

## DVD Database Astronomical Manuscripts in Georgia

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**Abstract.** Little known and unknown Georgian, Persian, and Arabic astronomical manuscripts of IX-XIX centuries are kept in the centers, archives, and libraries of Georgia. These manuscripts has a form of treaties, handbooks, texts, tables, fragments, and comprises various theories, cosmological models, star catalogs, calendars, methods of observations. We investigated this large material and published DVD database Astronomical Manuscripts in Georgia. This unique database contains information about astronomical manuscripts as original works. It contains also descriptions of Georgian translations of Byzantine, Arabic and other sources. The present paper is dedicated to description of obtained results and DVD database. Copies of published DVD database are kept in collections of the libraries of: Ilia State University, Georgia; Royal Observatory, Edinburgh, UK; Congress of the USA, and in other centers.

### 1. Introduction

Astronomical manuscripts usually involved wide textual descriptions, numerous tables detailed images and schems. Manuscripts reflected progress of the astronomical knowledge, new discoveries and theories, information on modern instruments. Numerous astronomical manuscripts preserved in universities, libraries and archives, which present to us old systems of universe, theories on movements of luminaries, stellar catalogues, calendars, constructions of astronomical instruments. The works of Hipparchus, Ptolemy, Al-Biruni, As-Sufi, Nassir Al-din Tusi, Regiomontanus, Copernicus, Tycho Brahe, Kepler, Galileo Galilei, William Herschel and others, which today are still the object of public interest and comprehensive research, have become known just through the manuscripts and their dissemination. Astronomy and mathematics since time immemorial have developed in Georgia as well. The Georgian manuscripts containing astronomical and astrological information have reached us in the form of separate manuscript books, collections, documents and fragments of various contents and volumes. The material of astronomical content, both original and translated represents extended texts, tables, drawings and their complexes, which are written in different Georgian alphabet – Asomtavruli, Nuskhva-Khutsuri and Mkhedruli. Especially should be noted the manuscripts containing some Georgian works: the paschalistic work (X c) of Ioanne-Zosime on Byzantine and Georgian calendar systems, which is involved the Sinai collection; the Treatise of Abuseridze Tbeli (or Abuserisdze) dated by 1233 “Complete Choronikon” (Figure 1); astronomical comments (XII c) of Ephrem Mtsire

supplied to his translation of Gregory the Theologian's work "Sitkvani"; and others. This large massive of scientific information is preserved in different scientific centers and antiques depositories in Georgia and other countries. Hundreds of Georgian astronomical manuscripts are still unknown or unstudied from the scientific viewpoint. In corresponding descriptions, in frequent cases, are pointed only names of the works and the list of evidences, their incomplete or non-exact annotations. These manuscripts (astronomical, cosmological, chronological), which probably involve unique data, facts, fundamental works, have not been analyzed by the specialists of astronomy history. The Georgian astronomical manuscripts often are of mixed character and involve some mixture of astronomy and astrology. Majority of these manuscripts are not deciphered, their astronomical importance has not been studied. They are unknown for a wide community of researchers. It should be mentioned here that the Georgian manuscripts of this type are preserved abroad, namely, in Greece, France, Great Britain, Egypt, Russia, and in eastern countries as well. More than 60 Arabic and Persian astronomical manuscripts (XV-XIX cc) are preserved in the National Center of Manuscripts. They involve the works of medieval classics: Nassir Al-Din Tusi, Ulugh Beg, Ali Qushji, Al-Balkhi, Al-Andalusi, Al-Birjandi, Al-Rumi and others in Arabic and Persian languages. Many translations from the oriental sources are presented in the Georgian antiques depositories.

