Copyright © 2024 by Cherkas Global University

Published in the USA
Russian Journal of Astrophysical Research. Series A
Issued since 2013.
E-ISSN: 2413-7499
2024. 10(1): 22-27

DOI: 10.13187/rjar.2024.1.22
https://rjar.cherkasgu.press


## Space Astronomy as a New Scientific Direction

Vladimir V. Oznamets [a, *]

[a] Moscow State University of Geodesy and Cartography (MIIGAiK), Moscow, Russian Federation

**Abstract**

The article explores space astronomy as a new scientific direction. Cosmic astronomy complements classical astronomy and is its development. Space astronomy can be considered as astronomy whose observation points are transferred from the earth's surface and near-Earth space into space onto space media. Space astronomy differs from classical astronomy not only in the transfer of observation points into outer space, but also in its methodological and organizational basis. Space astronomy, in addition to the basics of astronomy, uses new sciences as components: space geodesy, space geoinformatics, geodetic astronomy, spatial analysis, spatial logic, system analysis, computer science. The application of spatial logic is one of the features of space astronomy. The main means of observation in space astronomy is space monitoring, which uses the ideas of geoinformation monitoring. Space astronomy is a “situational” science. She not only observes, but also measures and forms management decisions. For example, the problem of selecting sites for landing spacecraft belongs to the field of space astronomy. The application of the information field model is an important difference in space astronomy. The information field is an integral model that unites different fields and allows for complex analysis and complex problem solving.

**Keywords:** space research, astronomy, space astronomy, space geoinformatics, space geodesy, information field.

### 1. Introduction

Space astronomy originated about 30 years after the launch of the first andsophisticated Earth satellites (AES). Since the launch of AES, Earth Remote Sensing (ERS) has been intensively developing. remote sensing of the Earth has a technological direction of research from space to Earth. Space astronomy (Zombeck, 2006) is directed from artificial earth satellites and spacecraft into space, that is, in the direction opposite to the Earth. Classical stronomy is conditioned by the needs of human practice in terrestrial and stellar coordination, in terrestrial navigation, in determining synchronous time, and studying the chronology of development. Classical astronomy studies the patterns of stellar and planetary arrangements. Astronomy studies the motion of celestial bodies, the structure of planetary systems, and the development of celestial systems and individual stars. Many definitions of astronomy do not refer to the direction of astronomy research. Astronomical research has long been carried out from the surface of the Earth into space. The creation of AES, orbital stations and spacecraft made it possible to transfer observations from the earth's surface to outer space. This created two directions of such observations. The first direction of observations is carried out from space to Earth. It is called remote sensing of the Earth (ERS)). For a long time, the second direction of observations from

* Corresponding author
E-mail addresses: voznam@bk.ru (V.V. Oznamets)

space to space was not called in any way. And recently, the name "space astronomy" has appeared for it. Space astronomy differs from classical astronomy not only in the transfer of observation points from the earth's surface to outer space, but also in its methodological and organizational basis. In some cases, space astronomy is implemented as a technological science. Its methods are aimed at solving applied problems. Space astronomy can be compared with geoinformatics, which at the beginning of development was created as a technological direction. The organizational components of space astronomy are: classical astronomy, geodetic astronomy (Gospodinov, 2018; Gospodinov, 2022), space geoinformatics (Bondur, Tsvetkov, 2015), space photogrammetry, dynamic photogrammetry, spatial logic, system analysis, computer science (Gospodinov, 2023; Polyakov, Tsvetkov , 2002) and space geodesy (Oznamets, 2023). Classical astronomy developed independently of geoinformatics. The main means of collecting information in space astronomy is space monitoring, which is carried out in different spectral ranges. Another difference between classical astronomy and space astronomy is the types of objects of observation. Classical stronomy is an "object" and "systemic" science. It examines objects and their systems. Space astronomy is an "object", "systemic" and "situational" science. It explores the spatial information situations in which objects are located, as well as systems of objects and systems of situations. Space astronomy considers the world as a system of systems (Monakhov i dr., 2004). Cosmic astronomy considers space as a system of nested spaces (Tsvetkov, 2015). In the modern world, information serves as the basis for development. Therefore, space astronomy uses the methods of computer science, which did not exist in the period of the emergence and application of conventional astronomy.

