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ДОКЛАДЫ НАЦИОНАЛЬНОЙ АКАДЕМИИ НАУК АРМЕНИИ

Том 98 1998 №3

ASTROPHYSICS

УДК 524.64

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On the Ambartsumian's Concept on Activity of Nuclei of Galaxies

(Submitted 13/VII 1998)

This year is special year not only for the scientiest of Armenia, but also for the all astronomical community over the world. 90 years ago on the Armenian sky new star was borne named Victor. I do not like compare it with flare of Nova or Supernova stars, because their enormous brightness quickly decrease during some monthes or year. I prefer to compare it with flare of FU Ori type stars, Ambartsumian called them "Fuors", because they keep the activity and high brightness after flare constant during many decades of years, as Victor Ambartsumian did.

All his long life he devoted studing and explaining the mysterious physical phenomena, which take place in Universe. Infriquent are the cases in the history of science when during his lifetime a scientist advences one after another ideas that are basically at variance with established scientific consepts and traditions. Still rarer are the cases when those ideas thrust their way through the endless zigzags of science and prove there viablity in the course of its development. Victor Ambartsumian belongs no doubd to this class of scientists. His ideas on the decay of stellar clusters, on the statistics of double stars and the age of the Galaxy, on stellar associations, explosive processes connected with flare stars and fuors and, finally, on the activity of nuclei of galaxies were as unexpected in those days as original and served the cause of heated arguments and discussions. Often they even seemed unreal. However most of them gradually won recognition through the world. In this paper we shoud like to touch briefly upon some aspects of V.A.Ambartsumian's idea on the optical activity of nuclei of galaxies.

Some 45 or 50 years ago the galaxies were conceived of as thoroughly formed steady systems with a rich past and with no prospect of radical changes in the future. Therefore the investigation of the structure of galaxies was in most cases confined to their classification and general photometry, based solely on their external morphological characteristics, setting little store by the composition of their central regions. V.A.Ambartsumian was the first to pay particular attention to the significance of galactic nuclei which form a typical particular of nearly all galaxies with high luminosity. This wonderful peculiarity of galaxies had for long been neglected by astronomers. The role of nuclei in the evolution of galaxies was manifestly underestimated.

In the second half of the 50's a new phase in extragalactic exploration set in, when a

new concept on the basic role of the nuclei of galaxies in their life and evolution had been advanced by V.Ambartsumian ([1-9]). Of course the origin of this concept was not unfounded. It was preceded by a number of wonderful discoveries resulting in the revision of our notions on the world of galaxies. In the first place this was the identification of one of the powerful radio source Cygnus A by Baade and Minkowski with the galaxy cotaining two nuclei ([10]). A similar picture was observed also in radiosource Perseus A (NGC 1275). The role of two papers was also significant: Haro ([11]) in 1956 discovered 44 galaxies, unusually blue in colour; and, specially, in 1943 Seyfert's paper ([12]), now regarded as classical, shoud be here singled out for mention. The galaxies which he investigated are distinuished by the high luminosity of their nuclei, and, more importently, by the width of the Balmer emission lines. The great width of the emission lines indicates that the turbulent motions of gas clouds in the nuclei of those galaxies, subsequently termed "Seyfert",at times attain a velocity of over 3000 km/s. Now it seems quite strange and surprising that this very important paper of Seyfert was not duly taken into account in the succeeding twenty years or so. It was only after Ambartsumian's idea concerning the activity of nuclei of galaxies had been made public that the astrophysicists returned to that paper, and a regular study of the Seyfert galaxies was started.

