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PHYSICAL CHARACTERISTICS OF GALAXIES AT DIFFERENT STAGES OF EVOLUTION

Givi Kimeridze, Tinatin Merabishvili, Gocha Inasaridze, Revaz Chigladze

Samtskhe-Javakheti State University, E. Kharadze National Astrophysical Observatory, Georgia

givikimeridze@gmail.com, tiko.merabishvili69@gmail.com, ginasaridze25@gmail.com, revazchigladze@yahoo.com

Abstract - A galaxy is a combination of gas, dust and numerous stars, whose unity is ensured by gravity.

We will see galaxies of different shapes and at different stages of evolution. Gas and dust are the main materials for the formation of a new star.

Spiral galaxies are among the brightest objects in the universe, elliptical galaxies are statistically older stars with less gas and dust, and irregular galaxies are the smallest galaxies in terms of size.

Keywords: galaxy; elliptical galaxy; spiral galaxy; irregular galaxy; Evolution of galaxies

I. INTRODUCTION

The chemical evolution of the galaxy is the history of the accumulation of all those chemical elements in the atomic galaxy that appear as a result of one or another process. This issue is directly related to human life.

Because we are talking about the chemical elements that we ourselves are made of, the planet we live on and the things around us.The foundations of modern ideas about the evolution of chemical elements in our galaxy were laid in the 50s of the last century.

The chemical evolution of a galaxy is the evolution of its constituent stars.

The chemical composition of stars at different stages of the galaxy is preserved, for example, the chemical composition of our galaxy 4.5 billion years ago is preserved in the Sun[1].

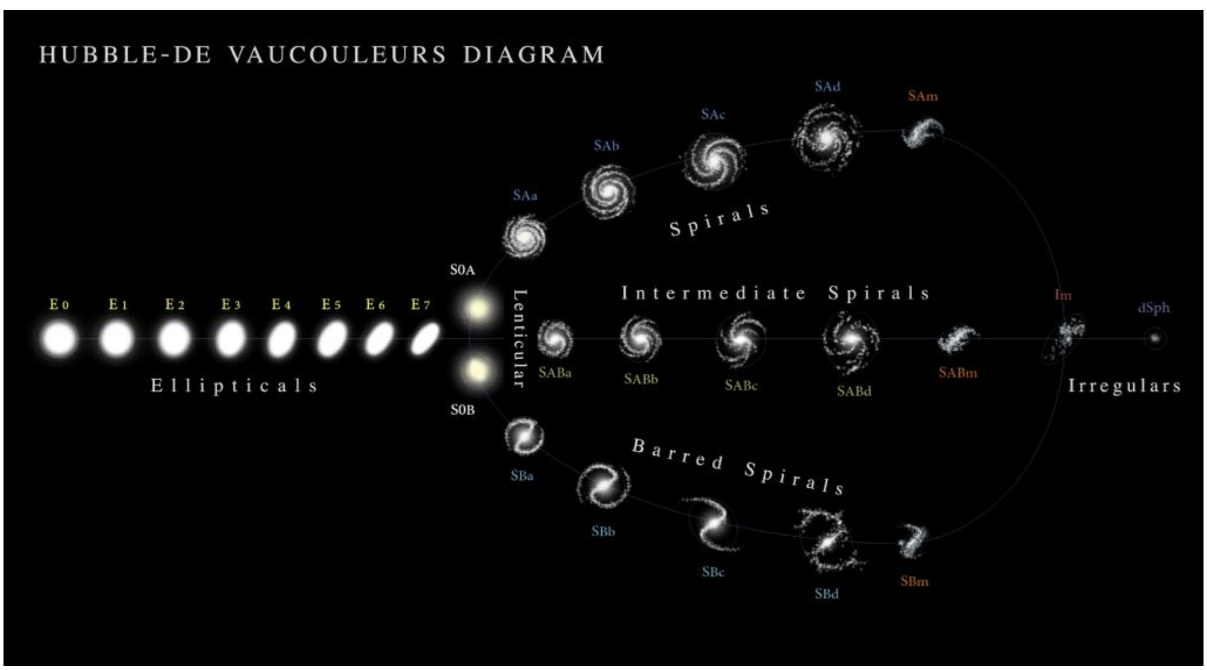
If we look at any of the older stars, we see the chemical composition of the galaxy at an earlier stage of evolution. If we look at the lifetime of the galaxy, i.e. the entire 13 billion years of its existence. We will see that over time, more and more heavy elements other than hydrogen and helium accumulated in it.One of the tasks currently facing astrophysicists is to. This is a study of stars with less and less heavy elements. Most likely, they are very old and did not manage to be saturated with the products of cosmic evolution
Currently, there are known stars in which the iron content is 100,000 times less than that of the Sun. It is logically probable that they are the oldest surviving stars in the galaxy, although we cannot consider them the first stars of the galaxy.

