

## REVIEW

ИНСТИТУТ ЗА КОСМИЧЕСКИ ИЗСЛЕДВАНИЯ И ТЕХНОЛОГИИ - БАН	
Вх. №	385
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of Prof. DSc Dora Pancheva

member of the Promotion Panel (PP) for selection of the academic position “PROFESSOR” for the needs of a department “Atmospheric optical investigations”, Stara Zagora branch of the SRTI-BAS

competition announced in the Official Gazette issue 98 from 13.12.2019

PP is appointed by an order № 15 from 24.01.2020 of the Director of the SRTI-BAS

**Area of Higher Education: 4** “Natural sciences, mathematics and informatics”

**Professional field: 4.4** “Earth’s sciences”

**Scientific specialty:** “Remote sensing of the Earth and planets (Investigations of the processes in the middle and upper Earth’s atmosphere)”

**Candidates:** Associate Professor Dr. **Veneta Hristova Guineva** (sole candidate)

### 1 Satisfaction of the scientific and scientometric criteria and requirements for holding the academic position “PROFESSOR” in Area 4, Professional field 4.4

The candidate Assoc. Prof. Dr. V. Guineva satisfies not only the minimum requirements for the country, but also the requirements of BAS, as most of them are significantly exceeded. For example, in group B, with the required 100 points, the candidate has **147.75**; in group G if 200 points are required the candidate has **395.69**; in group D with the needed 100 points the candidate has **261**, and in group E if 150 points are required the candidate has **530**. The satisfaction of the scientometric criteria is duly proven by a detailed list of papers, citations, management and participation in projects, etc. for each scientific group separately.

### 2. Data from the CV of the candidate

Assoc. Prof. Dr. Veneta Guineva was born on January 19, 1956 in the town of Chirpan. She graduated with a master’s degree in physics (engineering physics) with distinction at Sofia University “St. Kl. Ohridski” in 1980. In the periods of: 1980-1983 she worked as a constructor in the OZZU-St. Zagora, 1983-1987 as a physicist in the Central Laboratory for Space Research (CLSR)-BAS and in 1987-1990 again as a physicist, but at the Institute for Space Research (ISR)-BAS. In the period of 1990-1996 the candidate continued to work in the ISR-BAS, but already as a research associate II degree. Veneta Guineva defended her doctoral dissertation in 2001 and received the scientific and educational degree “Doctor” in the scientific field 01.04.08 “Physics of the ocean, atmosphere and near-Earth space”. From 1996 to 2001 she worked as a research associate II degree in the Central Laboratory for Solar-Earth Interactions (CLSEI)-BAS, where she continued to work until 2008 but already as a research associate I degree. In the period of 2008-2010 she was a senior researcher II degree

at the Institute for Solar-Earth Impacts, in 2010-2011 worked as an associate professor at the Institute for Space and Solar-Earth Research-BAS and from 2011 until now she has been an associate professor in the Space Research and Technology Institute (SRTI)-BAS. Assoc. Prof. V. Guineva has been a head of the scientific group "Comet's research" during being in the above mentioned laboratories and institutes of BAS and actively participated in the projects: "EMO-5", "VEGA", "VEGA-2", "IK Bulgaria-1300", "Interball". Assoc. Prof. V. Guineva received a Diploma in connection with 40 years since the flight of Yuri Gagarin in March 2001 for merits in the field of science and education to the municipality of Stara Zagora, as well as for active participation in the international space research programs. The candidate also received in 2019 a diploma and a jubilee medal of the SRTI-BAS on the occasion of the 50<sup>th</sup> anniversary of the Institute for Space Research and Technology and for merits in the field of space research and the establishment of the Republic of Bulgaria as a space power.