On the basis of the analysing of these facts, Ambartsumian came to idea of activity of nuclei of galaxies,which manifests itself mainly in the following forms :

1. Outflow of ordinary gas matter (in form of jets or clouds) from the nuclear region at the velocity of up to hundreds of kilometers per second).
2. Continuous emission of the flux of relativistic particles or other agents, producing high energy particles, as a result of which a radio halo may form around the nucleus.
3. Eruptive ejections of gas matter (M 82 type).
4. Eruptive ejections of concentration of relativistic plasma (NGC4486, 5128, etc.).
5. Ejection of compact blue condensations with an absolute magnitude of the order of luminosity of dwarf galaxies (NGC 3561, IC 1182). Here the division of the nucleus into two or more comparable components is also presumed, initiating the formation of multiple galaxies.

The presence of one or several of these phenomena allows us to call a galaxy active. At present a number of types of objects are considered as active: radio galaxies, QSOs, Seyfert galaxies, Lacertides, UV-excess galaxies, blasars,liners.

Let us come back to the phenomenon of radiogalaxies. Above mentioned well-known american astronomers Baade and Minkowski explained this phenomenon as a result of accidental collision of two galaxies. V.A.Ambartsumian was the first and only astronomer, who in his works ([2-4,7,8]), convincing shown, that in the case of radio-galaxies we have not collision, but just activity of nuclei of galaxies, which brings to ejection of matter from necleus, and in some cases as a result of this activity the radio-galaxy is originated.

I am lucky, that I have had chance in 1961 in Berkeley to be present at XInd General Assambley of IAU, were V.Ambartsumian gave a puplic talk on the idea of activity of galaxies. The interese to his talk was so high, that the conference hall and corridors were full by peoples (even outside, where the microphones have been mounted). During this Assembley he was elected as a President of IAU.

It was really revolutionary and extraordinary idea. It is said, that in Solvey conference in 1958 W.Baade even accused him of idealism and noted that for the scietist from Sovet Union speak about ejection and activity of nuclei of galaxies looks very strange.But just couple of years later american astronomers Sandage and Lynds ([13]) published very important paper under the telling title "Evidence of an explosion in the center of galaxy M 82",where have been shown, that some million years ago in galaxy M 82 a very powerfool explosition have been taken place with ejection of enormous mass: equel to about million of Solar masses.

Almost the same time in 1963 QSO-s have been discoverd. Actually, as Ambartsumian noted,they were just the naked active nuclei,which radiate unusual high quantity of energy, highest amongs known cosmical objects. Now we know that many of QSO-s realy surrounded by stellar population, which are called "Host galaxies".

Thus, the Ambartsumian's idea has been confirmed at first by observations of american astronomers.

The new stage in extragalactic field has been started: the era of active galaxies. Majority of large observatories over the world started to find a new active galaxies (AG).

By the leading of V.Ambartsumian the Byurakan observatory also engage itself in activities aimed at discovering galaxies with active nuclei. Ambartsumian and Shahbazian ([14]) were the first to show the existence of blue ejections and condensations associated with contiguous active elliptic galaxies. Subsequently Stockton ([15]) showed that those objects are in fact associated with galaxies and display emission spectra similar to the associations.Then on the initiative of V.A.Ambartsumian,B.E.Markarian started in Byurakan in the mid-sixties observations of the sky with a view to detecting galaxies with anomalous spectra, using the 40" Schmidt telescope with an objective prism of the same diameter.

The first Byurakan survey (FBS) is the most famous work done with this telescope. More than 2000 photographic plates, cover about 17000 square degrees of sky, were obtained.Each plate contains low dispersion spectra (2500A/mm near H-beta) more than 15 000 objects. As a result, 1 500 galaxies with strong UV-excess have been discovered. In 1978 Markarian with his co-workers began Second Byurakan Survey (SBS). The limiting magnitude of objecst have increased from 17^m (for FBS) up to about $19^m.5$ (for SBS). SBS covers about 1 000 square degrees.

But small dispersion of spectra on the Schmidt plates did not give us the possibility to understand in detail the physical structure of this galaxies with strong UV-excess. It was necessary to observe them with the high dispersion slit-spectrograph, which that time not possible in Byurakan observatory. In 1967-69 I was lucky to be first to observe almost all galaxies from the first Markarian list of UV-galaxies with the largest optical telescopes of USA.

