Detecting and Tracking Asteroids in The International Astronomical Search Collaboration Science Program

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Abstract: The article presents the work and the results of a group of lecturers, teachers, cadets and students in the International Astronomical Search Collaboration science program. The main stages of the astrometric processing of the astronomical images, in which, asteroids are detected and followed up, are addressed. With the help of a NASA's Jet Propulsion Laboratory software, are calculated the orbital elements and are presented the orbital diagrams of the new asteroids, discovered by the teams of Georgi Benkovski Bulgarian Air Force Academy.

Keywords: *IASC, asteroids, astronomical observations, orbital elements, Astrometrica*

1. Introduction

The Astronomical Community carries out research in order to study and understand the nature of the astronomical objects, as well as, protect the humankind from cosmic dangers. One of those dangers, which life on our planet has faced, is collisions with asteroids and comets. These objects date back to the formation of our Solar System, 4.6 billion years ago. One of the largest planetary catastrophes was caused by an asteroid, which fell in the area of Yucatán, Mexico. At that time, 64 million years ago, 95% of Earth's biosphere had vanished. Astronomers who study the Minor Bodies in the Solar System organize, manage and participate in various scientific and research programs. One of the most successful programs is the International Astronomical Search Collaboration (IASC). This scientific program enables cadets, students and pupils from universities and colleges to make real astronomical discoveries and search for and follow up asteroids, that are already known. Over 1 113 500 asteroids had been discovered by the end of 2021. The discoveries were made by professional astronomers, amateur-astronomers, cadets, students and pupils from universities and colleges from all over the world.

A group of lecturers, cadets and students from Georgi Benkovski Bulgarian Air Force Academy (BAFA) have been taking part in the IASC program, since 2020. They have taken part in several observational research campaigns. They have followed up hundreds of asteroids and have discovered four new asteroids, which are part of the Main Asteroid Belt, located between Mars and Jupiter.

2. Scientific and Research Process in The International Astronomical Search Collaboraion Science Program

International Astronomical Search Collaboration was started in October, 2006 by a group of lecturers from Hardin-Simmons University (HSU), Abilene, Texas and is organized and sponsored by National Aeronautics and Space Administration (NASA). Since then, Program Director has been the Professor of Mathematics and Astronomy – Dr. Patrick Miller, who also teaches introductory astronomy and astronomical research methods at HSU.

The IASC is a program, mainly oriented towards cadets, students, pupils and their lecturers and teachers from all around the world. Participants in the IASC program have access to astronomical data from observations, carried out with large professional telescopes. The participants process the data with the help of *Astrometrica* professional interactive software tool for scientific grade astrometric data reduction of Charge-Coupled Devices (CCD) images (*Figure 1*). This gives them the opportunity to make real astronomical discoveries of new objects – asteroids, to contribute to specifying of the orbital elements of the observed objects – asteroids, comets and trans-Neptunian objects [1].

The participants in the program undergo training, which is focused on the study of the basics of spherical astronomy and, in particular, equatorial coordinate system. This is necessitated by the need of a better understanding of the Astrometrica interactive software tool working principle, and the correct identification of the moving objects, discovered in the astronomical images.

The work of the teams, which take part in the IASC program is organized and divided into observational campaigns with varying durations from 20 to 45 days each. The participants receive astronomical images in an Internet space, which is different for each team. The sets of images contain a minimum of three images, most commonly four, captured in sufficiently short time intervals by large telescopes, equipped with CCD. For the fulfillment of the scientific tasks of the IASC program, are used the large telescopes of the international astronomical programs Catalina, Pan-STARRS and Faulkes Telescopes. The program is supported by NASA [2]. Among the IASC program partners is Rozhen National Astronomical Observatory. The sets of images are processed with the help of Astrometrica professional astronomical software tool (*Figure 1*).

