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QUASARS -- ACTIVE NUCLEI OF YOUNG GALAXIES

B.V. Komberg

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B. V. Komberg

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16. Abstract The hypothetical properties of "young" galaxies and possible methods of observing them are discussed. It is proposed that star formation first takes place in the central regions of protogalaxies which may appear as quasar-like objects. An evolutionary scheme is outlined in which the radio quasars are transformed in time into the nuclei of radio galaxies.

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SUMMARY

The hypothetical properties of "young" galaxies, as well as the possible means of their observation, are discussed. The hypothesis that the active star formation occurs almost instantaneously ($\Delta t < 10^8$ yrs) all over a "young" galaxy volume seems to contradict the observation data. It would be more natural to assume that the star formation first takes place in the central regions of photogalaxies, which at this stage, may appear as quasar-like objects. Under this assumption, an evolutionary scheme is outlined in which the radio quasars in the course of time are transformed into the nuclei of radio galaxies. By this we assume that the radio properties of the extended components of radio galaxies may remain the same for billions of years and be determined by the power of their nuclei in radio at the stage of formation (i.e. at the stage of a quasar-like object). The optical luminosity of the quasar-like object appreciably decreases after some $10^{7\div8}$ yrs, and the star formation process may at this stage extend to the rest of the galactic volume, spreading from its center outward. The assumption that the quasar-like phenomenon is a violent stage of nuclei formation in photogalaxies does not contradict the direct photoelectric and spectral observations of the neighbourhood of the nearest quasars now available. Moreover, the conclusion that one should look for "young" galaxies near the quasars naturally explains the fact that they were not detected in observations of the radio background fluctuations which exclude all strong radio sources.

QUASARS - ACTIVE NUCLEI OF YOUNG GALAXIES

B. V. Komberg

I.

The question of "young" galaxies, which is one of the basic in modern astrophysics, at this time is one of the most complex. Therefore, it is not surprising that today there is no unified point of view on a number of aspects important for this problem. This applies to the question of the time of formation of galaxies, views of the initial spectrum of perturbation and the nature of the perturbation (for a discussion of this question see, for example [1]). From observations, the peculiarities of stellar and gas composition of the nearest galaxies of different morphological types are approximately known. In principle, tracing the change of this composition in the galaxies found on different red shifts[1], one can talk about the evolution effect in them. The truth then is to make certain hypotheses as to the form of the initial function of mass of the stars forming and as to the changes in its form with time. In reference [3], for example, it is pointed out that the best agreement with observations are models of galaxies in which, besides decreased time for the rate of formation of stars, there occur irregular "flares of star formation," each lasting $\lesssim 5\cdot 10^8$ years. /5*

In connection with the fact that observations of young galaxies were important for understanding the processes leading to their formation, a number of models of "young" galaxies were proposed and attempts were made to observe them. In references [4, 5], a hypothesis was made that young galaxies form when $Z \simeq 10$-30 and lasting for the first $3\cdot 10^7$ /6
years, their luminosity in optics amounts to $\sim 3\cdot 10^{46}$ erg/e due to radiation of the forming masses of stars, making up in mass $\sim 10\%$ and in luminosity $\simeq 50\%$. Then, the gas in such forming galaxies will be

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[1]Unfortunately, only galaxies in the local group (distances < 100 Mps), although generally speaking, the galaxies are known to distances 10 times larger (up to $Z \simeq 0.8$) [2].