I would like to emphasize once more that the detailed spectral investigations of these objects indicated ([16-18]), that over 85% of them turned out to have emission lines, their intensity being directly dependent on the value of UV-excess. One can conclude that the presence of a strong ultraviolet continuum is closely associated with the formation of the emission spectrum and the more intense the continuous spectrum in the visible ultraviolet is, the more intense are the emission lines.

It became also evident that the spectra of those objects differ, nevertheless, essentially from each other as to the excitation degree of the emission lines and their widths. Moreover, they turned out to differ sharply in morphological characteristics as

well: one can come across the blue galaxies of Haro, the compact galaxies of Zwicky, the N type galaxies, spiral and irregular galaxies among the Markarian objects. Quite important is the discovery of the Seyfert galaxies and quasers among those objects.

As far back as 1968 I also demonstrated that on the basis of slitspectra, UV-galaxies can be classified in five groups ([16]):

1. Narrow line spectra both in emission and absorption.
2. Narrow, strong emission lines only.
3. Strong and diffuse emission lines; [OIII] lines much stronger than the hydrogen lines (Seyfert type 2).
4. Very broad hydrogen lines,narrow forbidden lines (Seyfert type 1).
5. No strong emission lines (BL Lac).

No new type of spectra of UV-galaxies has since been observed, except for galaxies with pure absorption line spectra ([23,24]).

These results have been presented at first international conference on Seyfert galaxies and related objects in 1968 (Tuson,Arizona,USA). Here I called these objects "Markarian galaxies". The further spectral investigations of Markarian galaxies from both Byurakan Surveys have been carried out intensively in Byurakan (M.Arakelian, A.Petrosian, K.Sahakian, J.Stepanian,H.Abrahamian, S.Hakopian, V.Chavushian, L.Erastova, A.Yegiazarian, N.Andreasian and others).

These searches show that among Markarian objects there are representives of all formes of activity predicted by V.Ambartsumian: QSO-s, Seyfert galaxies, BL Lac objects, galaxies with jets, blue compact galaxies, dauble nuclei galaxies and so on.

M.Kazarian, using the same methode of observation found more than 600 new UV-excess galaxies also showing different form of activity. But the most important is, as it was shown by Weedman and Khachikian, that 10% of Markarian galaxies turned out to be Seyfert galaxies.

The number of Seyfert type galaxies was extremely increased thank to study of Markarian objects. In the original paper of K.Seyfert there are only 6 galaxies of Seyfert type. But now more than 1 000 these type of galaxies are known!

On the base of detailed spectral investigations of namber of Seyfert type galaxies Weedman and Khachikian ([20]) have shown, that Seyfert galaxies dearly are divided to two types:

1.Galaxies with very broad hydrogen lines, and narrow forbidden lines (Seyfert type 1).

2.Galaxies with very broad both hydrogen and forbidden lines (Seyfert type 2). This classification of Syefert galaxies is generally accepted in scientific literature and is included in "Glossary of Astronomy and Astrophysics" (with foreword by Nobel Prize S.Chadrasekhar). There are many astrophysical objects and events have been studied in Byurakan observatory and in abroad speaking in favour of Ambartsumian idea.

I would like to dwell here upon two subjects: a) double nuclei AG, and b) variability in the spectrum of AG.

a) As it was mentioned above, the radio galaxy Cygnus A has two nuclei. It is interesting to note that majority of active galaxies (AG) turn out to be double nuclei. It is

necessary to stress that in addition to double nuclei there are galaxies with three and more nuclei(or nuclear type formations). It is known also that each of the nuclei of double ncleus galaxies can themselves consist of two components. Therefore the opinion conserning the nature of double nucleus AG are relevant to the multinuclei AG as well. It seems unimportant to use the term "multinuclear AG" or to say "central part of AG cosists of number of condensations". The terminology is not important, because I believe that these objects have been formed as a result of division of single maternal body.

