive in the disc galaxy environment? Isn't powerful gravity of the galaxy going to destroy the "violator" of its structural order by integrating its gas, dust, and stars into its temporarily established structure?

Traces of such cloud intrusion might well be observed in some galaxies, for instance, based on availability of similar composition of elements in intruding stars that have partially been scattered already but retained, on average, their common motion direction vector when entering this galaxy.

Such elongated clouds merged with galaxies on their way can also result in a corresponding halo component. For example, the halo of the Milky Way consists of two components. These two components are found in stars with significantly different concentrations of chemical elements. Based on the fact that stars in the inner halo contain three times as much "metals" as the outer component, the outer halo is most likely to have been formed out of a captured galactic cloud emerged from ejected matter from a different galaxy. It is indicated by sharp discrepancies in concentrations of chemical elements in the components as well as by the fact that the outer component rotates in the direction which is completely opposite to that of the Galaxy [12].

If stars have partially been formed in a relatively elongated cloud that has existed in galactic space for a long time and the cloud is captured by a spiral or disc galaxy, a scenario is possible where a peculiar ribbon-like stellar stream shall exist in the galaxy for a short period of time. For example, the Phoenix stream in the Milky Way [11] might have originated as a result of such a collision between our galaxy and a small elongated galaxy formed out of matter earlier ejected from another galactic centre. At least, it seems reasonable to make such an assumption due to low content of metals in Phoenix stars.

The foregoing argument can be additionally reinforced with examples of some satellite galaxies of the Milky Way. For instance, among the four recently discovered satellite galaxies, a dwarf galaxy Reticulum II turned out to be the most elongated. Its length is eight times greater than its width. An ultra-faint dwarf galaxy Tucana III is alleged to be a tail of gas and stars moving towards the Milky Way. Given "the least diverse chemical composition" of these dwarf galaxies [13], an assumption can be made concerning their origin – they might have originated in clouds from matter disposed of and ejected by jets.

Apart from elongated clouds, differently shaped clouds of gas and dust can also be ejected from active galactic nuclei as everything depends on the processes that occur inside the nuclei and are reflected on geometry and kinematics of jets. Thus, galaxies can encounter a great variety of differently shaped clouds and capture them from intergalactic space. For example, they can be clouds of geometric shapes shown in the scheme in [14]. These high-velocity clouds intrude into the outer periphery of the Milky Way. The fact that they enter the halo of the Milky Way at a high speed and have a high hydrogen concentration indicates that they originated from matter ejected from other galaxies. The clouds are quite new as new stars cannot be seen therein. Consequently, their sources are alleged to be Local Group galaxies close to the Milky Way.

Composition of intergalactic clouds of gas and dust born out of matter ejected by jets shall not be similar to that of clouds whose origin is different, such as clouds born out of supernova explosions or other galactic processes unrelated to the most powerful explosions of central galactic objects, which also result in hydrogen generation [2]. First of all, their distinguishing feature shall be their substantially higher hydrogen content and lower content of heavy elements, in percentage terms, compared to clouds of different origin.

Another distinguishing feature of the specified clouds is their relatively large mass compared to ejections from supernova explosions, for example. With close spatial orientation of several successive jets, quite a large amount of gas and dust can be ejected from an active galactic nucleus into space. Everything depends on initial conditions in the galactic nucleus: the amount of energy accumulated by the central object, the weight of the accretion disk, its orientation in relation to the axis the central object spins on, etc.

The third distinguishing feature of these clouds is that they move in intergalactic space at relatively high speeds. Supernova explosions are unlikely to be able to provide clouds of dust and gas with velocities they need to completely withdraw from the bounds of their host galaxy, except that supernova explosions have occurred on the outskirts of the halo, which might enable a part of their matter to leave the galaxy permanently. However, they will be small intergalactic clouds of gas and dust.

Over time, new stars might start to form inside intergalactic clouds of gas and dust. A more recently formed cloud that has not withdrawn far away from its host galaxy shall have fewer bright new stars and a better chance of discovering some other traces of recent "work" performed by its host, such as a quasar that has created this cloud of gas and dust. Since such clouds are illuminated by nearby quasars, they have been detected by lines of hydrogen.