*Numbers in the margin indicate pagination in the foreign text.

ionized by powerful ultraviolet radiation of hot stars and one can expect a strong line L_α in which up to 10^{45} erg/s can be radiated. Due to the large red shifts, the maximum radiation takes place in the difficult-to-observe region 1-3 μm, and possibly, due to conversion by dust, in the longer wave field of 150-350 μm [6]. At any rate, young galaxies are not detected in these ranges [7, 8]. One should not rule out the fact that this is due to a fairly strong thermoradiation in these fields from interstellar, interplanetary and possibly intergalactic dust (see, for example [9, 10]). In reference [11], a model of a young galaxy is considered with a massive $2\cdot10^{11} - 1.2\cdot10^{12}$ $M_\odot$) halo in which the rate of development of the stars is presented in the form $B(mt) \approx m^{-n}e^{-t/\tau}$, where n varies from 2 to 3 and τ from 10^8 to 10^9 years. A type of continuous spectrum is considered from this object in different hypotheses and for different Z (from 2.3 to 9). The authors draw the conclusion that young galaxies of this type would have visible angular dimensions of ≈ 5" and in models of the Universe with q_o = 0.05 would be weaker by $(0.5 \div 1)^m$ than the maximum values in the research work [7]. In reference [12], it was proposed that one look for protogalaxies along the radiation line 21 cm of neutral hydrogen shifted due to a red shift at the level of fluxes $10^{-28} - 10^{-29}$ W/m^2Hz. However, measurements at a frequency ν = 328 MHz (corresponding to Z ≈ 3.35), made on 20 sections of the sky for an area of 1 kV·degr. each for intermediate galactic latitudes gave negative results in the levels of radiation fluxes predicted [13]. Also attempts were made to discover protogalaxies (PG [protogalaktika, protogalaxy]) according to fluctuation of temperature of relict background radiation $\Delta T/T$. This effect is expected in different theories of the formation of galaxies at the level $\Delta T/T \approx 10^{-4}$ [14] for interaction of quanta of background radiation with ionizing gas of fluctuations of density (when Z ≈ 1000) in future galaxies. In one of these latter works on this subject [15], data of observations of fluctuation of the background at λ = 3.9 cm are presented; these give $\Delta T/T$ less than several units at 10^{-5} for angular scales from 5 to 150. For explaining this contradiction between predictions of the theory and observations, the idea was presented of a secondary warming up of intergalactic gas (see, for example [16]) due to powerful ultraviolet radiation of "young" galaxies. Then, the fluctuation of a relict radiation which occurs when Z = 1000 will be "washed /7 out" with passage of the quanta through the medium optically thick ($\tau \simeq 3$) according to Compton scattering on free electrons. However, in reference [17] it was pointed out that even in the presence of secondary warming, which washes out the primary fluctuations at $Z \simeq 1000$, all the same one observes significant $\Delta T/T$ (in any theories of formation of galaxies at $Z<30$) due to the occurrence around "young" galaxies of giant ionized zones in which the brightness temperature can reach 100 K. Powerful UV-radiation of young stars maintains this temperature, reaching $\simeq 10^{45-46}$ erg/s.

For instance, we again apparently are in contradiction to observations. In a number of works [18, 19] however, the opinion is presented that young galaxies are observed and they are quasars. In [18], this hypothesis is introduced for explaining the very strong cosmologic evolution observed for radio quasars and weak radio sources right up to $Z \approx 2.5$. The authors, within the framework of the adiabatic model of formation of galaxies at $Z = 5 - 10$, consider that for the first 10^{8-9} years, in young galaxies very many massive fast-evolutionary young stars develop, whose total radiation can, in certain cases, simulate a quasar-like phenomenon. However, for an explanation of a number of peculiarities in radiation of separate quasars (changeability of radiation with time, polarization, etc.), one can propose the presence of another class of quasars directly involving activity of the nuclei of the system. Attempts to separate quasars into several groups by one of another characteristic have been made more than once. In particular, in recent years, unusual red radio quasars were detected (for example, [20], [21]), which have a number of specific properties: those weak in optics and with a very steep spectrum, weak variability, an emission spectrum similar to the spectrum of the galaxy with a strong line [OII] 3427, a large ratio of fluxes of radio components. One should not eliminate the idea that this "variety " of quasars similar in certain characteristics to objects of the BL Lacertae type, also can have a certain relationship to the problem of "young" galaxies. /8

