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ADVANCES IN BULGARIAN SCIENCE

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BULGARIAN SCIENTIFIC THOUGHT AND PROGRESS IN THE WORLD

What have the Bulgarians given to the world?
To the Slavs – Cyrillic script and Christian culture;
To Europeans – first germs of the Renaissance;
To the Americans – computer and first steps on the Moon.

The basis of Bulgarian's rich scientific and technical culture is genetically foreordained. If we go back to the not so far past of Bulgaria, we shall meet names of Bulgarians who left a bright trace not only in the native culture and directed their personal and public activities to construction of democratic society.

Bulgaria is unique in establishment of its Academy of Sciences ten years before the national liberation from the Turkish yoke (in 1869 in Braila). The impressive fact is that it is realized with the support and participation of prominent figures of the national liberation movement, such as Rakovski, Karavelov, etc. Vasil Levski is among the founders of the Bulgarian Literary Society who gave his scarce funds for the needs of the first scientific community. At this time Dr. Petar Beron reports to the Royal Scientific Society in London his works on the Earth magnetism, system for extinguishing fires, „sub-sea wireless telegraph". In 1857 Nikolay Toshkovich together with his French colleague Francois Jerard patents improvement of the steam engine, and later – his own invention „screw propeller with double action".

Bulgarian Mikhail Momchilov together with the famous Alexander Eiffel constructs one of the bridges in Budapest. Noncho Ambarev with his original loom, Christo Dzhapunov with his shoe-making machine are among the many inventors of the XIX century. At the beginning of the XX century Ivan Mavrov creates method and means for locating the place of hostile artillery – the invention followed by electromagnetic pulsation („Krastev's effect") for registration of nuclear explosions, as well following it solution for providing precise gunfire hits. Dr. Krastyo Krastev is one of Bulgarians – winners of the highest award of the American army for civilians. According to the words of John Atanasoff, inventor of modern computer, distinguished personally by President Bush with US National medal for technics and technologies, in the USA scientific community there are at least 20 Bulgarians having higher merits than his. In spite of Atanasoff's modesty, in this connection we can't but mention Asen Yordanov, theoretician and constructor of „Douglas", „Boeing, „Lockheed" and „Piper"; landing on the Moon of the Lunar Module „Eagle" with astronauts N. Armstrong and E. Aldrin could not be possible without jet engines of this module constructed by John Nochev's engineering company. The contribution of Bulgarians to the space science doesn't consist only in sending cosmonauts, but in providing measurement devices and medical apparatus and special food for almost all European space expeditions. The beginning is set forth already in the XIX century by our first aircraft constructor Haralampi Dzhamdzhiev, grandson of Velcho, the organizer of the historical „Velcho's conspiracy".

We can mention the work of acad. Nadzhakov on photoelectronic state of substances as essential contribution to modern technologies and the basis for xerographic machinery. Bulgarian scientific schools won recognition of the world science: genetics of prof. Mihail Hristov, acad. Doncho Kostov, prof. Gencho Genchev; the school of Stransky and Kaishev in electro- and photochemistry; in mathematics – of Obreshkov, Chakalov, Tagamlitzky, in chemistry – of prof. Raikov, acad. Angelov (the inventor of serum and vaccine against cattle-plague), and acad. R. Tzanev in molecular biology. Our achievements in engineering science aren't less significant: A. Valchev's protective coating of graphite electrodes, D. Petrov and Y. Popov's electrolytic copper refining, T. Dragomirov's step regulators, G. Mitov's „prenomit" method, Kalev and Balevsky's method of counter-pressure casting, etc..

The young generation follows the way of the predescestors. Bulgarian children win prestigious awards from mathematical Olympiads, language courses and chess tournaments, and every second Bulgarian child covers Menza's IQ test.

The ambition of Bulgarians to live in a free civil society is accompanied by striving for creativity and construction. And probably this will make young people of Bulgaria free citizens of the united Europe in the globalizing world.

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National Centre for Information and Documentation

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- Performing the role of institutional contact point of the Sixth Framework Program in Bulgaria.

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NATIONAL SCIENTIFIC PROGRAMMES WITH EUROPEAN DIMENSIONS

Bulgarian SVET Space Greenhouse Project Proved Plants Utilization for MARS Manned Missions

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Our contemporary civilization plans to renew the manned space flight to the Moon stopped in 1972. After discovering huge deposits of frozen water on the Moon, the nature itself had paved the way for future scientific stations on the Earth's satellite. Future lunar stations could now be supported by an artificial, closed biological system, like the Earth's biosphere, with all the necessary plant and animal species – enough for food, and for air recycling. Settled on the Moon, the Earth inhabitants could launch spacecraft to other planets (initially to Mars) more easily and much more cheaply: six times less power is needed to escape the Moon's gravity than to escape that of the Earth. When flight to Mars becomes a reality in the near future, space greenhouse will occupy a considerable part of the interplanetary spacecraft's interior. Vegetable crops and even wheat–whose grains the astronauts will use to mill flour and to make fresh bread as on the Earth–will be grown there. At the time when trips to Mars become a reality and the habitable bases on the Moon begin to look like settlements with their gardens and parks, the history of astronautics will record that some of the first space greenhouses were developed and produced in Bulgaria.

The Bulgarian SVET (means „light") Space Greenhouse (SG), the first in the world automated plant growth facility, was developed under a Bulgarian-Russian Project on in the 1980s. The SVET SG was mounted in the Mir Orbital Station on June 10, 1990 (Fig. 1). The goal of the investigation was to study plant growth under microgravity, in order to include plants in future Biological Life Support Systems for long-term manned space missions. An American-developed Gas Exchange Measurement System (GEMS) was added to the Bulgarian-developed SVET SG equipment in 1995, to monitor additional environmental and physiological parameters. Many long-duration plant space experiments were carried out by the international crews in the SVET-GEMS complex right up to the end of the 20th century.

Significant results in the field of fundamental gravitational biology were achieved, as second-generation wheat seeds were produced under microgravity. The new International Space Station provides a perfect opportunity for conducting long-term, full life-cycle plant experiments in microgravity during the 21st century.

The team of scientists that created the first-generation SVET SG has developed a concept for a new generation Space Greenhouse with adaptive environmental control for optimal results during plant microgravity experiments, based on Bulgarian know-how and experience. Future long-duration manned flights to Mars and the scientific laboratories on the Moon, based on plant bioregenerative systems, will be a reality.

Plants and Biological Life Support Systems

The creation of a Biological Life Support System (BLSS) based on the recycling of chemical elements, as in the Earth's biosphere, is a fundamental and very complicated scientific task for our civilization, and is a prerequisite for future long-term manned space missions. A system that includes higher plants and animals theoretically ensures up to 90 to 95 percent of the needed substances for the crew. Plants will produce food and oxygen for the space crews while eliminating carbon dioxide from the closed cabin environment. The effect of microgravity on growing plants is an important area of research, because plants could be a major contributor to BLSS.