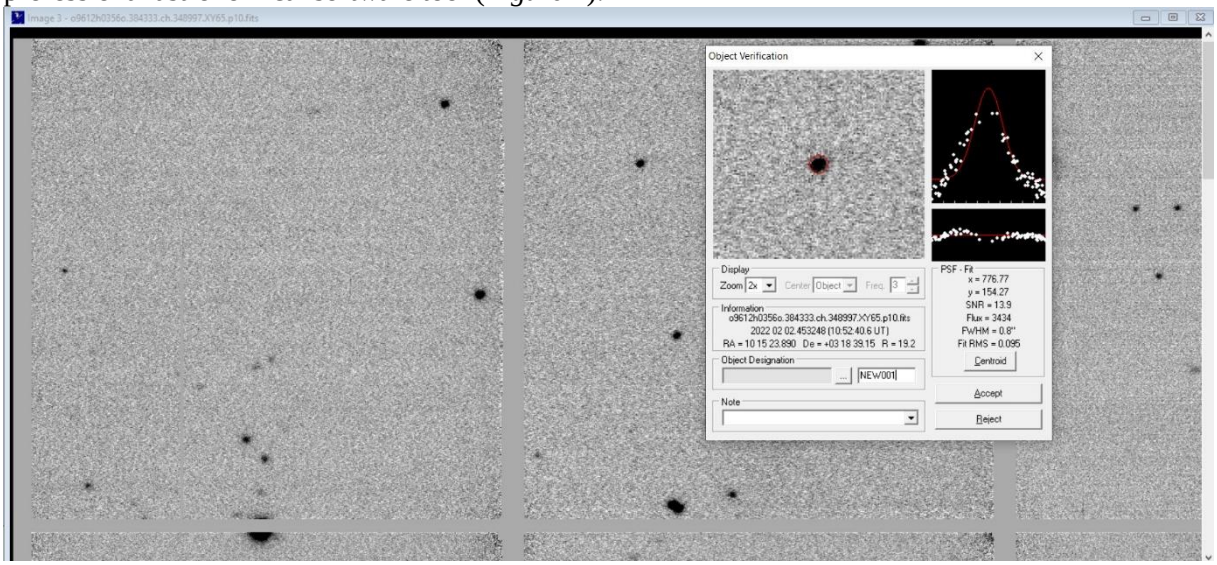


Figure 1. *Processing of astronomical images with Astrometrica professional interactive software tool*

This is an astronomical tool which facilitates the comparing of astronomical images, in order to search for, follow up and discover moving objects. The stars in the astronomical images are identified using the Positions and Proper Motions Star Catalogue (PPM Star Catalogue). The discovered object is compared and matched to the objects in the Minor Planet Center (MPC) database at Harvard-Smithsonian Center for Astrophysics. Regardless of the moving object being a new or already discovered asteroid, its equatorial coordinates – Right Ascension (*RA*) $\boldsymbol{\alpha}$ and Declination (*De*) $\boldsymbol{\delta}$ – are calculated. A text file (*.txt*) containing the calculated coordinates is then prepared to be included in the MPC database. This MPC report is sent to the IASC program database, which in turn sends it to the MPC database. The astrometrical observations performed by the participants, are included in the MPC database to be used for further refinement of the orbital elements of the asteroids, and defining the orbits of the new asteroids. A large number of preliminary discoveries of new asteroids are made, by the participants during each observational campaign [3]. After these asteroids have been monitored for a period of 5-7 years, their orbital elements are refined and these discoveries are designated as provisional. Then, an opportunity is given to the people who have discovered them to name them in accordance with the requirements of the International Astronomical Union (IAU) Division F Working Group for Small Bodies Nomenclature.

Bulgarian teams of students from secondary schools in Varna and Shumen, as well as, students from The University of Shumen, have taken part in the program, since 2008. Teams of cadets and students from Nikola Vaptsarov Bulgarian Naval Academy have participated in the IASC program, since 2017, and a group of lecturers, cadets and students from Georgi Benkovski Bulgarian Air Force Academy – since 2020.

So far, several thousand asteroids have been followed up by Bulgarian participants, over 200 preliminary and 24 provisional discoveries have been made, 4 of which have come as a result of the work of Georgi Benkovski Bulgarian Air Force Academy's teams.

3. Participation of Georgi Benkovski Bulgarian Air Force Academy in The International Astronomical Search Collaboration Science Program

The Aerospace Society of Georgi Benkovski Bulgarian Air Force Academy joined the IASC program in May 2020. Aerospace Society is the name of the group of lecturers, cadets and students from Georgi Benkovski Bulgarian Air Force Academy who take part in the program. Each year, the society participates in more than 10 observational campaigns.

Each cadet or student undergoes basic training on working with the Astrometrica interactive software tool for image processing. The participants in the IASC program receive a license to work with the Astrometrica software tool. Each cadet or student processes all image sets and sends them to the Team Leader – eng. Milen Simeonov. The team leader then checks all calculations and prepares a Report, containing the most precise and accurate calculations. The report is sent to the Program Coordinator. A summary report of all teams is sent for publication in the MPC's Circular at Harvard-Smithsonian Center for Astrophysics. Following their participation in each of the observational campaigns, the cadets and the students receive Certificate for participation and/or Certificate for discovery (preliminary discovery) of a new asteroid (*Figure 2*).

Figure 2. *Certificates for participation in various campaigns of The International Astronomical Search Collaboration science program*

The new asteroids are given preliminary temporary designations. After their following up and refinement of their orbital elements, the asteroids are assigned a permanent number (are linked) and they could be named. The following up of the newly discovered asteroids makes it possible for their orbits to be refined.

Aerospace Society – Georgi Benkovski Bulgarian Air Force Academy has participated in different types of campaigns of the International Astronomical Search Collaboration program, as follows:

- International Asteroid Search Campaigns (IASC) – the teams of Student Space Society – Bulgarian Air Force Academy (SSS) and Space Cadets – Bulgarian Air Force Academy (SC). More than 150 teams from universities and colleges from all over the world participate in this campaign, on a monthly basis;
- All Bulgaria Asteroid Search Campaigns (All BG ASC) – the teams of Student Space Society – Bulgarian Air Force Academy (SSS) and Space Cadets – Bulgarian Air Force Academy (SC). This is a campaign that is carried out once every two months and only Bulgarian teams from Georgi Benkovski Bulgarian Air Force Academy, Nikola Vaptsarov Bulgarian Naval Academy, Secondary School of Mathematics, Varna, Secondary Schools from Shumen and Veliko Tarnovo take part in it;
- Target Near-Earth Objects! Campaign (Target NEOs!) – the teams of Aerospace Society – Bulgarian Air Force Academy (ASS). Only the most experienced teams, which are able to perform the most accurate and precise image processing and orbital elements calculations, participate in this campaign. Its aim is to search for close to Earth and hazardous asteroids!