From the time of Kant and Laplace up to the present, the majority of heorists,as well as observers, believe that the Universe develops in a direction from concentrations of diffuse matter to the denser states. Perhaps V.Ambartsumian was the first who declared the opposite point of view. As far back as the end of the 40's, he stated the revolutionary idea that evolution in the Universe goes from the dense condition of matter to the rarefied one.

Unfortunately, very few scientists are attempting the construction of a physical theory for this concept, although there are fairly successful attempts in this field.It seems to me that observational data speaks in favour of this point of view. The existence of double and multinuclei galaxies is the good confirmation of this idea.

The number of double and multi-nucleus AG is increasing all the time. Zwicky compact galaxies with emission spectrum, many radio galaxies, so- called isolated gaint HII regions or Superassociations(SA) are double nucleus objects. Among the galaxies from FBS more than 100 double nucleus galaxies arediscovered. No doubt, that many of them (if not majority) are real double nucleus galaxies. That is, there are not a result of mergering or interaction of two independent galaxies.

Note that following observational data are difficult to reconsile with the hypothesis of gravitational merging:

1) the discovery of the Seyfert type double nuclei galaxies because of their most rarity between galaxies ([21,22]);
2) the discovery of the twin-objects with quite identical spectra and morphology similarto two isolated SA being considered as one galaxy with double nuclei each of which is SA ([23,24]);
3) the discovery of numerous double nuclei galaxies.

On the Fig.1, examples of well-known double nucleus active galaxies are presented.

The existance of galaxies with two condensations in the centre having Seyfert type spectra (Mark.266, 463, 673, 789) is the most definite evidence of the possibility of galaxies with double nuclei in general. However, double nuclei galaxies are not an unusual phenomenon among AG while they are particulary common among UV galaxies. In the following table some physical parametrs: the apparent and absolute photographic magnitudes of the components of the nucleus, distance between components in arcseconds and kiloparsecs (H=75 km/s.Mpc) and differences of their radil velosites for six AG with double nuclei are presented.

Mark 212
(1 mm ~ 2";1 ~ 5 kpc)

Mark 480
(1 mm ~ 1.4";1 ~ 3 kpc)

Mark 930
(1 mm ~ 2.2";1 ~ 1.6 kpc)

Mark 266
(1 mm ~ 1.7";1 ~ 6.5 kpc)

Mark 324
(1 mm ~ 0.6";1 ~ 0.1 kpc)

Mark 463
(1 mm ~ 1.3";1 ~ 4.3 kpc)

Fig.1. Photos and isodenses of some Markarian galaxies
I is a distanse between of nuclei

Parameters of 6 representative of AG with double nuclei

Mark.No	m(pg)	M(pg)	d"	d(kps)	V(km/s)
266	17.5	-17.8	12	6.5	127
	17.8	-17.5			
273	17.5	-18.4	4.3	3.2	–
	18.2	-17.7			
463	17.0	-19.5	4.5	4.3	50
	17.2	-19.3			
673	16.2	-19.6	5.3	3.7	166
	16.2	-19.6			
739	16.2	-19.1	6.6	3.8	85
	17.0	-18.3			
789	16.0	-19.5	4.1	2.5	2
	18.0	-17.5			

b) As it was mentione above one of the form of activity is the ejection from the nuclei of active galaxies isolated clouds with different contents. The further both spectroscopic and morphological investigations are shown that the nuclei of some AG are variable and are underwent irregular changes in brifhtness and in spectrum.In the end of

60-th and the beginning of 70-th it became clear that in central parts of same AG taken place the phy sical processes leading to ejection of huge amount of matter from the nucleus of AG. The small sizes of AG nuclei (AGN) about 10 arcsec don't permit to detect such a gas-newformation by means of derect observation in the near surroundings of them even in radio wavelengths. Therefore the only possibility for the investigation of these physical events is detailed spectrophotometrical observations with comparatively high dispersion. The most effective are investigations in optics.