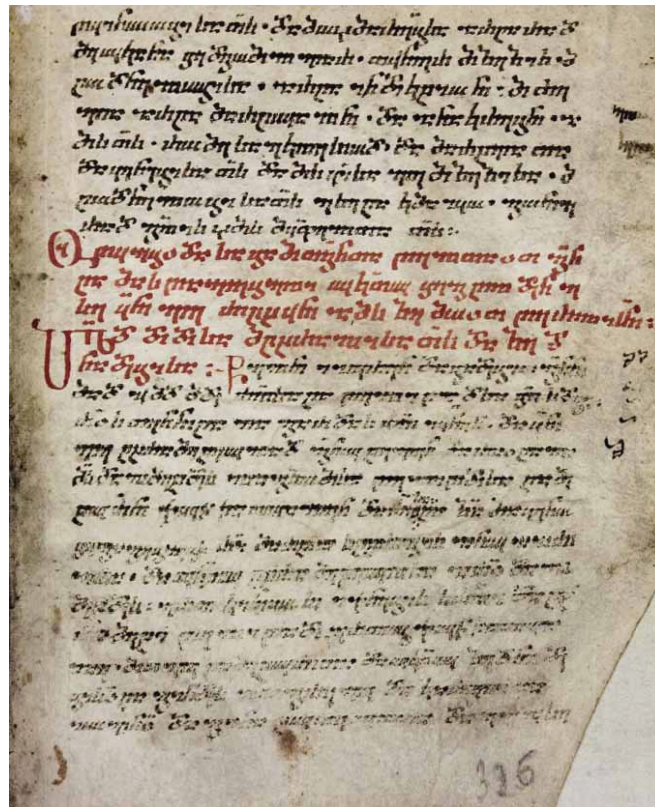


Figure 1. The fragment of "Complete Chronikon" treaties of Georgian astronomer and writer Abuseridze Tbeli, XIII century (GAM 5).

## **2. The Project “Astronomical Manuscripts in Georgia”**

Manuscripts of different content, history and periods are preserved in scientific centers, libraries, archives and museums of Georgia. The manuscripts of scientific, religious, socio-political and other content mostly belong to Late Antiquity, the Middle Ages, Renaissance and Enlightenment. The manuscript materials preserved in the centers and libraries differ with their volume and quality of protection and are written on parchment and paper. The structure of this material can be characterized by two main elements, namely, textual, and graphical-illustrative materials. These two elements often are organically merged in the manuscripts and fill each other – the texts are equipped with illustrations, drawings and schemes of different type, which are supplied to the textual explanations. Quite an important part of the manuscripts preserved in the depositories of antiquity of Georgia are manuscripts of the scientific content. This segment is widely presented with the exact sciences, geography, and medicine. A great number of manuscripts involves mixed material and is complex in its character – within one book, work or supplement we can, probably, come across religious, literary, scientific, political texts, materials on everyday life. The mentioned manuscript material reached us both in the original form and of late copies, in the process of formation of which a certain part of original forms and texts were either lost or enriched. The works or other material preserved in the manuscripts, in frequent cases, are anonymous. They are studied well from the codicological-philological viewpoint. Their subject research as of the monuments containing scientific material was not done as it was necessary. On the whole, study of manuscripts, apprehension of their importance, was mostly done from philological, linguistic history. Therefore in most cases, rich manuscript heritage is not comprehended from the viewpoint of exact sciences. It should be specially mentioned that the texts are published at high professional level and represent the most important step for their further comprehensive research. The depositories of antiquity of Georgia also preserve manuscripts in Persian, Arabic, Greek and other languages. This material is characterized with complex and diverse structure, involves both religious and secular works, material involving scientific information, historical documents, notes, comments, etc. On the basis of analysis of the general picture and the results of astronomical science development, we came to the conclusion that special attention should be concentrated on astronomical manuscripts as the monuments containing scientific information and unique data. We apprehended and established the main tasks and prepared the scientific project “Astronomical Manuscripts in Georgia”. The project was implemented in 2012-2015 years. We shall list main scientific centers and depositories of Georgia, in which are kept astronomical manuscripts of different period, different content: National Center of Manuscripts (Tbilisi), National Archives of the Ministry of Justice (Tbilisi), Library of Parliament of Georgia (Tbilisi), Historical-Ethnographic Museum (Kutaisi), depositories of antiquity in Gori, Akhaltsikhe, Zugdidi, Telavi, Batumi. In parallel with astronomical manuscripts in the centers mentioned above are also preserved the manuscripts of allied branches, physics and mathematics. On the whole, we described the Georgian astronomical manuscripts in general, without detailed analysis, explanations and interpretation; we looked through almost 3,000 originals. All this cultural layers and each separate manuscript (except some of them) demands deep scientific analysis. The Persian and Arabic astronomical manuscripts preserved in the depositories of antiquity of Georgia did not become the subject of historical-scientific study, which is also quite topical and urgent. Proceeding from the factors cited above, the main purposes of our project were outlined:

1. Research, systematization of the astronomical manuscripts preserved in Georgia, involvement of the data into scientific circulation, publication of the interactive database; research of unstudied or partially studied Georgian, Persian and Arabic manuscripts and determination of their scientific significance;
2. Study of unknown astronomical manuscripts revealed in the process of research;
3. Catalogization of the material, which will form the basis, reference-source, for their further deep and comprehensive study.