Because the latter should not contain heavy elements at all - should consist only of those elements that were synthesized as a result of the Big Bang. A lot of effort is being spent to find these stars with zero content of heavy elements.
Various theories have been proposed to explain their absence, for example, there is an opinion that the first stars were very massive and did not live long. Perhaps they existed before the formation of the galaxy, perhaps they were the first inhabitants of our galaxy. One way or another, they were formed, lived for the intended time - a few million years, exploded, contaminated the pre-galactic (i.e. progalactic) substance with heavy metals. Then, from this slightly polluted substance, the stars were formed, the remnants of which we now observe. After that, thermonuclear fusion proceeded more slowly, gradually accumulating heavy elements,The stars became richer and richer in these elements, eventually forming what surrounds us.
Recently, significant progress has been made in the study of not only our galaxy, but also other star systems. Powerful tools have emerged that provide a high-quality spectrum. These are the telescopes installed on the earth, and space telescopes named after Hubble and Webb.
A galaxy consists of many parts. Each of them evolves independently, but there is also a definite interaction between them.
The chemical evolution of a galaxy is a combination of many processes that are difficult to study in our galaxy[1,2].
The reason is that we are deep here and can't see much, because one object in our galaxy covers the rest. But thanks to new telescopes, we have been able to study in detail other masses in galaxies,Chemical composition of other structures. The further we look into the world, the deeper we reach into the past, which is also a way to study evolution.
Infrared telescopes have allowed us to peer into spectral regions that were previously impossible. Through the Spitzer and Herschel telescopes, we received a lot of new data,Also from newly launched telescopes. We are waiting for the latest information, all this will allow us to consider not only the synthesis of heavy metals, but also the processes of transition between phases[1,2].

For example, the transition from the solid phase (dust particles) to the gaseous phase (stars and interstellar matter). Many scientific studies are now being conducted on this very issue. The age of a star can be determined by its chemical composition. Young stars contain more metals than old ones.
Because these elements did not exist in the galaxy until one or two generations of stars produced them through the synthesis of light elements.
The chemical composition of stars can also be understood by the spectrum of their light — certain wavelengths are brighter or darker, depending on the elements present.
Individual stars in distant galaxies cannot be studied; They are far beyond the capabilities of our current technology. All we can do is study the light coming from different regions and understand what types of stars are in those regions[1,2].

II. Observations

One representative of an elliptical galaxy is NGC 185, which is distinguished from other galaxies of this type by the fact that it contains a young star cluster, there must be two reasons for this: one - the formation of stars in the cluster took place at a low rate until the recent past, Second, this cluster of stars is captured by him at a certain stage of evolution. The galaxy NGC 185 also has an active galactic nucleus and is usually classified as Seifert's status is questioned[3]. It may be the closest Seyfert galaxy to Earth.