In [15] it is reported that gas clouds have been discovered in the vicinity of six remote quasars. They are interpreted as the first “dark galaxies” since the Big Bang. Stars have not been formed there yet. But they are typical clouds formed out of matter ejected from galactic centres at the moments of their activity. These clouds have not had enough time to get far away from their “parents” – quasars. As stars appear inside them, these clouds shall become regular new galaxies.

With a sufficient number of new stars inside intergalactic clouds, they are detected quite easily and interpreted as new galaxies that are being formed. For instance, in [16] an example of such a galaxy is given. It consists of blue stars, which indicates its relatively young age.

Remote “fossil clouds” [17] include numerous gas accumulations formed out of processed baryonic matter ejected by jets. However, for the time being many of such clouds in intergalactic space are interpreted as residual hydrogen accumulated as a result of the Big Bang.

The described mechanism of how elongated gas clouds with high hydrogen concentration form in intergalactic space is a possible mechanism of origin of cosmic threads of gas known as filaments. Powerful ejections of a tremendous amount of matter, with extremely high initial velocities of a gas bank and further parts of a jet ejected at a gradually decreasing speed, lead to elongation of this giant fragment of gas as it drifts across intergalactic space.

A drifting fragment of gas shall not only elongate but it shall also extend sideways according to its drift direction due to the angular momentum it has acquired from the accretion disk and the central supermassive object. Such extension of an elongated cloud shall be partially contained by its own gravity.

If two gas clouds of this kind pass each other closely or even intersect, this shall result in gravitational interaction, which is a viable way towards formation of a new galaxy.

## 2. Galactic clouds and groups of stars

For a virtually formed galaxy with a disc, jets are most likely to eject matter at the cost of disc matter accretion. Thus, matter shall be mainly ejected from the central nucleus in the opposite direction from the disc. If a velocity at the jet base is not sufficent for the matter to withdraw from the galaxy permanently, the cloud shall slow down subsequently, stop, and eventually fall down onto the galactic disc.

Ejected jets do not have to be perfectly perpendicular to the galactic disc. They might slightly deviate from normality as in case with “hourglass”-shaped radio emitting areas tilted towards the galactic plane at a 10-degree angle or so. Such clouds have already been detected in the Milky Way. They are found within the spectrum of the Fermi bubbles [18].

In the Milky Way, there are also hydrogen clouds that fall down onto the disc from the far periphery of the galaxy [19]. Apart from clouds drawn from intergalactic space, there is a chance they include clouds formed out of ejections from our Galaxy. Comparative analysis of compositions of elements and concentrations thereof might answer this assumption.

Moreover, clouds made from its own processed galactic matter shall not have high velocities as they fall back, unlike clouds captured from intergalactic space. In addition, clouds from the host galaxy shall be paired, as a rule, with each couple located at two sides of the galactic disc, approximately at the line going through its centre. Obviously, the latter shall be true unless trajectories of some of the clouds have been greatly changed by galactic gravity or a part of the clouds has mingled with other clouds in the vicinity of the galactic disc when crossing it.

As shown by analysis, high-velocity clouds that are detected in the outer part of the Milky Way halo and that are also falling down onto the Galaxy have a 10 times lower concentration of heavy elements than that observed on the Sun [19], which might well indicate they have originated from matter ejected from other galaxies.

Quasar jets can carry matter extremely far away from its host galaxy. However, velocities at jet bases might not be sufficiently high to permanently break the gravitational bond with the original galaxy. In such cases, time required to slow the clouds down and draw them back to the galaxy may amount to millions of years. This group of clouds also includes “tails” left from many powerful ejections of matter produced by jets when the residual matter drifting at a speed insufficient to let it completely withdraw from its host galaxy stops and starts falling back onto the galaxy.

Stars might well start to form inside these accumulations of dust and gas. A concentration of heavy elements in emerging groups of stars shall be lower than that of the original galaxy and their stars shall be newer than halo stars. Apparently, there are such star clusters in the Milky Way, with some of them, as a matter of fact, being about 4 billion years younger than our galaxy [20].

Hence, it can be expected that available globular clusters concentrated in the vicinity of the galactic centre shall include groups of stars born out of matter ejected from the nucleus of the Milky Way when it was active. The criterion applied to clouds of dust and gas that was described above can also be applied here: globular clusters formed out of its own galactic matter shall be located in pairs in relation to the galactic centre.