### 3. General description of the presented materials

V. Guineva participates in the competition with a total of **464** published works distributed as follows: (a) PhD thesis and its abstract – **2**; (b) **33** papers in impact factor (IF) and /or impact rank (SJR) journals; (c) **14** papers in peer-reviewed and/or indexed journals without impact factor; (d) **123** papers in non-indexed peer-reviewed journals or in edited collected volumes; (e) **283** papers and posters presented at international and national conferences, and (f) **9** papers (lectures) presented at the seminars of foreign university/institute and in Bulgaria. The candidate has also **1** copyright certificate, as well as 3 publications related to the promotion of science and the activities of the SRTI-BAS Branch in Stara Zagora. Only those author's papers that have not been used in the defense of the PhD thesis and in the promotion of the candidate for associate professor will be reviewed in more detail, but the scientific contributions from all papers are taken into account.

V. Guineva participates in the competition for professor with **76** published works, distributed as follows: (a) **22** papers in referenced and indexed journals from the world-renowned data bases for scientific information, as **13** of them are in journals with impact factor; the total impact factor of these papers is **12.517**, and (b) **54** papers in peer-reviewed un-indexed journals or in edited collected volumes. **75** citations on all papers of the candidate are noted, as **71** of them are in foreign publications and **4** in Bulgarian ones. Most of the citations are in the prestigious international journals with impact factor, with a total impact factor of **105.748**. This indicates that the scientific results of the candidate are well recognized and are useful for the scientific community.

### 4. General characteristics of the scientific and scientifically applied activity

The main scientific interests and the predominant part of the V. Guineva's scientific works are concentrated in 4 (four) areas of research: (a) interrelation of the physical processes in the system solar wind-magnetosphere-ionosphere, or so called processes of the space weather; (b) spectral analysis of constituencies of planetary atmospheres; (c) studies of small constituencies in the Earth's atmosphere, and (d) long-period variations and trends of the global and mean hemispheric temperatures. The candidate successfully participated in the international rocket measurements in the summer mesosphere at high latitudes, applying new approaches to study the structure and thermo-dynamics of the middle atmosphere. She skillfully uses modern methods for analyzing time series, which enable her to obtain new and

interesting results. The candidate's research belongs to the priority topic of the ISRT-BAS: solar-terrestrial and space physics.

The candidate has an active participation in the instrument building, especially in the design of devices for optical experiments. Under the international project for rocket experiments HOTPAY1 under FP6, the modern device for rocketed experiments Lyman-alpha detector (ASLAF) based on an ionization chamber and modern electronics was developed and manufactured; it is designed to record the attenuation of the direct Lyman-alpha radiation in the atmosphere. Theoretical developments of instruments and main components of instruments for measuring the solar Lyman-alpha radiations have also been made.

## 5. Scientific contributions

The most significant results of V. Guineva are in the field of research of the characteristics of sub-storms taking place under different conditions, models related to radiation transfer and optical spectra, as well as the atmospheric investigations of the Earth. With regard to atmospheric research, special attention is paid to some small constituencies and long-term changes of the global temperature. As it has been mentioned above, another part of the candidate's contributions is related to the construction of optical equipment devices.

### A. Study of the sub-storm features and the impact of the changing solar activity

- The variations of the oxygen emissions 5577 Å and 6300 Å and their ratio at auroral and high latitudes during high-speed recurrent streams in the solar winds are analyzed and it was found that the polar edge of the auroral bulge is connected with the electron precipitations having very high energies.
- For the first time, a definition of the polar edge of the sub-storm bulge has been proposed and criteria have been developed for defining the boundaries of the polar edge of the sub-storm bulge by optical measurements.
- The measurements from the Multiscale Auroral Imaging Network (MAIN) in Apatity are systemized and a classification of the sub-storms in different groups and subgroups is created depending on the geomagnetic conditions under which they occur, as well as the characteristics of the individual groups are analyzed. A definition is given for the structured recovery phase of the geomagnetic storms and for the first time a criterion is proposed to determine when the recovery phase is structured.
- A detailed comparison was made between the dynamics of the sub-storms occurring at high and middle latitudes during two strong geomagnetic storms: March 17 and June 22, 2015.
- The relationship between long-term changes of the solar activity and the prevailing type of the atmospheric circulation is studied. For this purpose the circulation is presented by the North Atlantic Oscillation Index (NAO), reconstructed for the last four centuries. It has been found that when the southern solar hemisphere is more active, increasing solar activity in the secular solar cycle results in increasing zonality of the circulation, while when the northern solar hemisphere is more active, increasing solar activity increases the meridional circulation.