In concluding the survey of hypotheses on young galaxies, we also note that among galaxies of the Aro, Markaryan type and compact Zwicky galaxies, objects are encountered which can be classified as "young"

galaxies or intergalactic IN II zones. For example, galaxies studied /9
in reference [22] IZω18 and IIZω40, according to [23], can be: either

1) "young" galaxies with an age of $\approx 10^8$ years or

2) galaxies in which, due to an unusual function of mass of developing stars, the star formation at early stages was retarded, or

3) normal galaxies in which right now a flare of star formation is occurring.

II.

When considering the discussion above, however one must not forget that in them by "young" galaxies one means a gaseous complex with dimensions of several tens of kps and mass $\approx 10^{11} M_{\odot}$, in the entire volume of which more or less simultaneously (10^8 years), massive, rapidly evolving stars occurred in a quantity explained by a type of initial function of mass and rate of star formation. But once again the hypotheses (or part of them) cannot prove to be fully true. In any case, /10
data on observations of so-called "hot spots" in certain galaxies (for example, [21a], interpreted as possible "flares of star formation," lasting $10^6 - 10^8$ years and encompassing in mass and space only insignificant fields of galaxies (see, for example [23a]. Then, such a "flare of star formation," which occurred in the central region of a galaxy can be perceived as an active nucleus. This conclusion is made on the basis of calculations of a collapse of a spherical protogalaxy. In references (for example [24], [25]) it is pointed out that in this case, at first, a nucleus is generated in which due to accretion of the gas from the surrounding volume, one can maintain a high rate of star formation for a long time, reaching a maximum value (approximately 100 3V/year) with red shifts $Z \approx 2$-3. This, in the opinion of the author, is support for the point of view that it is this stage of turbulent star formation in the nucleus which can be called quasar. Developing this point of view, in reference [26] OH 471 ($Z_{em} = 3.4$) and 4C 05·34 ($Z_{em} = 2.88$) quasars are proposed as the "young" galaxies. However, in reference [11] a number of objections to this point of view are

presented. These objections involve the small value of absorption for the Lyman limit in comparison with the predictions in [19]. In reference [26], different methods of observation of "young" galaxies are considered which are found at a stage of maximum activity of the nucleus. Then the author starts from the supposition that in the galaxy with $R \approx 30$ kps and $M \approx 10^{11} M_{\odot}$ after $\approx 2.4 \cdot 10^{8}$ years after the collapse began[2], about 30% of the primary gas goes into the star and /11
forms a very bright nucleus with a diameter $\lesssim 1$ kps. Even earlier [27], it was pointed out that the concept of a quasar as a bright stage in the formation of a nucleus in a protogalaxy does not contradict the observations and agrees with the spatial density of galaxies in the hypothesis of the short lifetime (10^{6-7} years) of quasars in optics and the powerful evolution of their number $N \approx N_{0} X (I + Z)^{5-6}$ in the past (up to $Z = 2.3$). On the basis of the continuity of properties between quasars and bright galaxies, both in optical and in radio ranges, similar conclusions were drawn in a number of other works [28-35]. This is applicable, for example, to the continuity of general dimensions of radio radiating components involving different types of spheroid optical objects [28, 35]; "joining" of functions of radio luminosity of nuclei of normal E_{galaxy} and weak radio quasars [29, 33]. In references [30, 31], the question of activity of nuclei of spiral galaxies is considered, in 2% of these, according to estimates in [31], quasar-like objects can form. If this is so, then due to the fact that spatial density of spirals significantly exceeds spatial density of bright EG, quasars - nuclei of spiral galaxies will be observed more than quasars - EG nuclei.