In terms of elliptical galaxies, due to the random motion of structural elements (stars, clouds of gas and dust, etc.) therein, their accretion disks can have various orientations in relation to the galactic coordinate system. Their jets shall carry matter in different directions from the nucleus, forming clouds in a variety of areas both inside the original galaxy and beyond its bounds. However, vast accumulations of gas and dust that are most remote from the galaxy are expected to be generated by large masses of accretion disks whose planes are perpendicular against the angular momentum of the central supermassive dark star [2].

If matter was ejected several times in succession by accretion disks whose angular momentums were close, which is more likely to be found in spiral and lenticular galaxies, it could result in formation of clouds of gas and dust that would rotate in predominantly the same direction. Such orientation results from the overall rotation of the galactic disk and, correspondingly, accumulated matter. It is feasible to analyse directions in which clouds of the Milky Way rotate. Such analysis might answer this assumption.

Furthermore, a disc galaxy where jets had similar directions might engender star clusters or satellite galaxies whose trajectories are not going to be random as opposed to the standard formation scenario for satellite galaxies. Trajectories of such star clusters shall be determined by the overall orientation of jets close to one direction, time spans between their ejections, and dynamics of the whole system of galactic objects.

So far, such relatively “ordered” motion of satellite galaxies has been detected in Centaurus A, Andromeda, and Milky Way Galaxies [21]. But such groups of satellite galaxies involved in ordered motion are bound to be observed in other large disk systems. Such satellite galaxies formed out of its own galactic matter shall be characterized by their even number and pairwise countermotion. This statement shall be correct unless some of the satellite galaxies have been destroyed by gravity of their host galaxy by the point at which they are observed.

It has to be added to the aforesaid statement that each pair of such satellites shall have stars of the same age and the same concentration of heavy elements reflecting an approximate chemical composition of the part of the galaxy located most closely to the nucleus at the point when matter they are formed of was ejected. Moreover, two dwarf galaxies inside each pair shall rotate similarly.

Such conclusions might well be verified.

As a possible mechanism for formation of satellite galaxies with non-random trajectories, a scenario may be considered where an original galaxy started to form out of a huge rotating cloud of gas and dust (a conventionally considered pattern of galaxy formation). As stars are born and a galactic centre with a growing dark star appears, the centre shall absorb matter from the areas of the emerging galaxy whose matter is most accessible for accretion upon a massive nucleus.

For the rotating cloud, such areas shall be volumes of two cones with their peaks in the emerging galactic centre and axes of symmetry parallel to the axis of overall rotation of the cloud. Therefore, a great deal of accumulated matter shall be ejected by jets in directions close to the plane of rotation of the cloud. If a big amount of matter has been ejected beyond the bounds of the original cloud but stayed within the area of gravitational effect of the emerging galaxy, a small satellite galaxy might well be formed out of each ejection of the kind. More precisely, two small satellite galaxies.

Given that formation of the principal galaxy is associated with several ejections by jets directed in similar ways, there might well appear satellite galaxies whose trajectories shall lie in planes that are relatively close to the plane of rotation. These satellites shall drift to and from the centre of the host galaxy until they are destroyed by powerful gravity of fundamental galactic structures.

## 3. Additional consequences of hydrogen regeneration in galaxies

The described mechanism for processing baryonic matter at the initial stage of its formation in the emerging galaxy is able to only partially destroy nuclei of “metals” from inner layers of the accretion disk. If a galaxy is formed out of a rotating cloud of gas and dust, initial work of a quasar shall be limited to scattering primary matter along cloud’s plane of rotation, which goes through the galactic centre.

Relatively close ejections produced by the first weak jets result in increased density of the cloud of gas and dust near the galactic nucleus and of the emerging disk of the future spiral galaxy. In this case, with “metals” of the primary cloud even insignificantly processed by the accretion disk and weak ejecting structures, relative hydrogen content in the emerging central bulge in the galactic disk shall increase slightly.

The mechanism for formation of disk systems through ejections of matter by jets can explain bulges observed in centres thereof. With this in mind, analysing quasar’s long work on formation of a galaxy out of a gas cloud, it might be assumed that traces of former jets may have been left in bulges of some galaxies.

It is a plausible assumption, supposing jets were directed in several preferred ways in space quite frequently, creating powerful gas clouds everywhere they could reach. Such traces might confirm the proposed formation mechanism through matter ejected by jets for spiral arms as well.

In addition, a stellar bar can also result from quite spatially close ejections of the first matter by jets in one preferred direction at the stage of galaxy formation, particularly, as it has already been said, at the initial stage of its disk nucleus formation when dust and gases are emitted within a relatively short range and at a low speed.