The functional diagram of BLSS by analogy with natural ecosystems includes organisms of the principal trophic levels [1]. The first level is the energy „gates" of the system, through which energy enters from outside. This energy (light) is the basis of the system's existence. This level is produced by photoautotrophic organisms – plants. The next trophic levels are occupied by heterotrophic organisms, including men and animals, for which the organic matter produced on the first level (biomass) is a source of life. The last link of the trophic chain is presented by different soil microorganisms (fungi, bacteria, and so on), which complete the decomposition of organic matter and turn it into mineral elements utilized by plants.

A great quantity of energy is lost in the process of passing from one trophic level to another. Plants are a fundamental link of bio-regenerative BLSS for future use on space stations and in spacecraft making long journeys to other planets. By achieving maximum yields of edible plant products, the investigators can supplement the food, now carried from the Earth, with fresh food grown onboard in space. This would save weight, which is especially important in such long space journeys.

Plants can also regenerate the atmosphere onboard by expelling oxygen through their photosynthesis, and scrubbing the carbon dioxide produced by the crew's breathing. At the same time, having in mind the complexities of living and working on long-duration flights in closed spaces, we should not underestimate the uplifting psychological effect of taking care of a garden far away from the Earth, which will contribute to mission success.

The question of the possibility of growing plants in weightlessness has excited scientists from the very beginning of space research. Since 1962, almost all scientific programs for both piloted and automatic biological spacecraft have included plant experiments. For 20 years, biologists have almost managed to prove that the critical conditions in space were not a show-stopper for growing plants through a complete life cycle.

Limited success in a seed-to-seed cycle was achieved in 1982, when Arabidopsis thaliana plants were grown from seed to maturity. But growth was quite retarded and generally poor [2]. The plants were grown in a Russian Phyton-3 device on the Salyut-7 Orbital Station for 69 days. About 200 seeds were formed, half of them immature, after return to Earth laboratories. Further, the plant growth was considerably less vigorous and healthy than that achieved with ground controls in the same plant-growth devices, and many of the produced seeds were empty.

After this success, which eliminated weightlessness as an obstacle, in principle, for plant development, an international team of investigators under the direction of the Institute of Biomedical Problems (now the State Scientific Center) in Moscow took up the task of developing every single link of the space Biological Life Support Systems separately.

A new scientific program „Study of the ways and means for use of higher plants, algae, and animals in biological systems for life support of space crews" was set up within the framework of the Intercosmos Program in 1983. This was coordinated by G.I. Meleshko and Ye.Ya. Shepelev, and later by V.N. Sychev from the Institute for Biomedical Problems, Moscow, with scientific teams from other countries joining their efforts to design and develop instrumentation and new biotechnology. The goal was to develop the main links of a future closed biological system including plants and animals.

A team of researchers from the Space Biotechnology Department of the Space Research Institute of the Bulgarian Academy of Sciences developed the first Space Greenhouse, named SVET, for plant experiments. These researchers were included in this scientific task because their 15-year experience in developing equipment for space physics investigations was well known. The development and production of the SVET Space Greenhouse modules was funded by the Bulgarian side (a patent has been issued), while the Russian side ensured the launch and crew training, and led the flight experiment. Another scientific team, from the Institute of Animal Biochemistry and

Genetics of the Slovak Academy of Sciences, developed the Incubator-2 system, created for long-term experiments with animal eggs (Japanese quail) [3].

Both pieces of equipment, for plant and animal research, were launched to the Mir Orbital Station (OS) in 1990, and the first successful experiments in microgravity were carried out. The Bulgarian research activities on the SVET Space Greenhouse project can be divided into two main periods. From 1983 to 1991, Russian-Bulgarian collaboration took place within the framework of the Intercosmos Program, which included the launch of the first SVET complex of equipment and the first experiments. The second phase of activities (1994 – 2000) centered on the American-Russian-Bulgarian collaboration, characterized by the launch of the second-generation modified SVET-2 Space Greenhouse and many long-term experiments.

In the 1980s, the aim was to improve and optimize the equipment and biotechnology for plant growth, with the purpose of providing additional vitamins to the space crew's food. But in the 1990s, the research was directed to those experiments that would also clear the air, and even provide food for future long-term space voyages. It was of great importance to solve the problem of providing the crew with „bread" by growing a crop of wheat—a very good prospective grain crop for the future BLSS in weightlessness.

Some wheat experiments were being conducted in various Russian facilities onboard Mir OS, but again plants were less healthy than those grown in control groups on the ground. *Super-Dwarf* wheat was grown in the Russian Svetobock-M equipment for 167 days during 1991 [4]. When plants were harvested at the „boot" stage (each surrounded by a leaf, the head not yet visible), they were only 13-cm high and had only one tiller. There were no seeds gathered (nor were there any in the control experiment on the Earth), because of the poor light conditions. Some space plants matured under somewhat higher light, after return to Earth laboratories (28 seeds produced). However, the only head formed during the spaceflight turned out to be sterile.

First 'Space' Vegetables Grown in the SVET SG

The first SVET Space Greenhouse (Fig. 2) was created in order to grow plants under the long-term spaceflight conditions of the Mir OS environment. The equipment was mounted inside the Crystal module, docked to the Mir OS on June 10, 1990. In the same year, the first successful two-month vegetable plant space experiment was conducted. SVET SG was the only automated facility for such experiments onboard the Mir OS, and was used until Mir's plunge into the Pacific Ocean in March 2001. It was used to accommodate a series of plant space experiments (a total of 680 days) named „Greenhouse" during different international scientific programs in the period 1990-2000 (Table 1).

Table 1. Main plant experiments carried out in the SVET SG onboard the Mir OS in 1990-2000.

No	Year	Start-end	Days	Plant variety	Experiment
1	1990	16 Jun-8 Aug	54	Radishes, Chinese Cabbage	Greenhouse 1
2	1995	10 Aug-9 Nov	90	Wheat *Super Dwarf*	Greenhouse 2a
3	1996	5 Aug-6 Dec	123	Wheat Super Dwarf	Greenhouse 2b-I
4	1996-97	6 Dec-17 Jan	42	Wheat *Super Dwarf*	Greenhouse 2b-II
5	1997	31 May-30 Sep	115	Mustard Brassica Rapa (3 exp.)	Greenhouse 3
6	1998-99	18 Nov-26 Feb.	100	Wheat *Apogee*	Greenhouse 4
7	1999	9 Mar-17 Aug	130	Wheat *Apogee* (2nd generation)	Greenhouse 5
8	2000	21 May-15 Jun	27	4 lattice crops-genus Brassica	Greenhouse 6
		Total days:	**680**		

The SVET SG has a 1,000 square-centimeter growing area, and can accommodate mature plants up to 40 cm[5]. The plant chamber is well lit by fluorescent lamps and has two wide windows (the front one is transparent) for seed sowing, observation, and sample taking by the crew (Fig. 3).

The root module is divided into two equal sections and is filled with the substrate Balkanine, which is a natural zeolite that is enriched with mineral salts in order to sustain several kinds of vegetation (this is an original Bulgarian technology). This module is changeable, mounted on rails like a drawer. The substrate moisture is controlled precisely at a desirable level by sensors, valves, and a water pump, and the necessary oxygen is supplied to the root area.