- Autoregressive models have been established describing the development of the solar cycles separately for the Northern and Southern solar hemispheres and the total number of sunspots has been calculated by summation, as this approach has been used for the first time. The presented method allows not only assessments of future maxima, but also the development in time of the next 25<sup>th</sup> solar cycle to be shown. It is predicted that the 25<sup>th</sup> solar cycle will develop similarly to the 24<sup>th</sup> one. The maximum of the sunspots in the Northern Hemisphere is expected to be reached before that in the Southern Hemisphere, but the solar activity in the Southern Hemisphere will be dominant. A maximum of the total number of sunspots is predicted to be around 117 (with a confidence interval between 77 and 165) that will be observed in 2023.

## B. Spectral studies

- A methodology has been developed and programs have been created for calculating the profiles of O<sub>2</sub> concentration, pressure and temperature along the vertical profile of the direct Lyman-alpha radiation obtained from rocket measurements at high latitudes.
- A method for correct calculations of the equivalent spectral widths of the rotational lines has been established and the effective temperatures for different cases have been determined. A theoretical study of the background spectrum has been done; the latter has to be subtracted from the measured spectra. The comparison between the actual measured spectra by the spectrometric system in Stara Zagora and the theoretically calculated spectra under the same conditions gives a very good coincidence.
- A model for electronic and vibrational kinetics of the molecular components N<sub>2</sub>, O<sub>2</sub>, CO, CO<sub>2</sub> from the planetary atmospheres of Titan, Triton and Pluto has been developed.

## C. Study of the structure and thermo-dynamics of the Earth's atmosphere.

The contributions can be divided into two subgroups:

### 1. Investigation of small constituencies in the middle atmosphere

- A method for statistical analysis of NO<sub>2</sub> data based on the measurements of the GASCOD-BG device has been established. It is based on the removal of extreme values and homogenization of the data whereby the missing values are filled by regression with the other time series of NO<sub>2</sub> from nearby stations, interpolation and filling of the missing monthly data with seasonal averages. This approach particularly for studying the stratospheric NO<sub>2</sub> content is a novelty. An attempt was made to investigate the long-term trend of NO<sub>2</sub> changes by using a multiple linear regression, including various factors as solar activity, aerosols, QBO, El Niño.
- Methods have been developed for determining the total content of ozone in the atmosphere, as well as for defining and predicting the UV index and calculating the optical thickness of the cloud cover by using the GUV 2511 instrument and polynomial approximation. The results for ozone, UV index and cloud characteristics were validated by using satellite data, such as the data from the instrument GOME-2 on board the METOP-B satellite and from the instrument OMI on board of the Aura

satellite. The comparison demonstrates a very good correspondence for the time when the satellites fly over the territory of Stara Zagora.

- The long-term trend of NO<sub>2</sub> over Stara Zagora was investigated and a comparative analysis has been made with long-term trends of NO<sub>2</sub> for other European mid-latitude stations, as well as two subtropical stations, taking into account the influence of various factors.
- The changes in the CO<sub>2</sub> content in the atmosphere and the impact of various factors on the CO<sub>2</sub> emissions have been studied. The influence of the CO<sub>2</sub> concentration on the temperature variability over the surface and over the ocean has been studied.

## 2. Long-term variations and trends of the atmospheric temperature

- A method for detecting structural changes in the time series of temperatures anomalies have been developed, consisting in finding simultaneously up to 4 (four) points of structural changes (TSC) with a condition for continuity based on piecewise linear regression. Unlike the methods of other authors, this method works without other additional conditions. Using the proposed method, both TSCs characterizing long-term trends and TSCs of rapid changes can be obtained.
- Long-term time series of the global and hemispheric temperature anomalies have been studied. The points of structural changes, located around 1910, 1945 and 1970, have been found.
- Statistical studies of the temperature time series over the surface and over the ocean, as well global and hemispheric temperature time series, have demonstrated the dominant effect of the Atlantic Multidecadal Oscillation (AMO) on temperature and found that some of the long-term and short-term temperature changes in the Northern Hemisphere are generated by warming or cooling the Atlantic Ocean. It has been established that the structural changes in the temperature anomalies in the Northern Hemisphere and the global temperature anomalies are related to AMO. The behavior of the temperature anomalies for the next decades is predicted on the basis of the predicted variability of the CO<sub>2</sub> content and the values of the AMO index.