Modern informatics uses the concept and model of the information field (Raev, 2021) for integrated processing of observations. The concept of the information field of information is used in space research (Bondur, 2015). It is logical to apply this concept in space astronomy. Thus, space astronomy is a complex of sciences and its study is relevant.

## 2. Results and discussion

### Cosmic spatial logic

Logic is interpreted as the science of reasoning. Recently, logic has been interpreted as the science of finding and describing the laws of the surrounding world. For space astronomy, spatial logic is important. Spatial logic (Kudzh, Tsvetkov, 2020; Tsvetkov, 2020) describes the patterns of spatial systems and structures. Spatial logic in space astronomy includes geometric logic, figurative logic, and visibility logic. The logic of visibility is due to the peculiarity of space observations. Objects, such as planets, are large in size compared to terrestrial objects. Space objects move with huge Speeds. Spatial logic is used in trajectory calculations and analysis. Observation distances in space are orders of magnitude greater than those in terrestrial conditions. Spatial logic is used in the construction of virtual models of outer space. Logic is necessary in the study of near-Earth space and the study of the surface of planets.

The peculiarity of space astronomy and space geoinformatics is the widespread use of angular measurements (Savinykh, 2021). Many studies of planets do not have the possibility of linear contact direct measurements. Most measurements in astronomy and space astronomy are angular. Cosmic spatial logic allows for spatial and geometric constructions. It connects real angular measurements with the linear dimensions of celestial bodies.

### Coordinate systems in space astronomy.

Coordinate systems in space astronomy are used and developed on the basis of astronomical coordinate systems and terrestrial coordinate systems. Many of the tasks of space astronomy are related to measurements on the surface of planets. Different coordinate systems are used on the surfaces of the planets. The principle of system selection is similar to terrestrial coordinate systems (Rosenberg, Tsvetkov, 2009) Planetocentric, external, reference (model), surface (topocentric) coordinate systems and fragmentary (local) systems are used to model the surface of planets. On planets, as a rule, (with the exception of the Earth) it is difficult to create geodetic networks. Planetocentric coordinate systems are associated with the center of mass of the planet and are most often spherical. External coordinate systems have a conditional center. They are connected to the outer point of space and are not connected to the planet. They are usually also spherical or elliptical. Such a system is created in a conditional space relative to the planet and for its binding to the surface, points with known coordinates on the surface of the planet are required. An example of such systems are GPS, GLONASS systems. A planet is nested in this coordinate space and there is a need to bind this space to the surface or center of mass of the planet.

Surface (topocentric in relation to the earth's surface) coordinate systems are created relative to the points of the surface. They are tied to surface points. They are usually Cartesian coordinate systems. These systems are tied to a planet-centric system. Local coordinate systems are created in small areas to solve engineering problems. They are floating and are not tied to a planet-centric coordinate system. They are analogues of surface coordinate systems. They are created for the duration of engineering or construction work.

Planet-centric coordinate systems are associated with the center of mass of the planet. These coordinate systems are based on a model of the planet: either a spheroid or an ellipsoid. For an ellipsoid model, you need to specify the parameters of the ellipsoid, the plane of the equator, the poles, and the center. A planetary ellipsoid is used to simulate the shape of a planet if it looks like an ellipsoid. Therefore, the main task of such a model is to model the shape.

Reference coordinate systems are associated with the reference ellipsoid model. These systems are used for the studied areas. An additional procedure is the orientation of the reference ellipsoid in the body of the planet.Reference ellipsoids define a system of heights. Therefore, in contrast to the planetary ellipsoid, it is necessary to set the initial geodetic dates (*datum*) to orient and fix the reference ellipsoid in the body of the planet. The main task of such a model is to simulate heights on the surface of the planet.

The topocentric coordinate system is rectangular. Its origin is on the surface of the planet, near the surface or below the surface. The direction of the Z-axis is chosen along the normal to the surface of the planet model (spheroid or ellipsoid). The *x-axis* lies in the plane of the meridian, which passes through the reference point. It is directed to the North Pole. Y-axis complements the educated system to the left. The system participates in the daily rotation of the planet, remaining stationary relative to the points of the surface. Such conditions for specifying planetocentric and topocentric systems ensure the comparability of measurements on different planets.