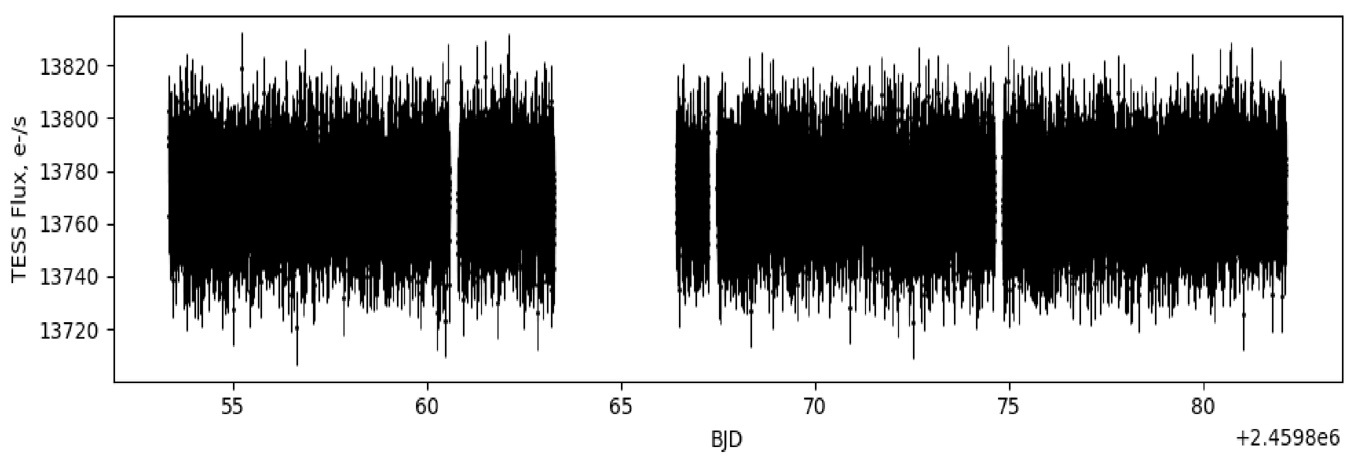


https://theskylive.com/sky/deepsky/ngc147-object

NGC 147 and NGC 185 . https://www.astronomy.com/science/ngc-147-and-ngc-185

Using two separate methods, the distance to NGC 185-galaxy is determined and the following is obtained: a) 640 ± 50 kpc. [3]; b) 620 ± 60 kpc.[4,5].

NGC 147 is a dwarf spheroidal galaxy in the constellation Cassiopeia. It is a member of the Local Group of galaxies and a companion galaxy to the Andromeda Galaxy (M31). It forms a physical pair with the nearby galaxy NGC 185, [5] another distant companion of M31.



Spectrum of NGC 185 galaxy data after processing (space data)

Visually, NGC 147 is fainter and therefore more difficult to see than NGC 185, which can be seen in small telescopes. The Webb Society Deep-Sky Observer's Handbook [6] describes the visual appearance of NGC 147 as follows.

A survey of the brightest Asymptotic Giant Branch (AGB) stars within a 2′ radius of the center of NGC 147 shows that the last significant star in NGC 147.

Star-forming activity occurred a long time ago. NGC 147 contains a large population of older stars that show a spread in metallicity and age[5].

The metallicity distribution suggests that NGC 147 had chemical enrichment. However, H I is not observed and the upper limit of the interstellar medium mass (ISM) mass is much lower than expected.

At least two techniques have been used to measure distances to NGC 147. The surface brightness fluctuations distance measurement technique estimates distances to spiral galaxies based on the graininess of the appearance of their bulges. The distance measured to NGC 147 using this technique is 870 ± 60 kpc. However, NGC 147 is close enough that the tip of the red giant branch (TRGB) method may be used to estimate its distance. The estimated distance to NGC 147 using this technique is 680 ± 30 kpc. Averaged together, these distance measurements give a distance estimate of 780 ± 30 kpc.]The metallicity distribution suggests that NGC 147 had chemical enrichment. However, H I is not observed and the upper limit of the interstellar medium mass (ISM) mass is much lower than expected,Spiral galaxies are very common in the local Universe, but their formation, evolution, and interplay with bars remain poorly understood after more than a century of astronomical research on the topic[4].

Galactic Cannibalism

Larger galaxies can also gobble up smaller ones through proximity and gravitational interactions, pulling material away to fuel their own growth. Researchers think the Milky Way is currently funneling away a stream of hydrogen from its satellite dwarf galaxies, the Large and Small Magellanic Clouds.

Changes in the chemical composition of cosmic matter over time

Today, it is generally accepted that stars originate in the interstellar gas-dusty environment, and at the end of their evolution, they themselves eject matter into space, which again becomes the interstellar medium.

But at a certain stage of evolution, the star "recycles" the substance of its core during thermonuclear reactions: it turns hydrogen into helium, helium into carbon and other heavy elements. Therefore, the substance that was already in the star and was processed has a different composition, and if new generation stars are born from it, their chemical composition will be different, it will obviously be rich in heavy elements.

Indeed, such an event is confirmed; The chemical composition of stars in globular clusters is characterized by the presence of heavy elements. These stars are old, formed from still unprocessed matter, which probably consisted entirely of hydrogen.

We will attribute such stars to the second population. And the stars of the first population belong to the new generation, a certain part of their original matter has already been processed, it has already been in the core of the star and passed the path of evolution, and heavy elements have accumulated in it.

Which version is correct?

Basically, there are three types of galaxies in the universe: spherical, spiral and irregular, the evolution they went through can be:

a) Hubbleian, which means that each galaxy must go from the spherical stage to the spiral stage; b) in the opposite way, irregular, spiral and elliptical stage; d) But there is also an opinion, elliptical galaxy is always elliptical, spiral galaxy - spiral. However, the objects included in it undergo their own evolution. As for irregular galaxies, they are mainly formed by merging[4,5,6].