The candidate's contributions can be assessed as:

- Novelty for science: (a) introduction of the definition 'polar edge of the sub-storm bulge' and development of criteria for defining the boundaries of the polar edge of the sub-storm bulge by optical measurements; (b) defining the 'structured phase' characteristics of the geomagnetic storm recovery and proposing a criterion for its determination, and (c) developing an original method for detecting structural changes in the temperature anomaly time series.
- Enriching existing knowledge: all other contributions can be attributed to this area.
- With practical applications: statistical models for predicting solar activity and temperature.

#### 6. Assessment of the extent to which the contributions are made by the candidate

From the presented **22** papers in the refereed and indexed journal in world-known databases for scientific information which is an indication of high quality scientific results, V. Guineva has **12** papers where she is a first author, in **3** papers is a second author and in the remaining **7** papers she is a third or next author. Consequently, in about **68%** of these representative publications (as first and second author) V. Guineva has a leading role. Considering that in the field of solar-terrestrial and space physics and especially in the construction of the optical instruments and conducting optical experiments, collective developments predominate, the contribution of Assoc. Prof. Dr. V. Guineva in the obtained scientific results is significantly decisive.

The ration is similar in the next most important scientific papers; these are **54** papers published in un-indexed peer-reviewed journals or edited collective volumes. In **24** papers she is a first author, in **8** papers she is a second author and in the rest **22** paper she is a third or next author. Therefore, in this case too V. Guineva is a leading author in about **60%** of the publications. These results clearly demonstrate that Assoc. Prof. Dr. V. Guineva has a leading role in more than half of the published works of her research.

#### 7. Participations in research projects

An integral part of the scientific activity of each researcher is the participation in various national and international projects. V. Guineva's strength is her ability to work successfully in a team and this quality largely determines her active participation in **24** international and national projects, as at **11** of them she was a leader. The project can be divided in the following groups: (a) participations in **3** space projects: Bulgaria-1300 (1983-1993), Vega (1985-2007) and Interball (1986-1993); (b) **3** projects under the research programs of the European Union, under FP6; (c) **4** consecutive EBR projects with Russia, **3** other projects with Russia and **1** project with the Czech Republic; (d) **2** projects with the University of Stockholm (MISU), Sweden and with the Belgrade Astronomical Observatory, Serbia; (e) **1** project funded by EOARD, London, UK; (f) **4** projects funded by NSF, MES; (g) **1** project with "Maritsa-East" mines, **1** project under Topic 13 of the Technical Progress Fund, and **1** project to the National Strategy for Development of Scientific Research 2020 (ICAMOS).

#### 8. Conclusion:

The presented documents for the competition comply with the requirements of the Law for Development of the Academic Staff in the Republic of Bulgaria (LDASRB) and the Regulations for its implementation, as well as the regulations for application of the law of development of the academic staff in the SRTI-BAS.

As it follows from the above, the research activities of Associate Professor Dr. Veneta Guineva in the field of space weather and more precisely in studying the sub-storms, as well as the processes in the Earth's middle atmosphere, is highly valued not only in our country, but also by the international scientific community. A clear evidence for this is not only the significant number of publications in international journals and numerous citations of her

scientific results, but also the participation and leadership of scientific projects, as a not small part of which are with well-known international teams of researchers.

For all the above reasons I am delighted to recommend to the members of the Promotion Panel and the Scientific Council of the SRTI-BAS to award the academic position “**professor**” to Associate Professor Dr. VENETA HRISTOVA GUINEVA in the scientific specialty: “Remote sensing of the Earth and planets (Investigations of the processes in the middle and upper Earth’s atmosphere)”.

Dora Pancheva, DSc, PhD *DP*  
Professor of Aeronomy and Space Physics



*DP*