The Z-axis of the topocentric system sets the conditional vertical and serves as the basis for measuring heights on the planet. However, there are many contradictions in the geodetic literature. "A vertical is a straight line in space, perpendicular to the horizontal plane." Horizontal planes do not exist in nature. The surface of any planet is not a horizontal, but a convex surface. Most large planets have a shape close to spherical. Therefore, other approaches must be used to determine heights.

Many planets have the geometric center of the planet's figure shifted relative to the planet's center of mass. Because of this, the direction of the plumb line does not correspond to the direction of the vertical for the ellipsoid references.

**The relationship of space astronomy to computer science and geoinformatics.**

Informatics (Gospodinov, 2023) and geoinformatics (Ivannikov et al., 2005) have had a great influence on the development of science and technology. This is mainly due to the use of various models that generalize the properties of real-world objects. In addition, computer science and geoinformatics allow you to transfer processing and analysis methods from one field to another. Space astronomy is closer to applied computer science than to computer science. Space astronomy closer to applied computer science than to computer science. Space astronomy is closer to applied geoinformatics (Ivannikov et al., 2005) than to general geoinformatics. The application of geoinformatics methods is due to the property of its integration (Maksudova et al., 2000). It is advisable to use this property in space astronomy.

Geoinformatics uses artificial intelligence methods (Savinykh, Tsvetkov, 2010). Space astronomy also requires the use of artificial intelligence, especially due to the fact that there is a problem of big data in it

Information models are the basis of processing in computer science and geoinformatics (Tsvetkov, 2005a). This principle has been transferred to space astronomy

Space astronomy relies on qualitative and comparative analysis. In comparative analysis in space astronomy, oppositional analysis is used (Tsvetkov, 2008).

The basis of observation in space geoinformatics is geoinformation monitoring (Tsvetkov, 2005b) and space monitoring. In space astronomy, this is the main source of information.

In computer science and geoinformatics, digital models are widely used at the intermediate stage of processing. As a result of processing, digital maps are used (Tsvetkov, 2000). In space astronomy, maps are used less often and synthesized images and photo schemes are used more often.

Metamodeling is used to generalize experience in computer science and other sciences

(Tsvetkov at al., 2020). In space astronomy, metamodeling is also used to generalize experience and build hypotheses.

**Field concept in space astronomy**

A field concept in space astronomy is that modeling and analysis take into account the model of the information field (Bondur, 2015). Reality is considered by its reflection in the information field. The information field has three functions (Tsvetkov, 2014a): reflection, integration and representation. The mechanism of reflection is to reflect reality in the global information model of the information field. Function integration consists in the fact that the information field unites disparate and related objects, including their connections and relationships. The function of representation is that the information field represents objects and situations in visual form. It was noted above that space astronomy can be compared with a satellite image. The information field, as well as a photograph, reflects reality. Therefore, conceptually, the information field fits into the theory of space astronomy.

The information field includes not only specific objects, but also information uncertainty. Information uncertainty refers to information that can be explained logically and on the basis of known theories. On this basis, explanatory information and uncertainty are distinguished. There is a lot of redundant information in the information field. For example, a raster photograph contains as much information as a map of the area. But it has an information volume of 3-4 orders of magnitude larger than the information volume of the map.

The addition of the information field is the information space. An example of an information space in a spacecraft is coordinate space. The information space contains different information fields. The information field has a meaningful characteristic of the space field function, the field function shows the value of the characteristic of the field at a given point in space. For example, a satellite receiver shows three-dimensional coordinates at a point in space. The presence of a field function indicates the presence of a field, the absence of a field function indicates the absence of a field. The information space is polymorphic. For example, the coordinate of a point in space can be defined in a polar coordinate system, a Cartesian coordinate system, a spherical coordinate system, a cylindrical coordinate system.