Starting from such indirect expressions, we made assumptions and attempts to reconstruct the course of evolution of peculiar objects from quasars (or quasar-like phenomena) to nuclei of galaxies of various types (see, for example [30, 31, 33, 34]). /12

Finally, in these evolved systems, there is not yet any uniformity

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[2] The time of origin of the collapse (or the time of stopping) is assumed to be the time of free fall:

$$t_{f.\ fall} \approx \left(\frac{3\pi}{32 G \bar{\rho}}\right)^{1/2} = 2 \cdot 10^{8} \left(\frac{r}{25\ \text{kps}}\right)^{3/2} \cdot \left(\frac{M}{10^{11} M_{\odot}}\right)^{-1/2} \text{yr.}$$

due to the fact that they do not contradict the existing observations but do not yet follow their laws. Moreover, because between separate sections of evolution systems there are no clear boundaries, one can still talk only of the initial, final and intermediate stages in the evolution of quasar-like objects. In most of these systems it is assumed that the optical radiation is attenuated much more rapidly than the radial. This, generally speaking, is fairly natural because radial radiation in all probability, is responsible for fewer energy particles, moving with relativistic velocity in extended fields (hundreds of kps) with weak (10^{-5} - 10^{-6}Gs) by magnetic fields. In reference [34] a stronger hypothesis is made that the total power of radiation in a radial range from extended components depends on the degree of activity of the nucleus of the galaxies on the stage of its formation, that is, on the stage of the quasar. It is considered that the galaxy extending for 10^{9} years and more, in this degree, will be a radial source in which its nucleus was a radial source in its active phase. From this point of view, the evolutionary system for nuclei of objects of different types could be looked at approximately in the following way (see also [31]):

1. A Quasar in a Spheroid System

a) radio sequence

radio quasar (QSR) → N - radio galaxy (NGR) → radio galaxy (RG)

b) not a radio sequence

not a radio quasar (QSE) → N - not a radio galaxy (NEG) → normal EG.

2. A Quasar-Like Phenomenon in SG /13

a) radiosequence (SyG)

Q SyG (time 3C-48) → NSyG (type 3C 120) → SyG

b) not a radiosequence (SG)

QSG → NSG → SG.

According to this system, the total activity of nuclei in all ranges with time drops (although less powerful recurrent flares are possible on this background) and the power of radiation of extended radio components, in whose relativistic particles all history of activity of the nucleus is accumulated, can radiate for billions of years and remain more or less at a single level and reflect the total energy of the nucleus in the period of its greatest activity. A similar, however not completely coinciding with ours, point of view is developed in [31]. According to the author, a quasar-like radio phenomenon is present all of the time in the nuclei of bright E galaxies and not radio and in bright S-galaxies. In weak S-galaxies, this phenomenon continues only for ≈ 2% of the time. The primary characteristic of activity of a nucleus is considered their radio properties and optical radiation and radio radiation from extended components are considered as secondary phenomena. Evolution with time, touches on primarily the extended radio components and nuclear radio sources change their activity to a lesser degree, deriving energy due to accretion at the center of the substance ejected during evolution of the star into the galaxy.

In the system considered in [31], quasar-like objects of various types (QSR, QSE, QSyG) developed in a certain type of galaxy, were retained (except for QSG in our terminology) in them for the entire time. That is, in [31] evolution of luminosity of quasar-like objects with /14
time is not considered; for us this is a basic moment distinguishing the activity of nuclei in "young" galaxies (QSR, QSE, QSyG and QSG) from the properties of nuclei in more remote evolved systems (RG, EG, SyG and SG).

Although many authors are agreed that quasar-like phenomena are a turbulent phase in the development of nuclei of certain types of galaxies, however there is no unity on the question of what stage of evolution of the galaxy this phenomenon is. A number of authors consider that a quasar is the final stage in the evolution of a nucleus of an old galaxy (for example, [36]), the other - that the quasar is a recurring phenomenon [37], a third (including this author) - that a quasar is a stage of formation of a nucleus in a young system. For supporting the latter point of view, one can introduce a number of indirect arguments.