The controller collects the environmental data from both the shoot and root zone and provides automatic control using actuators (lamps, ventilator, pump, and compressor). On June 16, 1990, Russian cosmonauts Alexander Balandin and Anatoli Solovyov, started the first long-term, 54-day plant experiments called „Greenhouse 1" with vegetables—white-topped red radishes and Chinese cabbage *Khibinskaya*. They were carried out in the SVET SG during the Russian-Bulgarian biological program in June-August 1990.

When fresh plant samples were returned to the Earth for investigation, they were normally developed, although small-sized. For the first time, we had grown a radish root crop under microgravity, but they were three times smaller than the control group grown on the ground (Fig. 4). The considerably large difference (4 to 8 times) in biomass for plants grown under space and Earth conditions showed that the space plants were exposed to significant moisture and nutrient stress. The balance between the optimal air and water content in the plant root media was disturbed; obviously, it was necessary to work on this problem for future experiments.

In any case, this first experiment was an indisputable success and proved the efficiency of the Bulgarian research equipment and biotechnology in space. Unfortunately, after this hopeful experiment, experiments in the SVET SG came to a standstill for almost five years. It turned out that Russia did not have enough funds to use all of the capacity of its orbital laboratory, and a number of important programs were simply given up.

In this critical situation, the question was whether this space station itself would be given up as well. NASA's interest in this long-standing, habitable space object saved the Mir OS. The Americans did not have their own space station, in which to conduct long-term experiments. After U.S. Presidents George Bush and Bill Clinton reduced the budget for space research and for the Freedom Space Station, the American scientists directed their attention to the Russian capabilities.

In 1993, Vice President Al Gore and Russian Premier Viktor Chernomyrdin signed an agreement to conduct joint space research using the hardware complex available onboard the Mir. An American-Russian-Bulgarian agreement was signed in Moscow in April 1994 to carry out long-term experiments within the framework of the MIR-NASA program in the SVET SG during 1995-1997. The fundamental biological task was to grow wheat through a complete seed-to-seed life cycle onboard the Mir OS, with the participation of American astronauts and by the good offices of the repeated flights and capabilities of the Space Shuttle and the Russian cargo missions.

The Struggle for 'Space'-Produced Seeds

According to the agreements, an American Gas Exchange Measurement System (GEMS) was developed for additional environment monitoring at the Space Dynamic Laboratory of Utah State University under the leadership of Gail Bingham. GEMS was added to the existing SVET SG in 1995 [6].

Two separate transparent bags were placed above the plants, one over each of the two root module sections, enclosing the plant chamber volume, so as to allow local gas exchange and leaf environment measurement. GEMS provided four infrared, high-precision gas analyzers measuring the absolute and differential carbon dioxide and water vapor levels in the air entering and exiting each bag, as well as the absolute and differential pressures of the measured gases. These were necessary to evaluate the photosynthesis, respiration, and transpiration of the plants. Cabin pressure and oxygen levels were also measured. A laptop computer collected all the environment data on a disk, and brought these data to the Earth at the end of the mission.

The SVET SG system provides one substrate moisture sensor per each root module section, which is enough for the measurement and control of the substrate moisture levels. GEMS supplements these with 16 additional substrate moisture level sensors (8 per module) to monitor the water distribution in the whole substrate volume. The additional sensors were designed to be integrated in the existing Bulgarian root module on flight.

A series of long-duration plant experiments was conducted in the SVET-GEMS complex during 1995-1997. The first attempt to grow *Super Dwarf* wheat in this complex was made in 1995 as a part of the Mir-Shuttle program. The Principal Investigator was Frank Salisbury, from Utah State University [7].

In the 90-day experiment „Greenhouse 2a," low light intensity and other technical problems strongly disturbed the ontogenetic cycle of the wheat plants; they stayed alive but were mostly vegetative [8]. A new, modified piece of equipment— SVET-2 with optimized units developed by Bulgarian scientists, was launched to Mir OS in 1996 (supported by NASA). The new light unit with 2.5 times higher lamp intensity and all the other units functioned well, and no hardware problems were encountered until 2000.

The *Super Dwarf* wheat experiment „Greenhouse 2b" was repeated (Fig. 5) by the same investigators in the new SVET-GEMS complex in 1996 [9]. The experiment was conducted in two stages, of 123 days and 42 days. During the first stage, the aim was to grow wheat during a full seed-to-seed life cycle, by the American astronauts Shannon Lucid (Fig. 6) and John Blaha. Although 297 perfect-looking wheat heads developed in the growing area, all the heads were sterile, with development stopped at the pollen development stage. Ground studies proved that ethylene, which was measured as 1 to 2 ppm in Mir's cabin atmosphere, induced male sterility in the wheat plants [10].

New wheat seeds were planted during the second experiment stage „Greenhouse 2b-II". The leaf bags were installed and for the first time successful transpiration and photosynthesis measurements were carried out for 12 days using the GEMS equipment [11]. GEMS demonstrated that open gas exchange measurements are possible in space. The green plants were frozen and returned to the Earth for biochemical analysis.

A mustard plant species, *Brassica rapa*, with a very short life cycle, was used in the next seed-to-seed experiment „Greenhouse 3" carried out in SVET-GEMS equipment in 1997. The Principle Investigator was Mary Musgrave, from Louisiana State University [12]. The collision of Mir OS with the Progress supply ship on June 25, 1997, caused a loss of power to the SVET SG, as well as lowering of the temperatures and changing of the atmospheric pressure and composition on Mir OS. American astronaut Michael Foale saved the experiments by supplying them with power from the main core module of Mir OS to SVET SG by a cord. The first successful seed-to-seed full plant cycle in space was completed. For the first time, 'space' seeds (produced in space), were planted again, germinated, and one normal plant was developed. A series of three experiments was completed during the 122-day opportunity on the Mir OS.

But the struggle of the scientists was to grow wheat seeds, and they knew that only one step was left for success. American scientist Bruce Bugbee, also from Utah State University, proposed using another wheat variety, called *Apogee*, because it is resistant to high ethylene concentrations.

The wheat plant experiments continued in 1998-1999. The „Greenhouse 4 and 5" experiments were carried out by Russian cosmonauts (mostly by Sergei Avdeev) in the Russian scientific program (Fig. 7). In the Greenhouse 4 experiment, 12 *Apogee* wheat plants produced a total of 508 'space' seeds and most of them were returned to the Earth (Fig. 8).

In the „Greenhouse 5" experiment, 10 of the 'space'-produced seeds were planted, and one of them produced second generation 'space' seeds. All the seeds developed during the „Greenhouse 4 and 5" experiments were normal. They were planted on the Earth, germinated, and produced healthy green plants [13].

The last experiment in the SVET SG „Greenhouse 6" was carried out in May-June 2000. Seeds of four different species of lettuce crops, genus *Brassica*, were planted by the last Mir OS space crew and grew normally. The plants were chosen for their short vegetation cycle. Samples of each plant were brought back to the Earth by cosmonauts Sergei Zalyotin and Alexander Kalery (Fig. 9). For the first time they ware allowed to taste some plants and „to evaluate the flavor qualities of the received plant production."

Basic Scientific Results on the Mir OS

There were more than 400 experiments on Mir OS during its 15 years in orbit, and the „Greenhouse" experiments are considered to be among the most important and successful. Unique results were obtained during the biological flight experiments in the SVET-GEMS complex in the field of fundamental gravitational biology. Reiteration of the seed-to-seed cycle was achieved, and the environmental variables in a human space habitat that have an impact on plant growth and development under microgravity were determined.