We expect to reach the following main results:

1. Primary general systematization of the Georgian, Persian, and Arabic astronomical manuscripts preserved in the centers of Georgia;
2. Primary scientific description of this material;
3. Discovery of unknown astronomical manuscripts and their scientific description.
4. Publication of the interactive database on DVD disc, which involve a complex of the material and textual, graphical documents, bulletins, images, information, etc.

It should be mentioned that the sphere of our interests involved also the material of allied sciences (especially, physics), which contain astronomical information. We elaborated special methods for their express-analysis and systematization, outlined and worked out main structure of the planned database, with the detailed components and integral parts. All this was theoretically substantiated, apprehended and described. In the very beginning of the project implementation we distinctly felt well-known difference between theory and practice, namely, we came across much more complicated, irregular, scattered and, certainly, less studied material. A technical side of realization of the set tasks appeared beyond expectations. In other words, the degree of complexity of set tasks turned to be much higher than it was expected. Within three years we conducted express-analysis of more than 300 Georgian and more than 60 Persian and Arabic astronomical manuscripts from the several centers. Within the project interest we did not study the material of Telavi, Batumi and Zugdidi museums for the reasons independent of us. It should be mentioned neither the private collections appeared in the area of our research. Private libraries and archives, collections of documents and manuscripts were also unavailable for us. According to the published data, the Georgian astronomical manuscripts are also preserved beyond the borders of Georgia in the libraries, archives and museums of different countries. Unfortunately, with rare exceptions, our possibilities failed to include the material preserved in mentioned countries into the present project. Let us pass to description of some important Georgian, Persian and Arabic astronomical manuscripts, which we analyzed and catalogued. The substance Georgian astronomical manuscripts is quite wide and irregular. Georgian manuscripts are written in Asomtavruli, Nushka-Khutsuri, and Mkhedruli letters. The Georgian alphabet passed three stages of development: Asomtavruli (rounded) is the oldest type, in which epigraphic and manuscript texts are done in V-IX centuries; Nuskha-Khutsuri (angled) – was used in parallel of Asomtavruli from X century; these two types of alphabet are mostly used in religious manuscripts; according

to the manuscript tradition, Mkhedruli, i.e. modern Georgian alphabet is in X-XI centuries and, mostly, was used for secular texts. To separate some definite places in the manuscript text (from IX century) was used red writing paint – singur (HgS), mixture of mercury and sulfur. Singur was used signs designating the text beginning and the end, titles and upper letters were written in singur, in some cases, also paragraphs, and great part of the text, colophons and postscripts, comments and explanations, etc. Under Georgian astronomical manuscripts we mean: Manuscripts of purely astronomical content; Expanded and short astronomical fragments, included into religious, secular and mixed type manuscripts; Separate extracts or scattered pages of astronomical content, which have no beginning page of any authorized note; Collections of different, often of mixed, type, which involve astronomical section or completed astronomical work; Astronomical and astrological works, in which astronomical content prevails. The most voluminous are manuscripts of second category. Material of this type is most frequently met in separate works, also collections of religious character. In such manuscripts, logical succession of religious or religious-philosophical chapters quite often breaks unexpectedly with astronomical supplements or additions – in the form of a separate chapter, short text or, even, a table or picture. The manuscripts of this type are numerous in our depositories. We considered them as regular astronomical works, though pointed that they belonged to broader context. We added to them a catalogue number and implied the whole work entire expanded manuscript. Respectively, quite a great amount of religious manuscripts are placed in the catalogue, only fragments of which or some pages are purely astronomical material. Majority of astronomical manuscripts are not authorized. It seems that in the Middle Ages in frequent cases such tradition existed – not to mention author or translator, often neither the copyists. However, it is clear that there are such Georgian astronomical treatises, textbooks, observation instructions, etc, authors or translators of which are unknown. To old Georgian astronomical material belong the works of cosmological character, treatises in practical astronomy, also the material, which presents description of celestial sphere and movement of luminaries, instructions for observations and notes for preparing the astronomical instruments, calendar-chronological treatises, different religious calendars, description of rare astronomical phenomena, almanacs, etc. Georgian astronomical manuscripts can be grouped as follows:

1. purely astronomical researches, descriptions;
2. notes on use of special methods, instruments, results;
3. textbooks and instruction material;
4. general educational texts.