The centre of mass of an incipient galactic nucleus in the form of a supermassive object or an existing one that is increasing its mass by absorbing cloud matter may be close to the actual centre of mass of the cloud but not the same as it. Hence, galactic centre prolonged formation and mass accumulation at the cost of cloud matter may lead to its slight shift in the center-of-mass frame of the original cloud, which shall also contribute to slightly shifted trajectories of incipient satellite galaxies.

Consequently, if a large cloud of gas and dust has been processed by a galactic nucleus for a long time, it results, by means of the specified mechanism, in specific layout of trajectories of some satellite galaxies in large disk systems briefly described in [21].

As it has already been said, there is a chance that spiral arms of spiral galaxies have formed as a result of gas cloud matter ejected by jets from the centre of the cloud, and not only as a result of the density wave mechanism. At the initial stage of matter absorption by two specified cones, accretion disks may not lie in exactly the same plane. Thus, arms of an emerging spiral galaxy might be slightly shifted from the Galactic Midplane, with one arm “above” the midplane and the corresponding second arm “below” it.

Additionally, it might be pointed out that the proposed mechanism for formation of spiral arms in spiral galaxies by means of jets can lead to formation of flocculent galaxies whose arm patterns are patchy and do not form continuous spirals [22]. Such discreteness in spiral structures is due to the fact that jets eject matter in chunks, which are determined by features of formation of accretion disks directed almost in the same way and with relevant ejecting structures formed.

A question arises: can this hypothesis be proven or refuted by comparing and contrasting topology of two completely opposite spiral arms? If the arrangement mechanism for spiral arms by means of jets is correct, fragmentations of two opposite twin arms have to be relatively “symmetrical” in relation to the galactic centre.

It should be noted that regular structure of spiral arms is less marked in 60% of spiral galaxies [22]. This fact indicates that formation of spiral galaxies out of matter processed and ejected by jets is quite plausible and that the cause of indistinctly marked spiral arms might be related to mismatched orientations of emerging accretion disks. In other words, directions of ejections lie in approximately the same plane, close to the galactic plane, however, their orientations are slightly different, which is reflected in the blurred state of spiral arms.

As matter ejected by jets has to be processed by a quasar, higher density of hydrogen is supposed to be observed in spiral arms, in comparison with its density in the space between them. In the Milky Way Galaxy, this fact is observed even at the moment.

All the things described above are just a flow sheet of a possible mechanism for formation of satellite and spiral galaxies. The flow sheet is in need of more precise model calculations. Moreover, a weakness of the presented chart is the origin of the odd number of spiral arms unless, of course, it is deemed possible that one of the jets might have been directed towards a thick layer of galactic matter, have failed to "break through" it, and have been dispersed inside the bulge.

## Conclusions

The present article based on astronomical observational data gives evidential findings of hydrogen regeneration in active galactic nuclei. Regeneration processes that occur in quasars result in ejections of processed star waste into galaxies and intergalactic space by jets. Such ejections of matter both within the bounds of galaxies and into intergalactic space contribute to renewal of stellar populations of galaxies and give new islands of stars – new galaxies – a chance to be born.

High-velocity gas emissions ejected far beyond galaxies in the form of elongating and rotating gigantic clouds is a straight way to formation of filaments – giant intergalactic threads of gas. Encountering similar long gas clouds from other galaxies, they start to interact with them, which leads to formation of new islands of stars.

Thus, existence of old, mature, and relatively young galaxies as well as formation of new stars and hydrogen clouds in existing galaxies and in intergalactic space – all these facts indicate that structural elements of the Universe are continuously renewed. Furthermore, this process is in no way related to the hypothetical Big Bang – hydrogen is obtained when star waste is processed during the active period of galactic nuclei in their quasar phase.

Only one conclusion can be drawn from the presented material based on available observational findings: the Universe is a harmoniously arranged and self-sufficient system. Its eternal existence and development are inherent in it.