The members of the Aerospace Society – Georgi Benkovski Bulgarian Air Force Academy are Milen Simeonov, Veselka Radeva, Kiril Kambushev, Mihail Yordanov, Kristiyana Nikolova, Nikolay Manev, Aneliya Bliznakova, Radina Bodurova, Borislav Ivanov, Aleks Sandev and Svetoslav Ivanov.

The periods of the campaigns, in which cadets, students and lecturers from Georgi Benkovski Bulgarian Air Force Academy have participated, are as follows:

- September 11 – October 06, 2020 – International Asteroid Search Campaign;
- October 9 – November 3, 2020 – All Bulgaria Asteroid Search Campaign;
- February 4 – March 1, 2021 – International Asteroid Search Campaign;
- March 5 – March 30, 2021 – International Asteroid Search Campaign;
- April 5 – April 30, 2021 – All Bulgaria Asteroid Search Campaign;
- November 1 – November 26, 2021 – All Bulgaria Asteroid Search Campaign and Target NEOs! Asteroid Search Campaign;
- January 28 – February 22, 2022 – All Bulgaria Asteroid Search Campaign.

4. Following Up and Discovering Asteroids in The International Astronomical Search Collaboration Science Program

The participation of the Aerospace Society – Georgi Benkovski Bulgarian Air Force Academy in the IASC program has been extremely successful. The members of the BAFA Aerospace Society have processed thousands of astronomical images and have made dozens of preliminary discoveries, as well as, four provisional discoveries. This means that, the teams of Georgi Benkovski Bulgarian Air Force Academy have discovered four new objects in the Solar System and the orbit of a large number of new asteroids is yet to be confirmed.

Table 1: *Summarized results of the individual teams' work in the astronomical campaigns for the period May 2020 – March 2022*

Year	Campaigns	Processed images	Preliminary discoveries	Provisional discoveries	Participants
2020	IASC	> 600	12	0	SSS / SC
2021	IASC All BG ASC	> 2350 in total	19	**2021 FE21** **2021 EM8** **2021 GK117** **2021 GH154**	SSS / SC
2021	Target NEOs!	> 100	10	0	ASS
2022	All BG ASC	> 200	3	0	SSS / SC

Note: The data is as at 23h59min59sec on March 15, 2022. The scientific and research work of the Georgi Benkovski Bulgarian Air Force Academy teams continues uninterrupted and new astronomical images are being processed. New preliminary and provisional discoveries are being made, as well.

In Table 1, the results of the scientific and research work of the Georgi Benkovski Bulgarian Air Force Academy's individual teams, are summarized and presented for the period May 2020 – March 2022.

In Figure 3 Certificates certifying the discovery of the four new asteroids, part of the Main Asteroid Belt, located between Mars and Jupiter, are presented.

Figure 3. *Certificates for the discovery of the four new asteroids (chronologically)*

5. Orbial Elements of the Four New Asteroids Discovered by the Georgi Benkovski Bulgarian Air Force Academy's Individual Teams

The orbital elements make it possible to calculate the ephemeris of the object, which means that, it can be observed and followed up at any time. The accuracy of the astrometric calculations affects the accuracy of the calculated orbital elements. Accurately calculated orbital elements, allow an accurate ephemeris to be made (table with object coordinates). The correct ephemeris will show the exact position of the object in the sky, which will allow it (the object) to be observed with telescopes. As a result of these observations, it will be possible to obtain a new image of the asteroid with the CCD matrix of the telescope.

Because of that, very accurate and precise calculations of the positions of asteroids have to be made.

The orbital elements that determine the position of an asteroid in the Solar System, are:

- ***Length of the Major Semi-axis of the Ellipse – a.*** It is measured in *astronomical units (AU)* (1 *AU* = 149 597 870 km);
- ***Perihelion Distance – q***. This is the distance from the Sun to the nearest point of the asteroid from the cometary orbit *p*. It is also measured in *astronomical units (AU)*;
- ***Orbital Eccentricity – e.*** This is a parameter which describes the type of the orbit. Eccentricity is the distance from the center of the ellipse to the Sun, divided by the major semi-axis of the ellipse;
- ***Orbital Inclination – i***. This is the inclination of the plane of the comet's orbit relative to the plane of the Earth's (ecliptic) plane. It is measured in *degrees (deg)*;

- ***Longitude of the Ascending Node – node; Argument of Perihelion – peri.*** This is the angle locked between the line connecting the Sun with the ascending node and the line connecting the Sun with the perihelion point *p* of the asteroid's orbit. This angle is read from the ascending node in the direction of the asteroid's motion. The perihelion argument describes the orientation of the celestial body's orbit in its own plane. The angle lies in the orbital plane of the body;
- ***Period of the Body's Orbiting the Sun – P.*** It is measured in *years*. The exact moment, a comet or an asteroid passes through its perihelion, i.e., through the point ***p (Date and Time of Perihelion) – Tp;***
- ***Anomaly – M –*** the position of the asteroid in a certain period of time;
- ***The Distance Between the Asteroid and the Sun – Q*** at the farthest point from its orbit – ***aphelion.***