The successful *Brassica rapa* and *Apogee* wheat experiments proved that the lack of gravity was not an obstacle for normal plant development in space. The impact of microgravity as a stress operator on the second- and third-generation space-produced seeds, in respect to normal plant sizes and yields, can be seen on a cellular level. The scientific results obtained during the experiments answered a number of questions concerning plant growth under microgravity:

- Light completely replaces the gravity vector and plant turn towards the light as they sprout. The plants, which are in the middle of the sowing area, turn upwards while the others turn to the side, because of the reflecting surface (mylar) put on the walls inside of the chamber.
- Seeds must be preliminarily oriented before sowing, because if the root begins to grow towards the light, the plant will die.
- The roots fill up the entire substrate volume and they are oriented not to the gravity vector but to substrate areas containing more nutrients and moisture.
- The nutrients flow towards the tuber not because of gravity, but because of capillary osmosis (seen in radishes grown in 1990).
- The space plants take the same time to flower and produce seeds in microgravity as they do under normal gravity conditions.

The researches conducted in this facility brought the scientists nearer to the possibility of growing plants for food in space. They proved the feasibility of Biological Life Support Systems development, if appropriate equipment is designed. The biological results obtained during the Greenhouse experiments suggest that the space biotechnology used is suitable for microgravity conditions and should be developed in the future.

Future Concept for the International Space Station

The International Space Station (ISS) will provide a perfect opportunity for conducting full life-cycle plant experiments in microgravity during the next 15 to 20 years. A number of plant growth facilities for scientific research, some of them based on the SVET SG's functional principles, are being developed by almost all advanced space countries.

Most of these facilities provide a fair level of environmental control to maintain defined environmental parameters considered adequate for normal plant growth. The first plant growth facility to support commercial plant experiments, already launched onboard the ISS in 2001, is called Advanced Astroculture (ADVASC), developed at the Wisconsin Center for Space Automation and Robotics [14]. It is configured as a double Mid-deck Locker; it has a closed plant chamber with approximately half the SVET SG growing area, and a height of 34 cm.

The principal ADVASC systems maintain constant parameters of the plant chamber environment, and full substrate wetting, ethylene removal, and water recovery. Light in the red and blue spectrum is provided using light emitting diodes (LEDs). Seed pods grown in this facility in the first 8-week plant experiment with Arabidopsis thaliana conducted during May-July in 2001, were returned to the Earth with seeds.

Our former partners in the Russian Institute for Biomedical Problems and Utah State University in America developed the LADA plant growth facility with the same infrastructure, and based on the same functional principles as the SVET SG, for the Russian Service Module onboard the ISS. LADA has two growth chambers with a smaller volume, one quarter the size of SVET SG [15].

The achievements reached during the SVET SG experiments, as well as the photosynthesis and transpiration measurements made by the American GEMS equipment, encouraged the Bulgarian researchers to continue working on the SVET SG project. The next step is to create a fully automatic space greenhouse that can measure growth physiological parameters during the entire plant life cycle, and can change the period of lighting, the water content in the root module, and the rate of gas-exchange between the plant chamber and the cabin air, depending on the requirements for these parameters. The goal is to maintain „non-stop" optimal conditions for plant growth, because plants are very sensitive to any change in the environment.

Plants do not have a developed nervous system and thus adapt to the extreme space conditions with much more difficulty than can man and animals. They react to unfavorable environmental conditions with „stress," stoppage of growth, and even death. Early signs of stress are invisible to the naked eye, and by the time these signs become visible, plants may already be too damaged to be saved. Crops need to be monitored to determine if they are healthy.

On the Earth crops can be monitored frequently to ascertain how they are growing, but in space astronauts have too many different duties to be able to do this, and the crops must be monitored automatically. Photosynthesis and transpiration are important plant processes whose normal rate can be affected by unfavorable environmental conditions. By measuring these processes as well as the environmental variables, and by knowing how they affect plant physiological parameters, researchers will receive the feedback to provide a „stressless" growth environment for the plants.

Photosynthesis is the most important process in green plants, and is, therefore, an excellent indicator of the physiological state of plants. Photosynthesis is the process in which plants absorb carbon dioxide and water, and by aid of light, convert them into organic compounds, with oxygen as a waste product. A classical method to evaluate photosynthesis is to measure the carbon dioxide assimilation of plants, which requires a partial enclosure of the system.

Plants regulate their temperature by evaporation of water from the plant shoot zone, a process called transpiration. Rates of transpiration increase with temperature. Leaf temperature could be measured to take account of water stress in plant. The correlation between leaf temperature and water stress is based on the assumption that as a crop transpires, the water evaporated cools the leaves below the air temperature.

As the crop becomes water stressed, transpiration will decrease, and the leaf temperature will increase. The American GEMS equipment was designed to measure both parameters, and its effectiveness was proven during the 12-day measurements in the SVET-GEMS complex in 1997. But the obtained measurement data were stored for further analysis on the Earth, and not used at the time for evaluation of the photosynthesis rate, which would have enabled the researchers to change the growth conditions in real time through feedback.

The new Concept for an advanced SVET-3 Space Greenhouse for the ISS (Fig. 10) is based on the Bulgarian experience and know-how, as well as international experience. The absolute and differential air plant chamber parameters and some plant physiological parameters are measured and processed in real time. On the bases of the photosynthesis and transpiration measurement data the necessary calculations are made and the plant status is evaluated.

As a result, adequate controlling signals are applied to the root and shoot environment control systems in order to provide the most favorable conditions for plant growth at every stage of plant development. The plant chamber parameters, optimized autonomously, provide „stressless" plant growth in order to obtain optimal results from the microgravity experiments. This feedback concept for adaptive environmental control is new; it differs from the SVET-GEMS on Mir OS (only passive parameters were monitored) and ADVASC on ISS (constant parameters are maintained).

The Proposed SVET-3 Space Greenhouse for ISS

The main units of the new SVET-3 Space Greenhouse conceptual Block diagram (Fig. 11), are the Light Unit (LU), Plant Chamber (PCh), Root Module (RM), Gas Analyzers, Actuators and Control Computer (CC) [16].

The Plant Chamber has a plant growing area of at least 1,000 square centimeters. The environment within the Plant Chamber is partitioned off from the ISS cabin atmosphere. The plant chamber provides a growing volume sufficient for economically important plant species. It can accommodate plants up to a height of at least 35 cm, and provides on-orbit access to the plant material for taking samples at different stages of development. A semi-transparent front window allows visual observation of the plants' status.

Two digital cameras photograph the plants from above and from the side, in order to evaluate the total leaf area. The cameras record the process of plant growth and development and downlink data via the telemetry system. Processing the data, scientists will obtain qualitative information about the state of the plants so as to understand and evaluate the experiment.

The Light Unit provides white light using fluorescent lamps with a spectrum concentrated in the red and blue spectral regions, as required for normal plant growth. The lamps are enclosed in protective hermetic bodies. They are mounted outside of the Plant Chamber, in order to provide separate cooling. The light intensity level can be regulated from 0 to 500 $\mu mol/m^2/sec$ photosynthetic photon flux (PPF) in steps, and the light period can vary from 0 to 24 hours with increments of 1 hour.