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## Галактичні сліди регенерації водню

Розглядаються прямі наслідки з механізмів регенерації водню, які існують в галактиках в період активності їх ядер. Раніше ці механізми були представлені через опис роботи структур, які формують джети квазарів. У даній статті наводяться прямі докази існування зазначених процесів на основі аналізу результатів спостережень нашої Галактики і міжгалактичного простору. Наведені докази – це космічні об’єкти, що з’явилися наслідок викидів джетами водню спільно з плазмою и пилом. Для галактики Чумацький Шлях цей факт підкреслюється прямими астрономічними спостереженнями її елементів. Доказові результати є також серед наглядових даних міжгалактичної астрономії, походження яких добре пояснюється в рамках викладеного підходу. Однак наведені результати традиційно розглядаються через призму пануючої концепції Великого вибуху. Наприклад, в цій концепції наявність великих міжгалактичних водневих хмар інтерпретується як залишковий водень від початкового вибуху. Серед результатів спостережень Чумацького Шляху є дані, що вказують на можливий внесок розглянутих процесів у формування деяких його структурних елементів, включаючи частину галактик-супутників. Наводиться критерій, згідно з яким, можна виділити галактичні газові хмари і зоряні групи, організовані з власної матерії галактики. Ця матерія, яка містить велику частку регенерованого водню, була викинута з галактичного ядра в період його активності. На прикладі спіральної галактики висловлюється припущення про можливу причетність активних галактичних ядер до формування її морфології. Робиться висновок, що центральний надмасивний об’єкт в період своєї активності, виконує основну свою функцію - здійснює переробку відходів життєдіяльності зірок. Цим процесом замикається ланцюжок життєвого циклу галактики, яка складається з двох взаємообратних процесів. Перший процес – це безперервне вигорання водню в зірках, і другий – епізодична активність галактичного ядра, в результаті якої з зоряних відходів відновлюється водень, необхідний для підтримки в галактиці прямих процесів. До зазначених двох примикає ще один – процес часткового повернення в галактику енергії зоряного електромагнітного випромінювання, що вийшов за її межі. Він реалізується за допомогою фрагмента темної матерії. Робиться головний висновок: Всесвіт, як функціональна система, є добре організованою і самодостатньою для свого вічного існування.

***Ключові слова:*** квазар; джети; регенерація водню; газопилові хмари; зоряні скупчення; галактики-супутники; спіральні рукави.

# Галактические следы регенерации водорода

Рассматриваются прямые следствия из механизмов регенерации водорода, которые существуют в галактиках в период активности их ядер. Ранее эти механизмы были представлены через описание работы структур, формирующих джеты квазаров. В данной статье приводятся прямые доказательства существования указанных процессов на основе анализа результатов наблюдений нашей Галактики и межгалактического пространства. Приводимые доказательства – это космические объекты, появившиеся следствие выбросов джетами водорода совместно с плазмой и пылью. Для галактики Млечный Путь этот факт подчёркивается прямыми астрономическими наблюдениями её элементов. Доказательные результаты имеются также среди наблюдательных данных межгалактической астрономии, происхождение которых хорошо объясняется в рамках излагаемого подхода. Однако приводимые результаты традиционно рассматриваются через призму господствующей концепции Большого взрыва. Среди результатов наблюдений Млечного Пути имеются данные, указывающие на возможный вклад рассматриваемых процессов в формирование некоторых его структурных элементов, включая часть галактик-спутников. Приводится критерий, согласно которому, можно выделить галактические газовые облака и звёздные группы, организованные из собственной материи галактики. Эта материя, содержащая большую долю регенерированного водорода, была выброшена из галактического ядра в период его активности. На примере спиральной галактики высказывается предположение о возможной причастности активных галактических ядер к формированию её морфологии. Делается вывод, что центральный сверхмассивный объект в период своей активности, выполняет основную свою функцию – осуществляет переработку отходов жизнедеятельности звёзд. Этим процессом замыкается цепочка жизненного цикла галактики, которая состоит из двух взаимообратных процессов. Первый процесс – это непрерывное выгорание водорода в звёздах, и второй - эпизодическая активность галактического ядра, в результате которой из звёздных отходов восстанавливается водород, необходимый для поддержания в галактике прямых процессов. К указанным двум примыкает ещё один – процесс частичного возвращения в галактику энергии звёздного электромагнитного излучения, вышедшего за её пределы. Он реализуется посредством фрагмента тёмной материи. Делается главный вывод: Вселенная как функциональная система является хорошо организованной и самодостаточной для своего вечного существования.

***Ключевые слова:*** квазар; джеты; регенерация водорода; газопылевые облака; звёздные скопления; галактики-спутники, спиральные рукава.

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