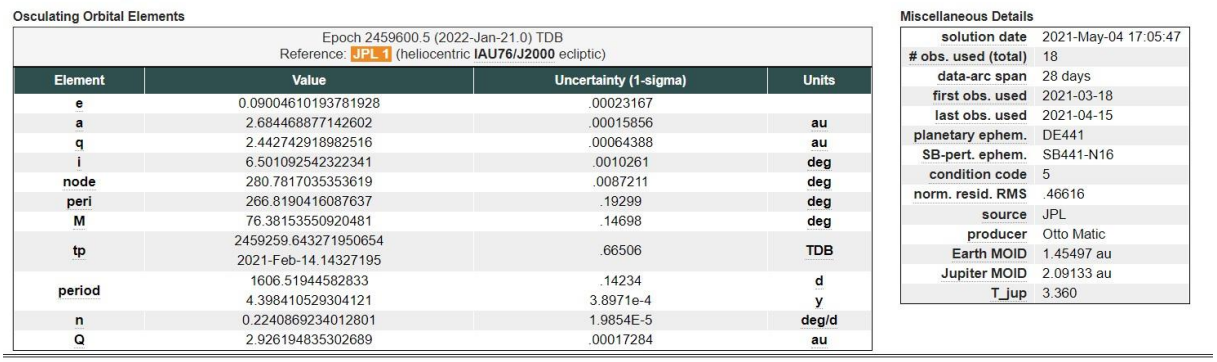
The asteroids, discovered by the teams of Georgi Benkovski Bulgarian Air Force Academy, are part of the Main Asteroid Belt, located between Mars and Jupiter.

Chronologically, the asteroids were discovered, as follows:

- **2021 FE21** – discovered by the members of the Student Space Society – Bulgarian Air Force Academy, citizen scientists V. Radeva, M. Simeonov, K. Kambushev, M. Yordanov, K. Nikolova and N. Manev;
- **2021 EM8** –discovered by the members of the Student Space Society – Bulgarian Air Force Academy, citizen scientists V. Radeva and M. Simeonov;
- **2021 GK117** – discovered by the members of the Student Space Society – Bulgarian Air Force Academy, citizen scientists M. Simeonov, V. Radeva, K. Kambushev, M. Yordanov, N. Manev and K. Nikolova;
- **2021 GH154** – discovered by the members of the Space Cadets – Bulgarian Air Force Academy, citizen scientists M. Simeonov, V. Radeva, K. Kambushev, M. Yordanov, N. Manev and K. Nikolova.

With the help of Orbit Viewer software of NASA's Jet Propulsion Laboratory (JPL), implemented using two-body methods, the orbital elements and the orbital diagram of each of the newly discovered asteroids, are calculated and presented.

The orbital elements of the asteroid **2021 FE21**, are presented in Figure 4.



Osculating Orbital Elements

Epoch 2459600.5 (2022-Jan-21.0) TDB
Reference: JPL 1 (heliocentric IAU76/J2000 ecliptic)

Element	Value	Uncertainty (1-sigma)	Units
e	0.09004610193781928	.00023167	
a	2.684468877142602	.00015856	au
q	2.442742918982516	.00064388	au
i	6.501092542322341	.0010261	deg
node	280.7817035353619	.0087211	deg
peri	266.8190416087637	.19299	deg
M	76.38153550920481	.14698	deg
tp	2459259.643271950654 2021-Feb-14.14327195	.66506	TDB
period	1606.51944582833 4.398410529304121	.14234 3.8971e-4	d y
n	0.2240869234012801	1.9854E-5	deg/d
Q	2.926194835302689	.00017284	au

Miscellaneous Details

solution date	2021-May-04 17:05:47
# obs. used (total)	18
data-arc span	28 days
first obs. used	2021-03-18
last obs. used	2021-04-15
planetary ephem.	DE441
SB-pert. ephem.	SB441-N16
condition code	5
norm. resid. RMS	.46616
source	JPL
producer	Otto Matic
Earth MOID	1.45497 au
Jupiter MOID	2.09133 au
T_jup	3.360

Figure 4. *Osculating Orbital Elements of the asteroid **2021 FE21** (image: Solar System Dynamics, NASA Jet Propulsion Laboratory)*

The orbital diagram of the asteroid **2021 FE21**, is presented in Figure 5.

The asteroid **2021 FE21** was discovered by the members of the Student Space Society – Bulgarian Air Force Academy, citizen scientist V. Radeva, M. Simeonov, K. Kambushev, M. Yordanov, K. Nikolova and N. Manev.

The asteroid **2021 FE21** is part of the Main Asteroid Belt, located between Mars and Jupiter.

The discovery was made using astronomical images, taken on March 18, 2021. The orbital elements were calculated on the base of 18 astronomical images. As a result of the processing of these astronomical images and the calculated equatorial coordinates, it is determined that the period of the asteroid **2021 FE21** orbiting the Sun is 4.3984105 years.

The team that made the discovery, has prepared a proposal for the Name of the asteroid, which will be sent to the IASC Program Director – the Professor of Mathematics and Astronomy – Dr. Patrick Miller, for submission to the IAU Division F Working Group for Small Bodies Nomenclature. The asteroid will be named "Benkovski", after the name of Georgi Benkovski (pseudonym of Gavril Gruev Hlatev) – a Bulgarian revolutionary and leading figure in the organization and direction of the Bulgarian Anti-Ottoman April Uprising of 1876, and Apostle of its 4th Revolutionary District. Georgi Benkovski is also the Patron of Georgi Benkovski Bulgarian Air Force Academy!