## 3. Conclusion

Space astronomy arose as a development of astronomy to solve applied problems. Because of this, space geoinformatics is about space astronomy. Space geoinformatics developed on the basis of applied geoinformatics, which is focused on solving applied problems. Space astronomy based on the traditions of geoinformatics is developing through the integration of various scientific areas (Savinykh, 2015). As the first feature of the integration of space astronomy, it should be noted its integration with remote sensing technologies. As the second feature of the integration of space astronomy, it should be noted the transformation of Earth sciences into space disciplines: space geoinformatics, space geodesy (Jin et al., 2013), geodetic astronomy, and so on. As the third feature of space astronomy, it is necessary to note the problem of big data (Buravtsev, Tsvetkov, 2019), which is characteristic of space research. Space astronomy shapes spatial knowledge (Tsvetkov, 2016) and cosmic knowledge (Savinych, 2016). Space astronomy research methods are aimed at the study of celestial bodies. Space astronomy (Gospodinov, Tsvetkov, 2023) complements astronomy and space geoinformatics and contributes to the formation of a scientific picture of the world.

## References

Bondur, 2015 – *Bondur, V.G.* (2015). Informatsionnye polya v kosmicheskikh issledovaniyakh [Information fields in space research]. *Obrazovatel'nye resursy i tekhnologii*. 2(10): 107-113. [in Russian]

Bondur, Tsvetkov, 2015 – *Bondur, V.G., Tsvetkov, V.Ya.* (2015). New Scientific Direction of Space Geoinformatics. *European Journal of Technology and Design*. 4(10): 118-126.

Buravtsev, Tsvetkov, 2019 – *Buravtsev, A.V., Tsvetkov, V.Ya.* (2019). Oblachnye vychisleniya dlya bol'shikh geoprostranstvennykh dannykh [Cloud computing for big geospatial data]. *Informatsiya i kosmos*. (3): 110-115. [in Russian]

Gospodinov, 2018 – *Gospodinov, S.G.* (2018). The Development of Geodesic Astronomy. *Russian Journal of Astrophysical Research. Series A*. 4(1): 9-33.

Gospodinov, 2022 – *Gospodinov, S.G.* (2022). Evolution of geodetic astronomy. *Russian Journal of Astrophysical Research. Series A*. 8(1): 3-11.

Gospodinov, 2023 – *Gospodinov, S.G.* (2023). Sovremennaya informatika [Modern computer science]. Saarbruken, 157 p. [in Russian]

Gospodinov, Tsvetkov, 2023 – *Gospodinov, S.G, Tsvetkov, V.Ya.* (2023). Nekotorye teoreticheskie aspekty instrumental'nykh metodov kosmicheskoi astronomii [Some theoretical aspects of instrumental methods of space astronomy]. Sofiya. Art Eternal Cinema. 92 p. [in Russian]

Ivannikov i dr., 2005 – *Ivannikov, A.D., Kulagin, V.P., Tikhonov, A.N., Tsvetkov, V.Ya.* (2005). Prikladnaya geoinformatika [Applied geoinformatics.]. M.: MAKS Press, 360 p. [in Russian]

Jin et al., 2013 – *Jin, S., van Dam, T., Wdowinski, S.* (2013). Observing and understanding the Earth system variations from space geodesy. *Journal of Geodynamics*. 72: 1-10.

Kudzh, Tsvetkov, 2020 – *Kudzh, S.F., Tsvetkov, V.Ya.* (2020). Spatial logic concepts. *Revista inclusions*. 7. Número Especial / Julio – Septiembre. Pp. 837-849.

Maksudova i dr., 2000 – *Maksudova, L.G., Savinykh, V.P., Tsvetkov, V.Ya.* (2000). Integratsiya nauk ob okruzhayushchem mire v geoinformatike [Integration of sciences about the surrounding world in geoinformatics]. *Issledovanie Zemli iz kosmosa*. 1: 46-50. [in Russian]

Monakhov i dr., 2004 – *Monakhov, S.V., Savinykh, V.P., Tsvetkov, V.Ya.* (2004). Metodologiya analiza i proektirovaniya slozhnykh informatsionnykh system [Methodology for analysis and design of complex information systems]. M.: Prosveshchenie, 264 p. [in Russian]

Oznamets, 2023 – *Oznamets, V.V.* (2023). The Evolution of Space Geodesy. *Russian Journal of Astrophysical Research. Series A*. 9(1): 14-19.