For example, evasion by the quasars of rich clusters of galaxies and the absence of physical pairs of quasars. ne can relate this to the continuity of properties of quasar-like objects along with properties of their ambient systems taking into account the spatial densities of the latter (see, for example, [33]). One can also enlist data on negative results for a search of young galaxies according to fluctuations ($\Delta T/T$) of background radio radiation [15, 38]. However, it is necessary to note that with the development of observation material of radio observations, all of the discrete radio sources are ejected including the quasars. But if the quasars find nuclei in "young" galaxies, then this procedure automatically results in ejection and "young" galaxies, that is, fields with probably the most marked $\Delta T/T$. That is, from this point of view, one should not be surprised that no secondary fluctuations of $\Delta T/T$ are observed. These primary fluctuations (when $Z \approx 1000$) can be "washed away" due to the large optical thickness of the ionization gas, which we were talking about earlier. /15

III

Finally, there are possibilities for direct evidence of the proposed youth of the systems around quasars. These possibilities, obviously, involve direct observations of the areas around quasars, primarily, those closest to them ($Z \leq 0.2$)[3]. Such observations have already begun both using a) electrophotometry, and using b) spectrophotometry. Let us discuss in more detail the results of these studies.

a) Even in 1963 [40] during studies of the question of possible entrance of the nearest quasars 3C 273 and 3C 48 into the cluster of galaxies around 3C 48 ($Z = 0.367$), a reddish nebula was detected with dimensions $6'' \times 12''$ (30 X 60 kps when $H_o = 50$). The total brightness of the nebula reaches $M_V = -22^m.8$, and the average surface brightness $\approx 23^m/\square''$. The quasar itself has $M_V = -24.3$ and lines in $3''$ to the north of the center of the nebula.

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[3] For a full list of quasars, see reference [39].

The 1973 [41] nebulae was detected around several close weak [4] quasars in photographs from a 6-meter telescope (Table 1). In this same year [42] it was found that N-galaxies showed up in optics as bright quasar-like nuclei surrounded by a weak extended (tens of kps) nebula which, according to the distribution of brightness /16 and light along the radius is similar to the giant ellipsoid systems. In the U and B filters, nonthermal radiation of the nucleus is dominant and only in the V radiation does the nebula give approximately 50% in the total luminosity of the object (Table 2).

In recent years, works have appeared on a certain object - quasars, N-galaxies, lacertids and Seyfert-like galaxies (Table 3). In truth, here one must keep in mind that due to selection, during observations on photographs of distant environments of quasars, as a rule, the N-galaxies are more rapid, that is, in our system the remote evolved quasars around which one can successfully form stellar systems (for a discussion of this question see, for example, [33]).

b) also spectroscopic studies were made of the environs of certain quasars and N-galaxies (Table 4). This a very difficult task because one must obtain spectra of extended weak-luminous ($\approx 23^m/\square''$) formations in a few angular seconds from the bright nucleus, that is, in conditions where scattering is strong and it must obligatorily be taken into consideration. Studies showed that in nebulae, narrow and strong forbidden lines are detected of a number of high-perturbation elements: [O II], [O III], [Ne III], [Ne V]. Broad resolved lines characteristic for quasars are not visible. The signs of stellar lines of absorption also are not detected. A nonthermal continuum is very weak and apparently, in it, the portion of scattered radiation from the quasar is large. For more detail on this, the nebula around 3C 48 was studied. The spectrum obtained at an angular distance of $\approx$ 4" from the quasar ($\approx$ 40 kps) showed that the lines have a larger equivalent than that in the quasar and are shifted in relation

[4] If one takes more distant or brighter quasars, then their radiation on the photoplates will "wash out" the weak image of the nebula, whose angular dimensions do not exceed a few seconds of an arc.