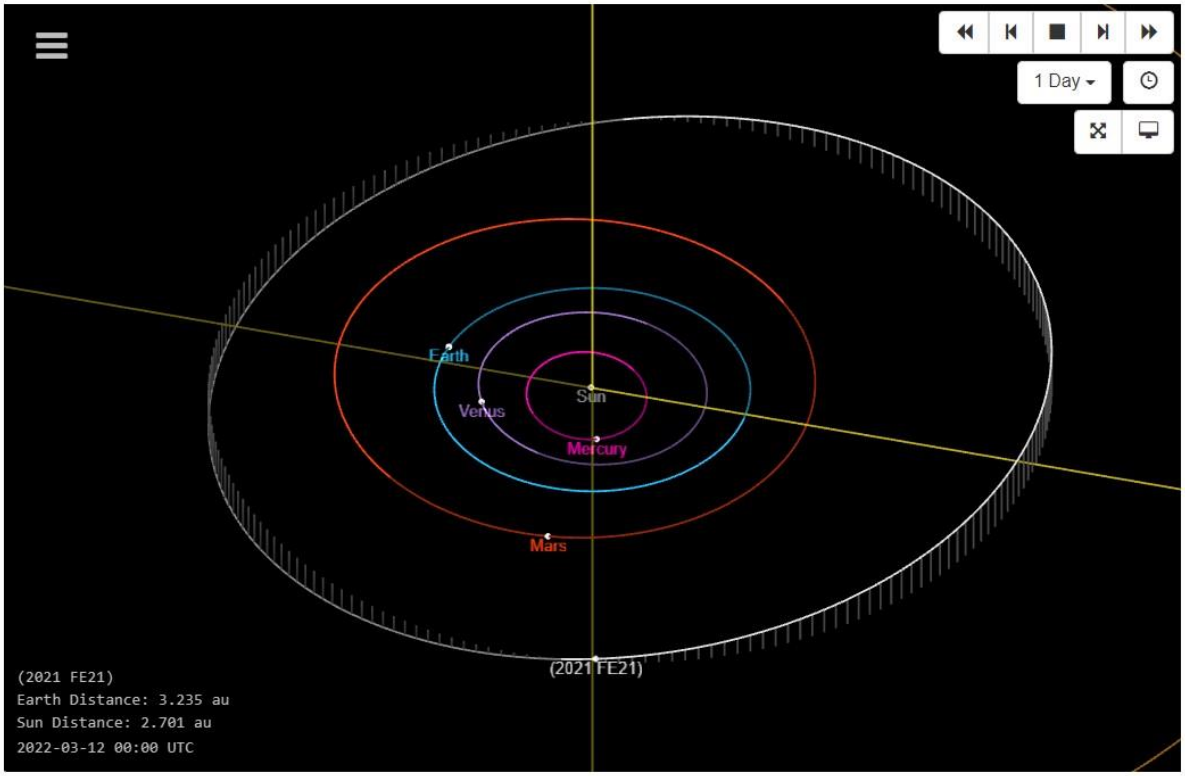


Figure 5. *Orbit of the asteroid **2021 FE21** at 00h00min UTC, 2022-03-12 (image: Solar System Dynamics, NASA Jet Propulsion Laboratory)*

The orbital elements of the asteroid **2021 EM8**, are presented in Figure 6.

Osculating Orbital Elements

Epoch 2459600.5 (2022-Jan-21.0) TDB
Reference: JPL 2 (heliocentric IAU76/J2000 ecliptic)

Element	Value	Uncertainty (1-sigma)	Units
e	0.1179994229220146	2.1729E-6	
a	2.634877565554463	1.3509E-7	au
q	2.323963533348874	5.6161E-6	au
i	5.667148464378872	1.1669E-5	deg
node	295.642162909326	.00017968	deg
peri	275.4054732227148	.00061375	deg
M	53.32693840058328	.00041547	deg
tp	2459369.089406367039 2021-Jun-03.58940637	.0017876	TDB
period	1562.208823654399 4.277094657506910	.00012014 3.2893e-7	d y
n	0.2304429437018986	1.7722E-8	deg/d
Q	2.945791597760052	1.5103E-7	au

Miscellaneous Details

solution date	2021-May-21 23:49:39
# obs. used (total)	34
data-arc span	4807 days (13.16 years)
first obs. used	2008-03-11
last obs. used	2021-05-09
planetary ephem.	DE441
SB-pert. ephem.	SB441-N16
condition code	1
norm. resid. RMS	.47983
source	JPL
producer	Otto Matic
Earth MOID	1.32745 au
Jupiter MOID	2.06503 au
T_jup	3.381

Figure 6. *Osculating Orbital Elements of the asteroid **2021 EM8** (image: Solar System Dynamics, NASA Jet Propulsion Laboratory)*

The orbital diagram of the asteroid **2021 EM8**, is presented in Figure 7.

The asteroid **2021 EM8** was discovered by the members of the Student Space Society – Bulgarian Air Force Academy, citizen scientist V. Radeva and M. Simeonov.

The asteroid **2021 EM8** is part of the Main Asteroid Belt, located between Mars and Jupiter.

The discovery was made using astronomical images, taken on March 11, 2008. The orbital elements were calculated on the base of 34 astronomical images. As a result of the processing of these astronomical images and the calculated equatorial coordinates, it is determined that the period of the asteroid **2021 EM8** orbiting the Sun is 4.1686652 years.