Polyakov, Tsvetkov, 2002 – *Polyakov, A.A., Tsvetkov, V.Ya.* (2002). Prikladnaya informatika [Applied Informatics]. M.: Yanus-K, 392 p. [in Russian]

Raev, 2021 – *Raev, V.K.* (2021). Informatsionnoe prostranstvo i informatsionnoe pole [Information space and information field]. *Slavyanskii forum*. 4(34): 87-96. [in Russian]

Rozenberg, Tsvetkov. 2009 – *Rozenberg, I.N., Tsvetkov, V.Ya.* (2009). Koordinatnye sistemy v geoinformatike [Coordinate systems in geoinformatics]. MGUPS, 67 p. [in Russian]

Savinych, 2016 – *Savinych, V.P.* (2016). On the Relation of the Concepts of Space Knowledge, Knowledge, Knowledge of the Spatial. *Russian Journal of Astrophysical Research. Series A*. 1(2): 23-32.

Savinykh, 2015 – *Savinykh, V.P.* (2015). O kosmicheskoi i zemnoi geoinformatike [About space and terrestrial geoinformatics]. *Perspektivy nauki i obrazovaniya*. 5: 21-26. [in Russian]

Savinykh, 2021 – *Savinykh, V.P.* (2021). Determination of the Linear Parameters of the Planet by Measuring the Angular Diameter. *Russian Journal of Astrophysical Research. Series A*. 7(1): 28-34.

Savinykh, Tsvetkov, 2010 – *Savinykh, V.P., Tsvetkov, V.Ya.* (2010). Razvitie metodov iskusstvennogo intellekta v geoinformatike [Development of artificial intelligence methods in geoinformatics]. *Transport Rossiiskoi Federatsii*. 5: 41-43. [in Russian]

Tsvetkov et al., 2020 – *Tsvetkov, V.Ya., Shaitura, S.V., Minitaeva, A.M., Feoktistova, V.M., Kozhaev, Yu.P., Belyu, L.P.* (2020). Metamodelling in the information field. *Amazonia Investiga*. 9(25): 395-402.

Tsvetkov, 2000 – *Tsvetkov, V.Ya.* (2000). Tsifrovye karty i tsifrovye modeli [Digital maps and digital models]. *Izvestiya vysshikh uchebnykh zavedenii*. Geodeziya i aerofotos"emka. 2: 147-155. [in Russian]

Tsvetkov, 2005a – *Tsvetkov, V.Ya.* (2005). Informatsionnaya model' kak osnova obrabotki informatsii v GIS [Information model as the basis for information processing in GIS]. *Izvestiya vysshikh uchebnykh zavedenii*. Geodeziya i aerofotos"emka. 2: 118-122. [in Russian]

Tsvetkov, 2005b – *Tsvetkov, V.Ya.* (2005). Geoinformatsionnyi monitoring [Geoinformation monitoring]. *Izvestiya vysshikh uchebnykh zavedenii*. Geodeziya i aerofotos"emka. 5: 151-155. [in Russian]

Tsvetkov, 2008 – *Tsvetkov, V.Ya.* (2008). Ispol'zovanie oppozitsionnykh peremennykh dlya analiza kachestva obrazovatel'nykh uslug [Using oppositional variables to analyze the quality of educational services]. *Sovremennye naukoemkie tekhnologii*. 1: 62-64. [in Russian]

Tsvetkov, 2014a – *Tsvetkov, V.Ya.* (2014). Information Space, Information Field, Information Environment. *European researcher*. 8-1(80): 1416-1422.

Tsvetkov, 2015 – *Tsvetkov, V.Ya.* (2015). Kosmicheskii monitoring: Monografiya [Space monitoring: Monograph]. M.: MAKS Press, 68 p. [in Russian]

Tsvetkov, 2016 – *Tsvetkov, V.Ya.* (2016). Formirovanie prostranstvennykh znanii: Monografiya [Formation of spatial knowledge: Monograph]. M.: MAKS Press, 68 p. [in Russian]

Tsvetkov, 2020 – *Tsvetkov, V.Ya.* (2020). Prostranstvennaya logika v geoinformatike [Spatial logic in geoinformatics]. *Vektor GeoNauk*. 3(2): 91-100. [in Russian]

Zombeck, 2006 – *Zombeck, M.V.* (2006). Handbook of space astronomy and astrophysics. Cambridge University Press.