The Root Module uses a substrate matrix of about 1-1.5 mm particle size as a medium for plant root development. The substrate moisture level in the nutrient matrix is measured by three sensors located near the water source, in the most distant region, and in the middle. The dose water supply control system maintains the moisture automatically in the range of 5% to 95% by actuators—a pump injecting water portions through valves, and porous tubes into the substrate.

Aeration by a compressor ensures effective gas exchange (oxygen) in the root zone. The environmental parameters within the plant chamber, air temperature (AT), and humidity (AH), light intensity (LI), carbon dioxide and oxygen concentrations are measured and registered. A fan maintains the air humidity and carbon dioxide concentrations by controlling the rate of airflow entering the plant chamber from the cabin. An air filter removes the gaseous contaminants (including ethylene) from the ISS cabin air.

Two high-precision infrared Gas Analyzers (GA) are connected to the plant chamber inlet and outlet. The cabin airflow passes through a filter and is delivered to the GA inlet by a fan. Carbon dioxide, oxygen, water, humidity, temperature, air pressure, and air flow-rate parameters are measured in real time in the gas analyzer. The ISS cabin air parameters are currently measured by a different sensor system.

The airflow entering the chamber is distributed in the plant leaf area. After gas exchange caused by the plants' physiological processes, the air leaves the chamber, and enters the GA outlet, where the same parameters are measured. The water recovery system and ethylene scrubber (not shown in the figure) are available to clean the air outflow before entering the cabin.

The well-known method for carbon dioxide photosynthesis measurement is described above, but we are working on the question of how another one could be used. Different pigments, the most important of which is chlorophyll, absorb light—the energy that drives photosynthetic reactions. However, not all of the light absorbed is used in photosynthesis. Part of it is converted into heat, and another part is re-emitted as light—fluorescence—with a higher wavelength than the absorbed light. Most of the fluorescence is emitted by chlorophyll.

If conditions are unfavorable, leaf chlorophyll content will begin to decrease. By measuring leaf chlorophyll content, the photosynthetic rate can be evaluated, and from that the physiological status of plants. Leaf temperature, leaf area, and plant height are also measured. Having all these data, the computer calculates transpiration and photosynthesis, evaluates the state of the plants, and carries out adaptive control of both the root and shoots environments.

The Control Computer collects and records sensor data, calculates plant parameters, and, as needed, changes adaptively the main controlling procedures in order to operate the actuators to provide the environment that the plants need. The Control Computer is connected to the ISS telemetry system (TMS), which downlinks data and carries out feedback control from the Earth.

An LCD display and a keyboard give the crew the possibility of communicating with the greenhouse. An autonomous (manual) mode for control of each actuator is also provided for the experiment. The basic system is open for further modifications and extensions, depending on the experimental requirements. The proposed Concept is feasible and can be used in the Space Greenhouse project for ISS, if financial support is provided.

Discussion

In developing space greenhouses for the ISS, scientists suffer the contradiction between their wish to enlarge the growing area so as to allow more effective experiments, and the almost non-stop reduction of funds for space research, with a view to the strained international situation and economic crises.

ADVASC, the first ISS greenhouse, does not allow observation of the plants growing in the chamber. There is only a miniature video camera, which records in shadowy violet color (a combination of the red and blue LEDs) what is going on inside with the plants. Because the systems that maintain the environmental parameters at fixed levels fill the limited chamber volume, only a very small space is left for the plants. The plant air volume could be enlarged, but only at the expense of the control systems.

The astronauts like the experiments very much, and take real pleasure in taking care of the growing plants. During our Greenhouse series of experiments on Mir OS, instead of watching over the plants once every five days, as prescribed in the instructions, astronauts „floated" to the greenhouse at least five times a day to enjoy the growing plants.

In an interview with astronaut Michael Foale, who worked with the SVET SG in 1997, he was asked if he „would consider taking plants on long duration missions just to take care of them, and not as subjects for experiments" [17].

The answer was categorical: „Yes, very much so. I think, just like we have house plants for no reason but for their being there, I think exactly the same – in fact, more so –would we value having Earth plants in space, for no reason but that they're pretty, or that they're a reminder of the Earth. It's something to follow. They grow, they flower."

The chamber of a future ISS greenhouse should be large enough to accommodate more experimental plants and should be well illuminated, using white light with characteristics similar to normal sunlight. It should also be visually open, allowing easy access by the astronauts attending on the plants; there should be a large window, as the psychological effect of viewing the plants should not be underestimated.

Plants species resistant to the extreme ISS conditions have to be selected in advance, based on Earth investigations. For example, if the *Apogee* variety of wheat used in 1998-1999, which is resistant to the high ethylene concentrations in the Mir OS environment, had been chosen earlier for the 1996-1997 plant experiments, the failure of the months-long, high-cost Super Dwarf wheat experiments could have been avoided.

We recommend using leaf crops with rich biomass and a short vegetation cycle, which grow well in high cabin temperatures (25 to 28°C), and low lighting (because of the limits on energy available). Their rich biomass may meet the crew's needs for fresh food, and they could be used to clear the cabin air by absorbing carbon dioxide. And, not least of all, their luxuriant green mass would delight the astronauts' eyes through the transparent chamber wall as „a reminder of the Earth."

The possibilities of long-term manned missions have been continuously increased in recent years. Astronauts from all over the world have stayed for long times in space on board the Mir OS and ISS. Several expedition crews have worked successfully on the ISS up to now, stayed on the station an average of three months. The experience of these station missions will serve the long-term purpose of mankind– expeditions to Mars and the other planets. That is why providing the crew with food is a central problem at present.

As a result of the international experiments in the Bulgarian SVET Space Greenhouse facility, half the way from growing wheat seeds to making „space" bread has already been travelled. The experience gained will help to improve the technology for growing plants in space in the future. But there is still much to be done before habitable bases on the Moon, still in our dreams, become a reality.