The appearance of additional new emission components of Hydrogen lines in the spectrum of AGN first was discovered in 1969 by Khachikian and Weedman ([25,26]). During one year (between February 1968 and January 1969) in the spectrum of Markarian 6, wich was Sy2 galaxy, new broad emission components of Hydrogen lines H-alfa, H-beta and H-gamma have been detected.Their blue- shift velocity is correspound to 3 000 km/sec.

In January 1970 the intensity of H-beta component was equal to 50% that of basic H-beta line. These observations have been conformed by many authors ([27-32]).

It is known now many active objects with double Hydrogen lines structure in the spectrum 3C 390.3, NGC 1097, NGC 1566 ([33-35]). There are some models,which have been suggested to explane this phenomenon ([26,27,36-39]).

All these models do not give complete explanation of phenomenon. In ([40]) the new fairly simple model is suggested, which gives quantitative accordans with observational data. In Fig. 2 the schematic pitcure of the model is shown.

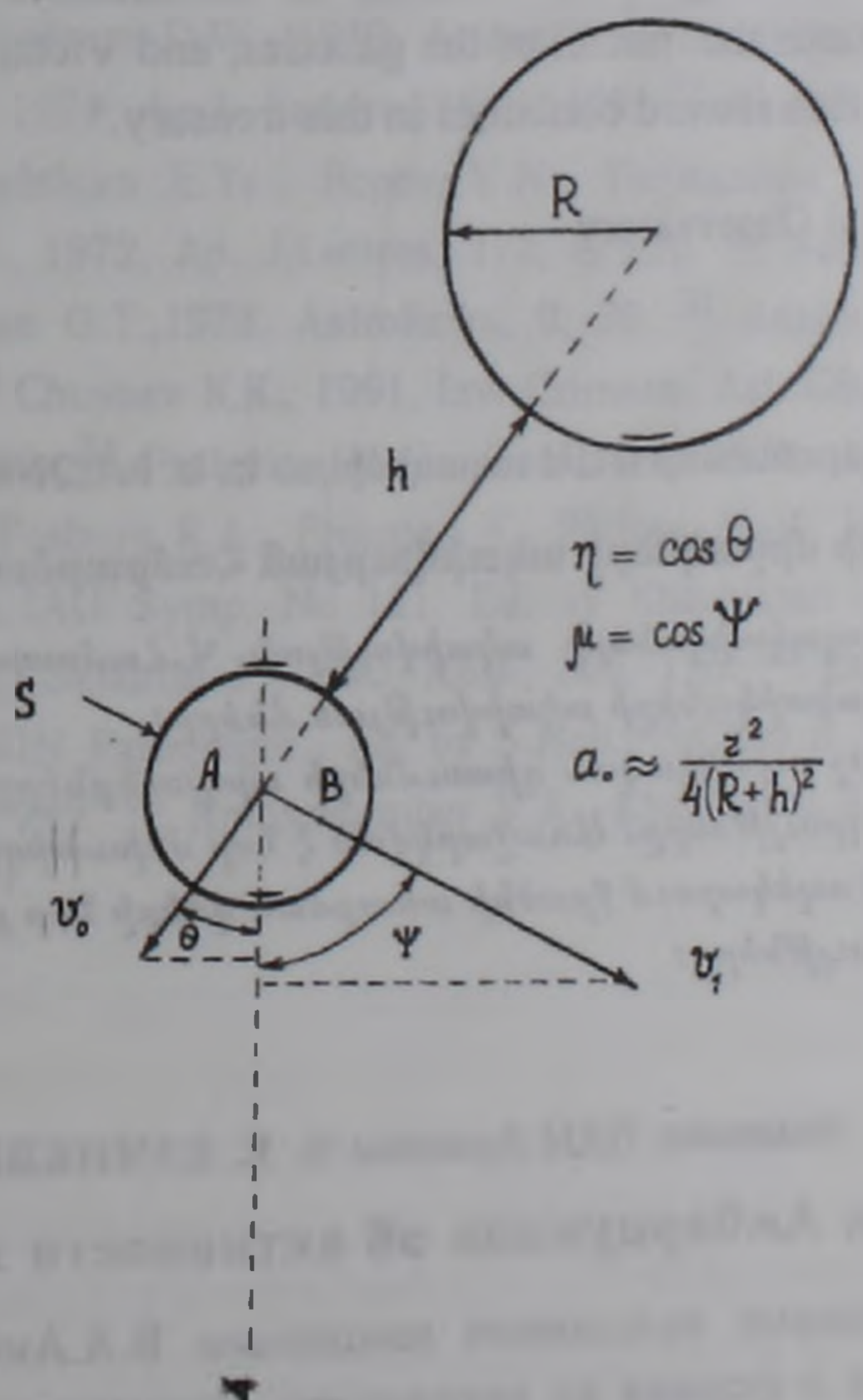

Fig.2

From the nucleus of AG a compact formation S is ejected with the velocity Vo. On the some distance from the surface of AG it exploded. As a result of this explosion globular gas cloud S, mainly consisted of Hydrogen atoms, is formed. Similar to situation in planetary nebula the Lc-quanta of AG lead to ionization of Hydrogen atoms in S. As a result of recombination and following cascade transitions the subordinate Hydrogen lines are formed. On the whole the additional components of subordinate lines are arising. The shift of additional lines relatively to that of nucleus of AG is explained by speed of ejection of S from AGN. As for the widths of additional lines they depend on velocity of expansion of S. The simple estimation presented in this work show that comparable small size and mass of S cloud and acceptable value of speed of his expantion can explain the phenomenon.