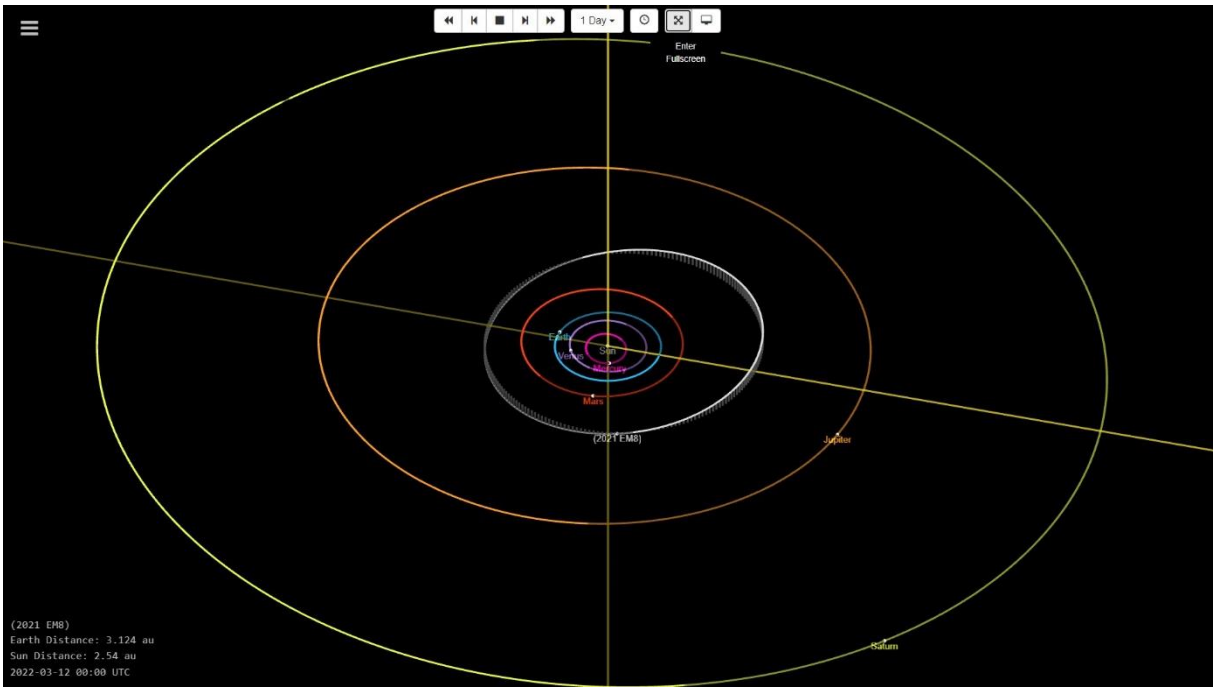


Figure 7. *Orbit of the asteroid **2021 EM8** at 00h00min UTC, 2022-03-12 (image: Solar System Dynamics, NASA Jet Propulsion Laboratory)*

The team that made the discovery, has prepared a proposal for the Name of the asteroid. The asteroid will be named "Yordanov" – after the name of Assen "Jerry" Jordanoff (born Asen Hristov Yordanov) – a Bulgarian-American inventor, engineer, and aviator. Jordanoff is considered to be the founder of Aeronautical Engineering in Bulgaria, as well as a contributor to the development of aviation in the United States. The proposal will be sent to the IASC Program Director – the Professor of Mathematics and Astronomy – Dr. Patrick Miller, for submission to the IAU Division F Working Group for Small Bodies Nomenclature.

The orbital elements of the asteroid **2021 GK117**, are presented in Figure 8.

Osculating Orbital Elements

Epoch 2459600.5 (2022-Jan-21.0) TDB
Reference: JPL 1 (heliocentric **IAU76/J2000** ecliptic)

Element	Value	Uncertainty (1-sigma)	Units
e	0.1861766160348929	1.071E-7	
a	2.428335537505881	3.6979E-8	au
q	1.976236244535764	2.8117E-7	au
i	4.120431775591388	1.6208E-5	deg
node	215.5766876138728	.00010218	deg
peri	75.91027757068744	.00019679	deg
M	20.81627105608044	.00013401	deg
tp	2459520.578816978365 2021-Nov-02.07881698	.00051362	TDB
period	1382.170025086436 3.784175291133295	3.1571E-5 8.6437e-8	d y
n	0.2604599965749416	5.9494E-9	deg/d
Q	2.880434830475999	4.3863E-8	au

Miscellaneous Details

solution date	2021-Jul-02 01:46:20
# obs. used (total)	36
data-arc span	6977 days (19.10 years)
first obs. used	2002-05-05
last obs. used	2021-06-11
planetary ephem.	DE441
SB-pert. ephem.	SB441-N16
condition code	0
norm. resid. RMS	.54912
source	JPL
producer	Otto Matic
Earth MOID	.966104 au
Jupiter MOID	2.30531 au
T_jup	3.482

Figure 8. *Osculating Orbital Elements of the asteroid **2021 GK117** (image: Solar System Dynamics, NASA Jet Propulsion Laboratory)*

The orbital diagram of the asteroid **2021 GK117**, is presented in Figure 9.

The asteroid **2021 GK117** was discovered by the members of the Student Space Society – Bulgarian Air Force Academy, citizen scientist M. Simeonov, V. Radeva, K. Kambushev, M. Yordanov, N. Manev and K. Nikolova.