Many Georgian astronomical manuscripts are translated from Greek, Persian, Arabic and other sources. We have Georgian original astronomical manuscripts as well – treatises, descriptions, tables and textbooks. The degree of their preservation differs. We placed into the catalogue 300 Georgian astronomical manuscripts. However, the certain part of the manuscripts, are not in the catalogue due to of the certain reasons, some of them were not available, some others were a full copy of the old material; origin, text content, etc of some manuscripts, was uncertain. We can say the same about the Georgian astronomical manuscripts preserved in Gori and Kutaisi depositories of antiquity. In frequent cases we used digital copies and microfilms of the

manuscripts preserved beyond the borders of Georgia. Scientific profile of the Georgian astronomical manuscripts can be determined thus: majority of them, more or less, directly or indirectly are connected with old cosmological ideas, theories and models, calendar-chronological systems, educational-practical means of spherical astronomy. In old times, till late Middle Ages in general comprehension of the world Georgians give preference to geocentric system, Calendar-chronological systems, methods and theories are, mostly, concentrated on religious interests and are connected with strengthening of the Orthodox church rule, customs and traditions by means of time recording, chronology. We should mention in regard to this, as it seems, purely Georgian phenomenon from the group of Georgian manuscripts, which are called “Jhamni”. In these collections distinctly elaborated calendar system determines strict, legalized in time succession of Orthodox ceremonies, dates of Christian holidays and other important events connected with the church life. At the same time, these collections involve practical astronomical material, dates of rise and set of luminaries, names of stars and their location, characterization of rare astronomical phenomena. A clear example of teaching-practical textbook is the Textbook of Astronomy, compiled by Vakhtang VI Bagrationi, King of Georgia (Abuladze 1990). The present course concerns wholeness of the world, methods of astronomical observations, evidences on luminaries, etc. In some Georgian astronomical manuscripts we come across elements of ethnoastronomy, which contain legends and narrations on the sky, folk names of bright stars, sayings and stories connected with rare astronomical phenomena. From this viewpoint specially mentioned should be the information reflecting ethnoastronomical knowledge proved in “The Knight in the Panther’s Skin” of Shota Rustaveli, medieval Georgian poet and thinker (Tevzadze 1979). Georgian astronomical manuscripts of XVII-XVIII century differ with more scientific depth, there appear, namely, more exact theories, descriptions and data, more modern scientific interpretation of phenomena, which corresponds to general contemporary scientific achievements in the world; also appear translations of textbooks in physics, in which astronomical and cosmological elements are presented in abundance. Of special interest is the X-XIII century old Georgian astronomical manuscripts. To this unique material we should attribute the translations of cosmological sections in the works of Basil the Great, Gregory of Nyssa, John of Damascus, done by Giorgi Mtatsmideli, Ephrem Mtsire, Arsen of Ikalto; also calendar-paschal work of Ioanne Zosime, calendar-chronological work of Abuseridze Tbeli “Choronikoni Sruli Misita Sautsqeblita Gangebita”. To the study of old Georgian astronomical materials were dedicated the works of Tskhakaia (1959), Kharadze (1958), Giorgobiani (1965, 1971), Chagunava (1986), Abuladze (2009), Simonia (2001, 2004). The study of Georgian manuscript heritage we conducted showed quite complicated and, in some cases, contradictory picture: the Georgian manuscript heritage involves interesting and, at the same time, practically unstudied astronomical material. It is mentioned in the work of Jones (1996) that Byzantine astronomy, to a certain extent, was astronomy of manuscripts. In our opinion, the same can be said about old Georgian astronomy. On the basis of results of our studies we prepared and published the interactive database – “Astronomical Manuscripts in Georgia” (Simonia et al. 2015). This database contains rich textual and graphical information, catalogues, tables, instructions, full texts, and etc. Georgian astronomical manuscripts contain a main part of the database and have the index GAM – Georgian Astronomical Manuscripts. The following Georgian astronomical manuscripts require special attention:

GAM 3 – “Gardamotsema” of John of Damascus;