Acknowledgements

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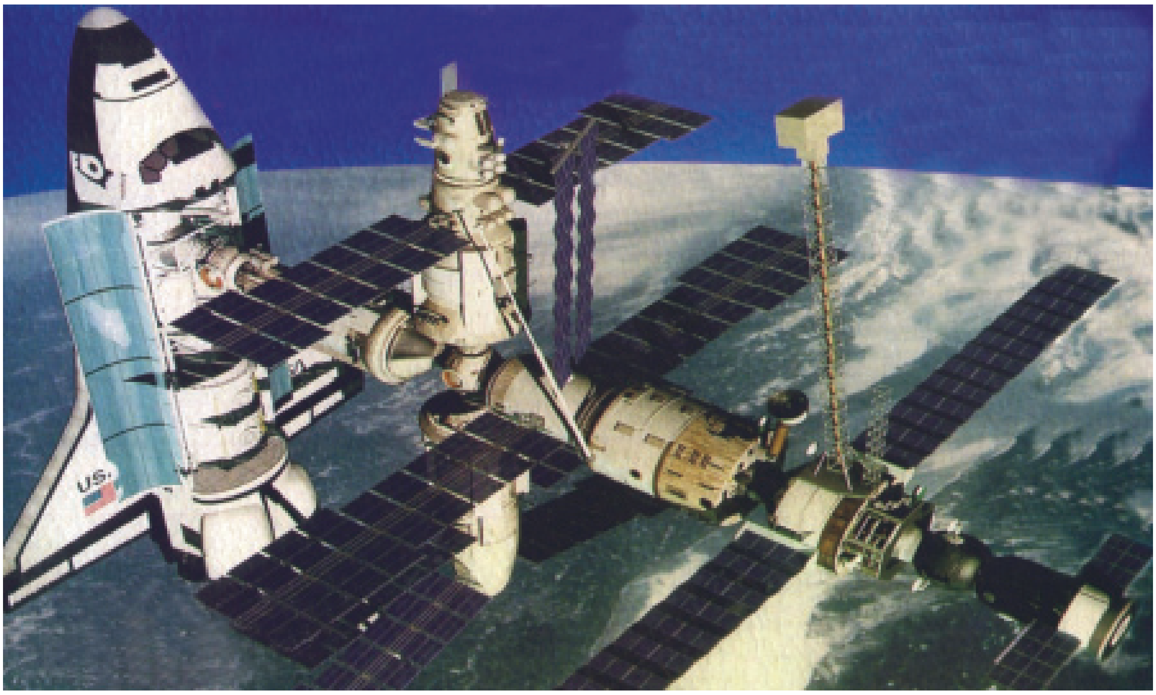

Figure 1. Russian Mir Orbital Station with docked US Space Shuttle to the Crystal module, where the SVET Space Greenhouse was mounted

Figure 2. The SVET Space Greenhouse, with the lettuce growing in the plant chamber and the control box on the right.

Figure 3. Radish plant sampling in the SVET Space Greenhouse

Figure 4. Freshly gathered radish plant samples, wrapped in wet filter paper, were delivered to the Earth by the crew in August 1990.

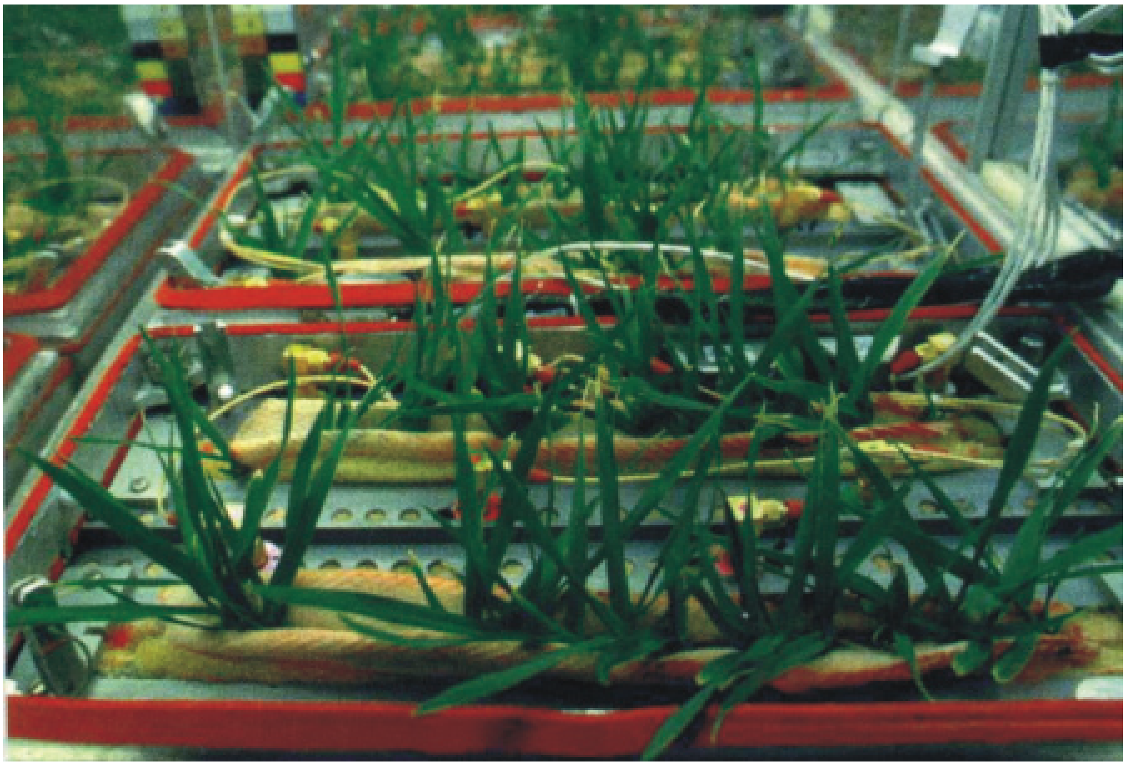

Figure 5. A frame of down linked video from Mir OS showing the *Super Dwarf* wheat growing in the SVET SG on the 15th day of the „Greenhouse 2b" experiment in 1996.

Figure 6. The American astronaut Shannon Lucid enjoys the space wheat planted and maintained by her on Mir OS in 1996 – the photo is exposed in Houston Space Museum

Figure 7. The Russian cosmonaut Sergei Avdeev enjoys his job to monitor the wheat plants maturation in the SVET-2 SG in 1999.

Figure 8. A photo of *Apogey* wheat plants grown during the „Greenhouse 4" experiment in SVET-2 SG, where the first 'space' seeds on Mir OS were produced.

Figure 9. The Russian cosmonaut Alexander Kalery takes a plant sample during the „Greenhouse 6" experiment carried out in the SVET-2 SG in 2000.