to the quasar lines by $\Delta Z = + 0.019$, which in the system of coordinates 3C 48 corresponds to the difference of velocities equal to +420 km/s. An analysis of these data [53] permitted concluding that the 3C 48 quasar is in a very rich gas galaxy ($Ne \approx 3 \cdot 10^{-2} - 5 \cdot 10^{-2}$ cm^{-3}, M of the gas $= 10^{10} M_{\odot}$) and that for ionization is responsible for strong radiation from 3C 48 in soft X-rays (~ 0.1 keV). All of this taken together leads one to the idea that the 3C 48 quasar is a nucleus of a spiral (and not an elliptical) galaxy rich in gas. The peculiarities of the structure of radio radiated fields are evidence of this - the 3C 48 does not have extended components. /17

Spectroscopic and electrophotometric studies of the environs of quasar-like objects are, at the present time, one of the basic problems in observations of quasars and the clarification of their nature. These studies make it possible, in the final analysis, to answer the question of whether or not quasars are active nuclei in the stellar systems which have formed or if they are powerful forerunners occupying a position around which, in time, a stellar system will yet arise. It seems to us that the more correct hypothesis on a quasar is that it is a turbulent stage in the birth of a nucleus in a still gaseous protogalaxy. The occurrence at the center of the protogalaxy of this type of source of ionizing radiation which is a quasar must halt the process of star formation in all protogalaxies (even if they have begun) which can be renewed (or begun) only after extinction (after 10^{7-8} years) of powerful UV-radiation of the quasar. After this "wave of star formation" it moves, apparently, from the center to the periphery. This is due to the fact that recombination first encompasses denser central fields where star formation begins. One should not eliminate the idea that it is in this connection that a number of facts observed on change of properties of galactic formations occurs (such as HII zones, spherical clusters, etc.) as one gets farther from the center of the Galaxy. From this point of view, one should not eliminate the idea that certain compact galaxies can be objects in which star formation has not yet successfully encompassed the periphery. Therefore, it is not surprising that in them one observes a powerful gaseous component concentrated in the exterior fields. /18

While further observations confirm the hypothesis that quasars are an active phase of formation of a nucleus in "young" galaxies, one more interesting problem arises. It involves the question of possible methods of "survival" of certain protogalaxies in the gaseous phase up to the present time. Apparently, here there are two possibile ways:

1). The main portion of the protogalaxy passes through an cluster of galaxies where the amplitude of fluctuation of density was higher and the galaxies, like stellar systems, were formed earlier. In these protogalaxies, which did not drop into the cluster (remember that quasars avoid clusters), the process of star formation was prolonged.

2). At the present time, the process of formation of galaxies of the second generation from gas already enriched with heavy elements due to evolution of stars in galaxies of the first generation, can occur; (the situation here must remind one somewhat of the problem of stars of the first and subsequent generations). In this case, the second generation galaxies and their nuclei can differ from first generation galaxies. In particular, this difference will apply to the chemical composition and, as a result, the type of initial function of the mass of forming stars.

Finally, it is impossible to eliminate any intermediate cases. /19
In particular, it is possible that in this whole problem there are applications of so-called high-velocity clouds of hydrogen - gigantic gaseous complexes detected along the 21 cm line close to certain galaxies of the Local group (see, for example [49]). One should not eliminate the idea that more powerful gaseous complexes can exist around (or between) clusters of galaxies. In certain cases, they can be the material for the formation of protogalaxies at the present time. (Possibly, not without galaxies of the first generation dropping enriched metals of gas into them.) Truly the question remains unclear as to how these gaseous complexes could form or in what way they were swept out from the giant galaxies or clusters of galaxies.

In conclusion, we will pause very briefly on a few aspects of the problems of young galaxies.