According to our investigations, based on the available observational material, the third option should take place, although the investigations are still ongoing.

Irregular galaxy spectra are characterized by strong emission lines, due to hot young stars and surrounding HII regions. Most galaxy spectra are redshifted (spectral features have shifted to longer wavelengths than the rest wavelength values), though some few are blueshifted[6].

In this regard, we will also study the following known outer galaxies:

Members of the Local Group of galaxies

name of galaxy	type	dimensions (light-years)	distance (10^6 light-years)	year of discovery
WLM	Irr	11,000 x 3,600	3.1	1909
IC 10	Irr	4,600 x 4,000	2.15	1889
Cetus dwarf	E4	3,700 x 3,200	2.54	1999
NGC 147	E5	9,400 x 5,900	2.15	1829
Andromeda III	E	3,200 x 2,200	2.48	1970
NGC 185	E3	9,100 x 7,800	2.15	1787
M110	E5	14,000 x 9,000	2.48	1773
Andromeda VIII	dSph	35,000 x 7,900	2.7	2003
M32	E2	7,900 x 5,300	2.48	1749
Andromeda Galaxy	Sb	200,000	2.48	964
Andromeda I	E	1,900	2.64	1970
Small Magellanic Cloud	Irr	16,000 x 9,100	0.20	*
Andromeda IX	dSph	4,200	2.90	2004
Sculptor dwarf	E3	3,400 x 2,600	0.29	1937

LGS 3	Irr	1,500	2.64	1978
IC 1613	Irr	13,600 x 12,600	2.35	1906
Andromeda X	dSph	5,900	2.90	2005
Andromeda V	dSph	1,800	2.64	1998
Andromeda II	E	2,300 x 1,600	2.22	1970
M33	Sc	60,000	2.58	1654
Phoenix dwarf	Irr	1,900 x 1,600	1.30	1976
Fornax dwarf	E3	1,600 x 1,400	0.46	1938
UGCA 92	Irr	2,700 x 1,400	4.70	1974
Large Magellanic Cloud	Irr	31,000 x 26,000	0.16	*
Carina dwarf	Irr	2,200 x 1,500	0.33	1977
Canis Major dwarf	Irr	5,200	0.03	2003
Leo A	Irr	3,300 x 2,000	2.25	1966
Sextans B	Irr	7,000 x 4,800	4.70	1966
NGC 3109	Irr	21,000 x 3,800	4.50	1835
Antila dwarf	E3	2,700 x 2,000	4.60	1985
Leo I	E3	2,300 x 1,800	0.82	1950
Sextans A	Irr	6,900 x 5,800	4.00	1942
Sextans dwarf	E3	7,700 x 5,500	0.29	1990
Leo II	E0	2,400 x 2,200	0.69	1950
GR 8	Irr	2,800 x 2,200	7.90	1946
Ursa Minor dwarf	E5	2,300 x 1,500	0.20	1954

Draco dwarf	E3	3,900 x 2,400	0.26	1954
Milky Way Galaxy	Sb/c	144,000		*
SagDEG	E7	5,400 x 14,000	0.10	1994
SagDIG	Irr	3,200 x 2,300	3.85	1977
NGC 6822	Irr	7,300 x 6,400	1.63	1884
Aquarius dwarf	Irr	2,100 x 1,100	3.10	1966
Tucana dwarf	Irr	2,400 x 1,000	2.84	1990
UKS 2323-326	Irr	2,100 x 1,600	4.70	1978
Andromeda VII	dSph	1,600 x 1,300	2.25	1998
Pegasus dwarf	Irr	3,600 x 1,900	2.48	1958
Andromeda VI	dSph	8,300 x 2,600	2.54	1998

Conclusion

Great care and extensive data mining is required to uniquely determine the initial type of a galaxy, paying particular attention and critical consideration to whether the galaxy has accreted other galaxies or parts of them.

We do not find observational evidence that spiral arms are driven by stellar bars or by invariant manifolds. Most likely, discs that are prone to the development of strong bars are also reactive to the formation of prominent spirals, explaining the observed coupling between bar and spiral amplitudes.

According to our investigations, based on the available observational material, the third option should take place, although the investigations are still ongoing: „Eliptical galaxy is always elliptical, spiral galaxy - spiral. However, the objects included in it undergo their own evolution. As for irregular galaxies, they are mainly formed by merging”.

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