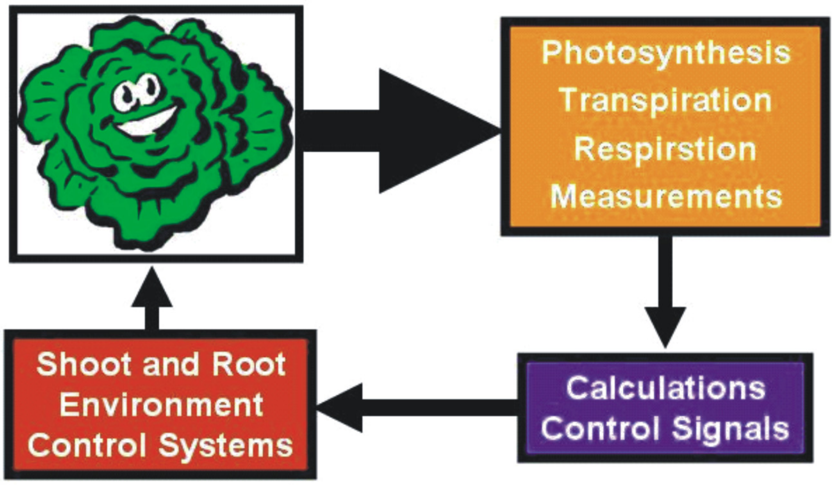

Figure 10. Concept for the new generation SVET-3 Space Greenhouse for the ISS

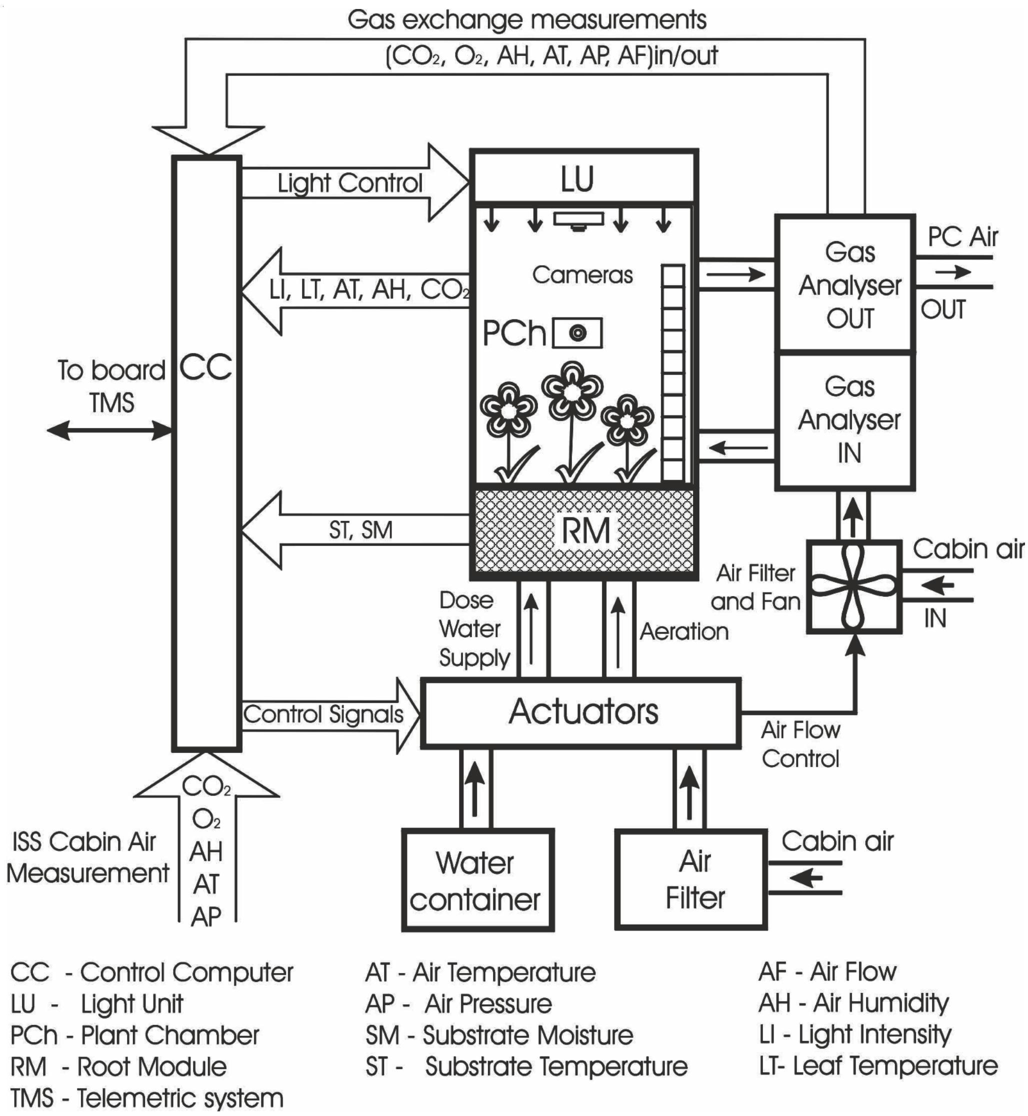

Figure 11. Concept for the new generation SVET-3 Space Greenhouse for the ISS.

BULGARIAN ADDED VALUE TO ERA

BULGARIAN CENTER OF SOLAR ENERGY - CENTER OF EXCELLENCE IN SOLAR TECHNOLOGIES

Assoc. Prof. Petko Vitanov, PhD
Director of Central Laboratory for Solar Energy and New Energy Sources BAS

Central Laboratory for Solar Energy and New Energy Sources (CL SENES) at the Bulgarian Academy of Sciences has been carrying out research activity in solar energy in Bulgaria since the late 70s. A considerable scientific potential in the field is concentrated in it. During the 80s the principal tasks of the Laboratory mainly related to fundamental investigations on material featuring and technology development for solar energy utilization.

Two are the basic directions of specific activities:

– Photovoltaic solar energy conversion, including preparation and study of new materials and technologies for solar cells, investigations of modules and solar system design;

– Photothermal solar energy conversion including development of selective coatings, energy controlled coatings, solar collectors and heat accumulation.

The structural changes in energy, industry and society taking place in the last few years put ahead new requirements for the research activities in renewable energy sources and those demanded new organization of research and applied work of the CL SENES. Contacts were established with the leading groups in Europe for joint participation in projects supported by the European Commission (EC). The Laboratory backed up the RES involved non-governmental organizations by expertise and consulting. The contacts with the energy institutions become closer and now the Laboratory is one of the principal consultants in „clean energy" problems for the state administration.

In February 2003 CL SENES was selected as a Center of Excellence in the frames of the 5th WFP EC Program project responsible for coordination of scientific research and training in the field of solar energy application at national level.

This new disposition required broadening of the fields of activity of the Laboratory and it was approved as the Bulgarian Center of Solar Energy (BGCSE).

Through research, implementation, consulting and education activities the Center aims at three principal goals:

1. Rise of the scientific and technological level of „clean energy" production.

2. Promoting the rapid implementation of solar systems and installations.

3. Improvement of education on, and understanding of the potential and wide implications of solar energy use, its significance for human welfare and the environment, within the framework of sustainable development.

To achieve them the Center is considering the following problems:

1 Development of advanced technologies of solar energy elements and systems adaptable for industrial production.

2. Scientific support for organization and transfer of new productions for solar energy installations.

3. Education and training in the field of solar energy.

4. Support and development of socially engaged significant demonstration projects.

5. Formation of a working group for solar system test methods and standard preparation and

establishment of an authorized certification unit.

6. Building an international testing ground for solar energy devices and systems.

7. Improving links with non-governmental organizations by consulting, joint workshop and event organization, project commitments, etc.

Realization of the above mentioned problems will contribute to industry restructuring through new production implementations and creating new working places. Application of the solar energy technology will raise the ecological culture and human life quality and will reduce the harmful emissions from the conventional energy production.

The particular activity of the Center coincides with the science development priorities in Bulgaria and closely relates to the principal priorities of the 5^{th} and 6^{th} Frame EC program.

The significant innovative elements in the Center activity concern the following items:

– Creation of conditions for developing advanced technologies applicable in industrial production.

– Realization of demonstration projects of substantial social and energy impact.

– Solar energy installation testing and certification.

– Preparing the organization of an international solar energy regional center.

Based on the obtained research results, development and transfer of advanced technologies suitable for solar energy conversion devices and installations are envisaged. Three of the trends are assessed as the most adequate:

Research in the field of technologies for solar cells:

– Low cost technology for highly efficient crystalline Si solar cells. The availability of original results and patents permits solar cells of 17-19% efficiency to be produced without expensive or sophisticated processes. In the frames of the ADVOCATE project (NNES5-2001-0703) researchers from the CL SENES participated actively in developing an advanced technology for high efficiency solar cells on thin multicrystalline silicon wafers. Partners in these projects were 4 companies – IMEC (Belgium), Photowatt (France), Second Semiconductor Equipment (Austria), FAP (Germany), 2 universities and 2 institutes. Part of the obtained results is published in 11 publications and 1 patent (EP 1 489 667 A).