The asteroid **2021 GK117** is part of the Main Asteroid Belt, located between Mars and Jupiter, as well.

The discovery was made using astronomical images, taken on May 5, 2002. The orbital elements were calculated on the base of 36 astronomical images. As a result of the processing of these astronomical images and the calculated equatorial coordinates, it is determined that the period of the asteroid **2021 GK117** orbiting the Sun is 3.7841753 years.

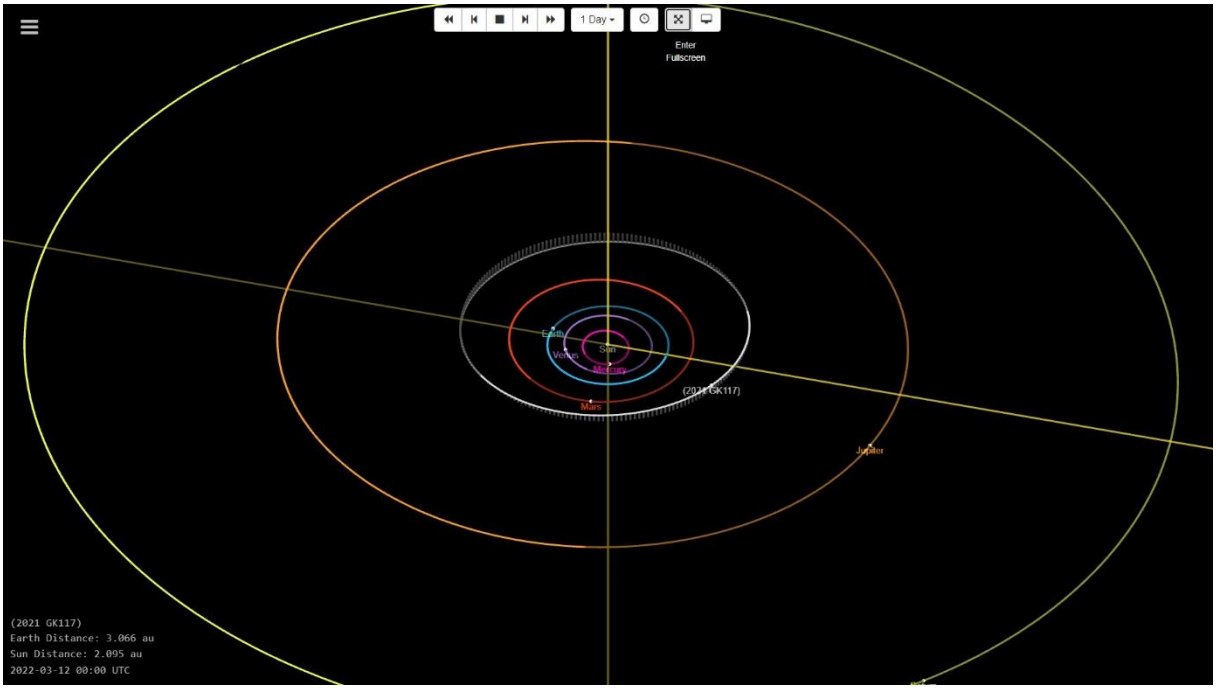


Figure 9. *Orbit of the asteroid **2021 GK117** at 00h00min UTC, 2022-03-12 (image: Solar System Dynamics, NASA Jet Propulsion Laboratory)*

The team that made the discovery, has prepared a proposal for the Name of the asteroid. The asteroid will be named "Spisarevski" – after the name of Dimitar Svetozarov Spisarevski – a Bulgarian fighter pilot known for taking down an American bomber by ramming it during the bombing of Sofia, in World War II. The proposal will be sent to the IASC Program Director – the Professor of Mathematics and Astronomy – Dr. Patrick Miller, for submission to the IAU Division F Working Group for Small Bodies Nomenclature.

The orbital elements of the asteroid **2021 GH154**, are presented in Figure 10.

Osculating Orbital Elements

Epoch 2459600.5 (2022-Jan-21.0) TDB
Reference: JPL 1 (heliocentric IAU76/J2000 ecliptic)

Element	Value	Uncertainty (1-sigma)	Units
e	0.1668910517292669	8.729E-5	
a	2.2421580437295	.00016273	au
q	1.867961929668248	.00015759	au
i	5.027811850290158	.00095133	deg
node	142.25240508689	.0077817	deg
peri	152.2954079816067	.027905	deg
M	13.52960362634005	.039757	deg
tp	2459554.412799126839 2021-Dec-05.91279913	.13174	TDB
period	1226.302911198146 3.357434390686231	.1335 3.6550e-4	d y
n	0.293565314664601	3.196E-5	deg/d
Q	2.616354157790752	.00018989	au

Miscellaneous Details

solution date	2021-Jul-09 18:04:53
# obs. used (total)	10
data-arc span	32 days
first obs. used	2021-04-06
last obs. used	2021-05-08
planetary ephem.	DE441
SB-pert. ephem.	SB441-N16
condition code	5
norm. resid. RMS	.449
source	JPL
producer	Otto Matic
Earth MOID	.85482 au
Jupiter MOID	2.5723 au
T_jup	3.610

Figure 10. *Osculating Orbital Elements of the asteroid **2021 GH154** (image: Solar System Dynamics, NASA Jet Propulsion Laboratory)*

The orbital diagram of the asteroid **2021 GH154**, is presented in Figure 11. This is the last discovered asteroid from the members of the Aerospace Society – Georgi Benkovski Bulgarian Air Force Academy as at 23h59min59sec on March 15, 2022 in the IASC scientific and research program.