- GAM 6 – mixed collection;
- GAM 11 – collection: Sulkhan-Saba Orbeliani – “Teaching Described by Explanation”, Khelta, church and indiction evidences, calendar in verse;
- GAM 13 – Davitni/Book of Psalms, “Mtsketa Manuscript”, is supplied with calendar-paschal fragments;
- GAM 17 – “Katighoria Simetne”, translated by Cathalicos Anton I;
- GAM 22 – Concise Physics, translated by Cathalicos Anton I;
- GAM 24 – Sulkhan-Saba Orbeliani “Sikvis Kona” (“Bunch of Words”);
- GAM 30 – Georgian translation of Nasir ad-din Tusi “Teaching Book of Astrolabe”;
- GAM 32 – Synaxarium;
- GAM 39 – “Dialectics” of John of Damascus and commentator works of Amonius Ermia;
- GAM 42 – Synaxarium;
- GAM 51 – Astrological-astronomical collection;
- GAM 53 – Baumeister’s Physics, translated by Cathalicos Anton I;
- GAM 58 – Ulugh Beg, “Ziji – Star Catalogue”, translated by Vakhtang VI;
- GAM 61 – Collection;
- GAM 66 – Vakhtang VI, Kvinklos;
- GAM 67 – Collection;
- GAM 72 – “Hydayat Al-Nujumi Ū Book of Stars”, translated by Vakhtang VI;
- GAM 83 – “Sakme metsniereba mzisa da mtovaris shetqueba (shetqoba)”;
- GAM 96 – the Moon Cycle;
- GAM 98 – Short narrations about life of old philosophers;
- GAM 102 – Menaion;
- GAM 106 – Gulani of Svetitskhoveli;
- GAM 140 – Horologion;
- GAM 167 – Mtvaris Msrboloba (The Moon Movement);
- GAM 170 – Astronomical-astrological treatise “For Passover”;
- GAM 172 – Physics of David Batonishvili (Prince David);
- GAM 178 – Astronomy;
- GAM 207 – Calendar-liturgical and dogmatic collection;
- GAM 222 – Epimerte or Astronomy;
- GAM 224 – Horologion;
- GAM 242 – Church calendar;
- GAM 252 – Concise Physics, translation of Chr. Wolf’s “Physics” by Anton I;

GAM 266 – Sin 34, Liturgical collection;

GAM 296 – Collection: Basil the Great, Gregory of Nyssa, Gregory the Theologian, Athanasius of Alexandria, etc.

We enlisted here almost 12% of those Georgian astronomical manuscripts, which are in the catalogue. We consider that this old material can appear to be most interesting for the research of medieval astronomy of East Europe, Near and Far East. These old manuscripts should add a new layer to the history of Georgia-Byzantium, Georgia-Persia cultural and scientific relations. We separated the above-listed manuscripts by out subjective criteria as well. Taking into consideration inhomogeneous character of the manuscript heritage we recommend the scholars working on these topics to familiarize with complete content of the catalogue of Georgian astronomical manuscripts. The collections of National Center of Manuscripts preserve also Persian and Arabic astronomical manuscripts. Within the present project we analyzed the Persian and Arabic astronomical manuscripts of different content, volume and level of protection. It is interesting material, which is also unstudied from the viewpoint of history of astronomy. Majority of these manuscripts is later copies of the classical works of Oriental astronomers and mathematicians. We come across unknown authors and anonymous works as well. The astronomical manuscripts written in the Persian and Arabic languages concern the issues of cosmology, spherical astronomy, descriptions of planets and stars, calendar and chronology, angle-measuring astronomical instruments, etc. Widely presented are star catalogues and tables. The degree of protection of these manuscripts is different – from good to the very damaged. Their part was being copied directly in Georgia. In our depositories are preserved the works of such renowned astronomers, as: Nasir Al-Din Tusi, Ali Qushji, As-Sufi, Al-Rumi, etc. This astronomical heritage is also little studied. They could have special importance for research of Oriental astronomy, cultural and scientific relations of Georgia and Oriental countries. According to the results of our research we prepared a second catalogue of astronomical manuscripts, which involves the Persian and Arabic astronomical materials. This catalogue is also presented in the database. These manuscripts received the catalogue index AM – Astronomical Manuscripts. We will enlist some of them, which are of interest:

AM 2 – Ulugh Beg's "Zij"/"Star Catalogue";

AM 10 – Persian calendar;

AM 11 – "Sufficient Teaching of Astrological Science";

AM 17 – Astronomical-astrological work;

AM 19 – Astronomical-astrological work;

AM 22 – Astronomical collection;

AM 28 – Collection of works of Nasir Al-Din Tussi;

AM 34 – Astronomical work of Abd Ar-Rahman As-Sufi: "Book of Constellation Images";

AM 38 – Extracts from astronomical treatise;

AM 47 – Explanation of the celestial spheres. Author – Baha Al-Din Muhamed Al-'Amili;



AM 53 – Issues on celestial spheres, tables, etc.