In a recent work [60], different statistical tests confirm the conclusion of the avoidance by quasars (both with large Z and with small) of fields of the sky occupied by rich clusters of galaxies from the Abel catalog. At the same time, radio galaxies from the 3CR catalog often enter into the composition of these clusters. Going from this, the authors conclude that quasars must not be considered as nuclei of giant galaxies. However, this conclusion is not true. The quasars, as optically bright objects, live for a short (10^7 - 10^8 years) and old galaxies of clusters have already passed through this stage. Very distance protoclusters of galaxies could have been or can be observed at Z $\gtrsim$ 5 as a **poor cluster of** quasars). The data of authors [60] indicate only that in rich clusters of galaxies that there are no (or very rarely) young galaxies whose nuclei we observe as quasars. This involves, as we have already discussed, apparently, the fact that fluctuations of density from which galaxies are formed were larger in clusters. This must result in the earlier formation of galaxies in them. (The situations which remind one of the absence of young stars in spherical clusters). However, a situation is possible where a remote quasar shines closer to us than a cluster of galaxies. In this case, in the spectrum of the quasar an absorption line of intergalactic gas can appear corresponding to Z of this cluster. /20

In references [61, 62], a powerful evolution in the past for quasars with steep radiospectra (with extended radio components) and weak for quasars with flat radiospectra (with central compact components) is noted. These facts are evidence of the fact that in particular, the extended radio components live considerably longer than quasars in optics and the compact - **less**. In all probability, the latter for $\tau < 10^7$ years expand and weaken greatly. This can result in impossibility of observation at large V and as a result - absence of evolution for their effect.

Thus, the views developed in this work and the hypotheses drawn amount, essentially, to a single thesis which finally, must undergo careful experimental testing: "young" galaxies must be sought around quasar-like objects which are a turbulent stage of the birth of nuclei in protogalaxies.

TABLE 1

QUASAR-LIKE OJBECTS WITH WEAK CLOUDINESS AROUND THEM (ACCORDING TO THE DATA OF REFERENCE [41])

a) proven

Object	z_{em}
PHL 1070	0.08
B 264	0,095
B 340	0,184
B 256	0,131
3C 48	0,367

b) under question

Object	z_{em}
B 154	0,183 (?)
0736+01	0,191
4C 1.4	0,261
2135-14	0,202
3C 323.1	0,264

[The commas in the Tables indicate decimal points in this Table and all succeeding Tables.]

TABLE 2

GALAXIES AROUND NUCLEI IN N-GALAXIES (ACCORDING TO THE DATA OF REFERENCE [42]

Object	Z_{em}	V_{nuc}	V_{rad} $(26^m/\square'')$
3C79	0,256	I9,8	I8,9
I09	0,306	I9,3	I8,2
I20	0,033	I4,9	I3,9
I7I	0,238	20,2	I9,2
227	0,086	I8,9	I6,I
234	0,I85	I8,8	I7,4
287.I	0,2I6	I9,8	I8,I
303	0,I4I	20,0	I7,I
37I	0,05I	I5,8	I4,3
390.3	0,057	I5,7	I4,9
445	0,057	I7	I5,0
459	0,22I	I8,9	I7,7

TABLE 3

QUASAR-LIKE OBJECTS WITH WEAK NEBULAE AROUND THEM (ACCORDING TO THE DATA OF REFERENCE[43-51])

Object	Z_{em}	Reference
3C 120	0,033	[48], [49], [59]
Ap Lib	0,049	[51]
Ton I542	0,064	[44]
BL Lac	0,07	[45], [46]
Ton 256	0,I3I	[43]
3C 3I8	0,752	[47]

TABLE 4

SPECTROMETRIC DATA ON NEBULAE AROUND QUASAR-LIKE OBJECTS (ACCORDING TO THE DATA OF REFERENCES [52-58])

Object	z_{em}^{nuc}	z_{em}^{cloud}	Reference
3C 48	0,3679	0,3698	[52, 53]
4C 37.43	0,3708	0,3698	[54]
BL Lac	0,07	-	[55, 56]
3C 249.I	0,3II	0,3I25	[57]
3C 37I	0,05I	-	[58]

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