The asteroid **2021 GH154** was discovered by the members of the Student Space Society – Bulgarian Air Force Academy, citizen scientist M. Simeonov, V. Radeva, K. Kambushev, M. Yordanov, N. Manev and K. Nikolova.

The asteroid **2021 GH154** is part of the Main Asteroid Belt, located between Mars and Jupiter, as well.

The discovery was made using astronomical images, taken on April 6, 2021. The orbital elements were calculated on the base of 10 astronomical images. As a result of the processing of these astronomical images and the calculated equatorial coordinates, it is determined that the period of the asteroid **2021 GH154** orbiting the Sun is 3.3574344 years.

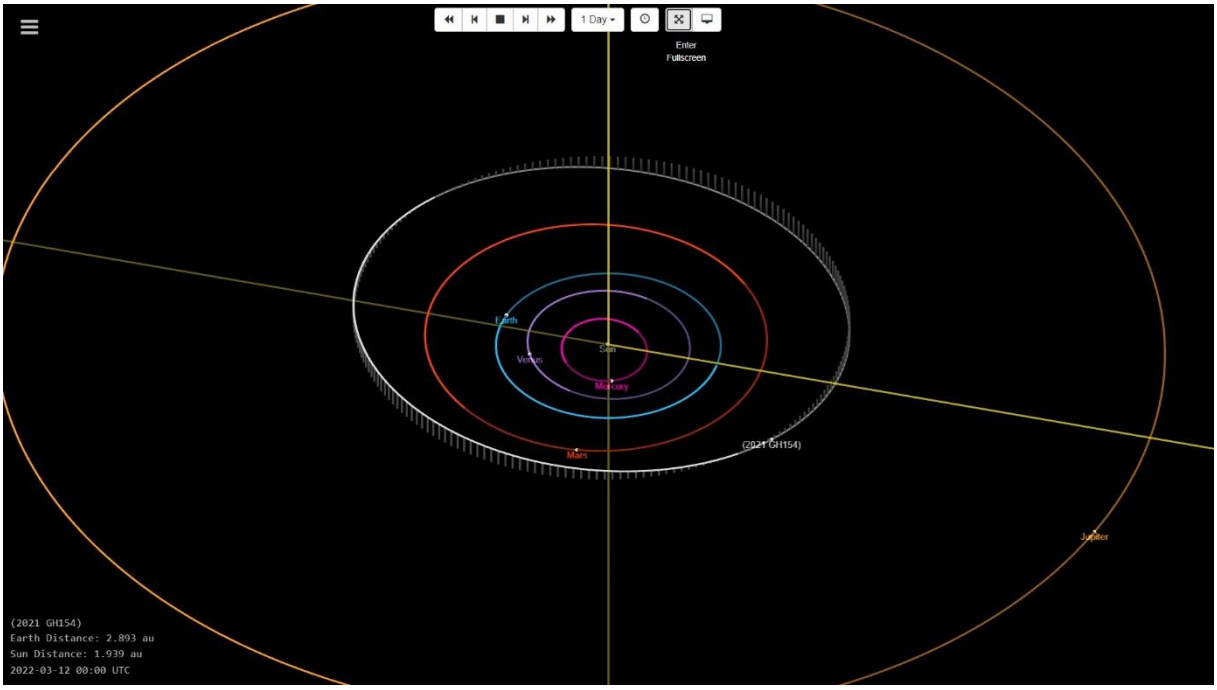


Figure 11. *Orbit of the asteroid **2021 GH154** at 00h00min UTC, 2022-03-12 (image: Solar System Dynamics, NASA Jet Propulsion Laboratory)*

The team that made the discovery, has prepared a proposal for the Name of the asteroid. The asteroid will be named "Drangov" – after the name of Boris Stoyanov Drangov – a Bulgarian colonel and warfare pedagogue. In honor of Boris Drangov, three Bulgarian settlements have been named Drangovo – Drangovo, Blagoevgrad district, Drangovo, Kardzhali district and Drangovo, Plovdiv district. Boris Drangov has been also named Drangov Peak in Antarctica. The proposal will be sent to the IASC Program Director – the Professor of Mathematics and Astronomy – Dr. Patrick Miller, for submission to the IAU Division F Working Group for Small Bodies Nomenclature.

6. Conclusions

The search for and discovery of new asteroids in the Solar System is an important part of the process of its study. Following up already discovered asteroids helps for better understanding of their motion.

The participation of lecturers, cadets and students from the Aerospace Society – Georgi Benkovski Bulgarian Air Force Academy in the International Astronomical Search Collaboration science program is a contribution to the study of asteroids in the Solar System, as a whole. In this way, Earth-hazardous objects can be detected and also followed up long before a catastrophic collision with our planet Earth occurs.

In addition, the opportunity given to students to be an active part of the astronomy research process, motivates them to expand their knowledge of Astronomy.

Understanding each activity in the process of work, discussing emerging problems, self-checking the results and their analysis – these are important steps in mastering the difficult process of scientific knowledge and research.

By participating in the International Astronomical Search Collaboration research program, supported by NASA, the teams of Aerospace Society – Georgi Benkovski Bulgarian Air Force Academy contribute to the protection of the Earth from space hazards.

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