We cited here 18% of the Persian and Arabic astronomical manuscripts preserved in Georgia. They are selected by our criteria. We recommend the specialists in old Oriental astronomy to familiarize with the complete version of the catalogue. We should mention here that we consider as “unstudied manuscript” the concrete copies, variants and units. The database contains Georgian translations of Armenian and Russian astronomical sources. We conducted laborious work from the viewpoint of catalogization and study of the astronomical manuscripts preserved in Georgia. The results obtained, surely, demand expansion and further deepened research which, we hope, will be realized in the future. We consider the obtained results as the primary analysis of astronomical manuscript heritage preserved in Georgia and efforts to determine from the right course in boundless world of old books and manuscripts dedicated to the stellar universe.

### **3. The Structure of DVD database**

Interactive database “Astronomical Manuscripts in Georgia” involves vast textual and graphical material with relevant descriptions and instructions. The database is supplied with the References, which consists of fragments of the manuscripts in the form of textual quotations and images. The database is equipped with the system of indexes, designated for search of the documents arranged according to the search words. After the “Introduction” and the “tasks and results” is given an instruction about receiving the image of some, especially interesting, important manuscript. Each image is supplied with explanatory inscription. Here are presented the Georgian, Persian and Arabic manuscripts. In the database is given an instruction on the catalogue of Georgian astronomical manuscripts. The catalogue, in its turn, is equipped with short information on a concrete manuscript and a detailed bulletin (for each manuscript). Each bulletin is a text with description of the manuscript and a graphical fragment of the manuscript. The bulletin involves general data of the manuscript and its astronomical description. It also presents to us bibliographical information and relevant index GAM (Georgian Astronomical Manuscripts) or AM (Astronomical Manuscripts). Each bulletin is a PDF file. Then instruction follows on the Persian and Arabic astronomical manuscripts and, also on the additional catalogues (the catalogue of those manuscripts, which are not introduced into the database in the form of informational bulletins). Our interactive database presents full copy (in the JPEG format) of some Georgian, Persian and Arabic manuscripts. These copies are designated for research and non-reproductive purposes. Then the interactive database gives a link on short dictionary of Georgian astronomical terms, in which is given relevant English equivalent of the main term. In the link “Additional Material” one can search for mixed information of different kind. The database presents a short list of internet-resources required for research. The database “Astronomical Manuscripts in Georgia” is published by Ilia State University Press in the form of DVD discs.

### **4. Conclusion**

It is clear that the old Georgian, Persian and Arabic astronomical manuscripts, preserved in the Georgian antiques depositories and yet unstudied, demand deep research

and stage by stage publication. This is multi-aspect issue, which implies interdisciplinary (astronomy, codicology-textology, etc) continuous research. This can be settled only by inter-connected and inter-filling steps, by using the latest modern scientific methods and technologies. With the aim of forming the reliable grounds for settlement of the above-mentioned problem, we have prepared and implemented a special scientific project, the purpose of which was analysis and systematization of the Georgian, Persian and Arabic astronomical manuscripts, preserved in the antiques depositories and scientific centers of Georgia. We have published the database, involving an important source of scientific information for the specialists studying old astronomy; the scientists studying manuscript heritage, lost and unknown scientific data. For the university professors, researchers of different institutes and laboratories, employees of libraries and archives, students of relevant specialties the present database will perform the function of a navigator in the sphere of little studied astronomical heritage. We express hope that the present database will be for you a valuable source of information, which will promote preparation and publication of new scientific works. Researchers can find copies of DVD discs in Libraries of: Ilia State University, Georgia; Byurakan Astrophysical Observatory, Armenia; Royal Observatory, Edinburgh, UK; University of Cambridge, UK; University of Hamburg, Germany; also in libraries of Alexandria, Egypt; Congress of the USA and in other centers.

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