The terms "active galaxies", "active nucleus", introduced by Ambartsuman, is now generally accepted in science, although some scientiests (mostly younger one) have no idea about that. Therefore, his followers sometime has to remaind about tremendous inpact of V.Ambartsumian in science, in particular in extragalactic astronomy.

Ambartsumiann's idea on the activity of galaxies exerted tremendous influence on the further development of extragalactic astronomy and stimulated numerous studies in many observatories of over the world.In well-known Volume of the U.S. Academy of Sciences "The Heritage of Copernicus", commemorating the quinquecentennial of the birth of Copernicus,this Ambartsumian's idea is considered as a Copernicous type revolutionary idea, which has changed our notion about the nature of the galaxies. American astronomer Sandage said "Nobody of astronomers would deny today, that mystery indeed surrounds the nuclei of the galaxies, and Victor Ambartsumian was first who understood how rich reward containes in this treasury."

Byurakan Astrophysical Observatory

Հայաստանի ԳԱԱ ակադեմիկոս **Է. Ե. ԽԱՉԻԿՅԱՆ**

Գալակտիկաների միջուկների ակտիվության Համբարձումյանի թեզի մասին

Շարադրված է գալակտիկաների ակտիվության Վ.Համբարձումյանի կողմից առաջարկված թեզը և գալակտիկաների ակտիվության ձևերը:

Քննարկված է որոշ օպտիկական դիտումների արդյունքները, որոնք հաստատում են այդ թեզի հիմնական դրույթները: Առաջարկված է նոր մեխանիզմ, որը բացատրում է ակտիվ գալակտիկաների սպեկտրում ջրածնի առաքման գծերի նոր բաղադրիչների առաջացման ֆիզիկական երևույթները:

Академик НАН Армении **Э. Е. ХАЧИКЯН**

О концепции Амбарцумяна об активности ядер галактик

Изложены основные положения концепции В.А.Амбарцумяна об активности ядер галактик и формах их активности. Рассмотрены некоторые результаты оптических наблюдений галактик, подтверждающие основные положения этой концепции. Предложен новый механизм, который объясняет феномен по-

явления новых дополнительных эмиссионных компонентов у водородных линий в спектрах ядер активных галактик.

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