„High Efficiency Silicon Solar Cells with Low-Cost technologies" workshop was held in Sofia in May 2004. The basic topics concerned low-cost technologies suitable for industrial upgrading and that was the reason to look for among researchers involved in that particular area. 5 scientists from leading companies and institutes took part as invited lecturers. Scientists from CL SENES and the Faculty of Physics at Sofia University delivered lectures, too. Overall, 58 specialists from institutes of the Bulgarian Academy of Sciences, Sofia University, South-West University in Blagoevgrad, Technical Universities in Sofia and Varna, engineers from companies in the electronic industry participated in the event. 19 of them were young people below 35.

– Thin film solar cell technologies. Previous investigations on amorphous Si, CdTe, CdS and $CuInSe_2$ (CIS) thin films provided the base for working groups from the Laboratory to be included in the EC supported JOULE Program. The achieved results stimulate further efforts an end product to be created. At the end of September 2005 a „Low Cost Technologies for Thin Film Solar Cells" workshop was held in Sofia on the problems. The main topics were: CIS based solar cells, thin film silicon solar cells, organic and polymer photovoltaic, photo electrochemical and dye-sensitized solar cells. The aim is researchers from Bulgaria and abroad to be informed about the achievements in the low-cost deposition methods for preparation of thin film solar cells and, also, to help in establishing closer contacts among the scientists in the field. Five lecturers from leading European research centers were invited and delivered lectures on the above-mentioned themes. Simultaneously, short announcements were given to present recently achieved results. Discussions and debates on the possibility of joint investigations and participations in future projects took place.

Through workshops, seminars and exchange of visiting researchers closer contacts will be established between scientific institutions and producers. Joint development of advanced technologies for industrial production must be a direct result of the Center actions.

The formation of a working group on Standardization of solar thermal collectors and photovoltaic (PV) modules is a new item in the Center activities. Measurements are carried out in accordance with the EU standards under outdoor conditions.

A testing laboratory for PV modules has been created in the CL SENES. It comprises a sun tracking supporting construction (Fig. 1) and a measuring system for electrical characterization of PV modules (Fig. 2). The main purpose is to perform precise operational testing and energy rating of terrestrial photovoltaic modules. Since producers use different technologies for solar cell material (crystalline-Si, amorphous-Si, C-I-S thin film etc.) and different solar cell designs, the installation for testing should be as flexible as possible.

The system for testing water solar collectors has also been developed in accordance with the following EU standards: EN 12975, EN 12976 and EN 12077. Test measurements are carried out in stationary regime and under real conditions. The aim is a laboratory for solar thermal installation assessment and quality certification issues to be organized. It will twin the Laboratory of Testing and development of Solar and Other Energy Systems at the Demokritos Center in Athens, Greece. Our specialists visited the Center and Greek specialists are invited to Sofia to discuss problems connected with testing and assessment of solar installations. A bilateral cooperation is the appropriate way to do this.

Traditionally, each three years CL SENES is organizing a national conference on RES. The Third National Conference on RES was held in October 2003 at the National Palace of Culture, Sofia, under the Honorable Chairmanship of Milko Kovachev, the then Minister of Power Engineering. It was organized as a part of the BGCSE program. 144 specialists took part in the Conference. 46 reports were delivered in the field of solar, wind and geothermal energy and biomass. Institutions of higher education were widely presented and especially technical universities alongside with the institutes of the Bulgarian Academy of Sciences. Representatives of many firms and companies as well as of governmental institutions, NGOs and the media participated, too. The biggest part of reports (25) concerned solar energy utilization, including measuring methods and solar radiation simulation, solar data from different regions in Bulgaria, photovoltaic conversion, passive and active solar thermal systems. A concomitant exhibition on solar thermal technologies in Bulgaria was organized with the kind cooperation of Energy Center Sofia and the Greek center Exergia. 3 Bulgarian and 14 Greek companies took part in it.

The third task of BGCSE relates to further stimulation of solar technology application by training specialists and popularizing the achievements and advantages of solar energy utilization. Those include visits of young researchers to the leading European centers in the field, working on joint projects, organizing and holding common conferences and schools on renewable energy sources for young people.

The National School „Renewable Energy Sources: Nature, Development, Perspectives" was a separate work-package in the Center of Excellence Program. The included topics were selected specially for teaching young specialists, doctorial and post-doc students in various profiles. There were over 25 received lectures covering all the aspects of solar energy utilization: photovoltaics, wind energy, biomass, geothermal, etc. 55 PhD students from 5 academic institutes, 10 universities, 2 companies involved in solar energy took part and there was one application from the European University in Budapest, Hungary, too.

To inspire the interest of the young participants and to stimulate them the PhD students were given certificates for attending a specialized course covering a wide range of the RES utilization fields. That should be considered as separate credit points in favour of their PhD programs. Besides the Program an opportunity was provided video records illustrating some RES technologies and accomplishments in Japan, Poland, Germany, the UK, etc. to be presented.

The possibility of BGCSE to disseminate information about the advantages of solar energy usage grew substantially after a 10 kW grid-connected PV system was put in operation (Fig. 3). This system is built in the frames of an EC project (PN Enlargement) and it is the first demonstrational project of this kind in the country. This system is going to take part in 4-year monitoring together with 26 similar installations in Europe and it has to prove the availability of real resources for decentralized electric energy production. Using local grid-connected solar photovoltaic generators is a promising technology and quite appropriate for the climatic conditions in Bulgaria.

The results of the BGCSE work activated more strongly than expected the RTD activities in solar energy usage. The BGCSE project exhibited the Central Laboratory for Solar Energy and New Energy Sources as the leading scientific unit to which a number of companies and institutions refer to for scientific and technical support. Professional contacts have been established with the „Energy Solution" company which is the only one producing PV modules in Bulgaria now. Our scientific links with leading European science centers in photovoltaic technologies grew stronger. Our scientists and specialists collaborate beneficially with the colleagues from IMEC – Belgium and Photowatt – France. A delegation from India visited the Laboratory after an invitation from the Ministry of Foreign Affairs. We discussed a joint project for building a 1 MW_p Solar Photovoltaic Plant and other joint ventures. Specialists from CL SENES were invited as co-organizers of the Symposia „Environmental Friendly Energy Production in PHARE Countries – Solar Energy" held in Prague and Athens. General Electric Global Research offered their PV modules to be tested by our Test Laboratory under outdoor conditions in the frames of a bilateral contract. Companies from Bulgaria and Europe that produce solar thermal collectors offered their products for testing and that is a good opportunity for close contacts to be established with industry and thus to create the foundation for joint development activities.

Together with other projects in the frames of the EC scientific programs the Bulgarian Center of Solar Energy contributes to the real integration of Bulgaria in the RES policy of the European Union.

Fig.1. A view of the PV module supporting and tracking system

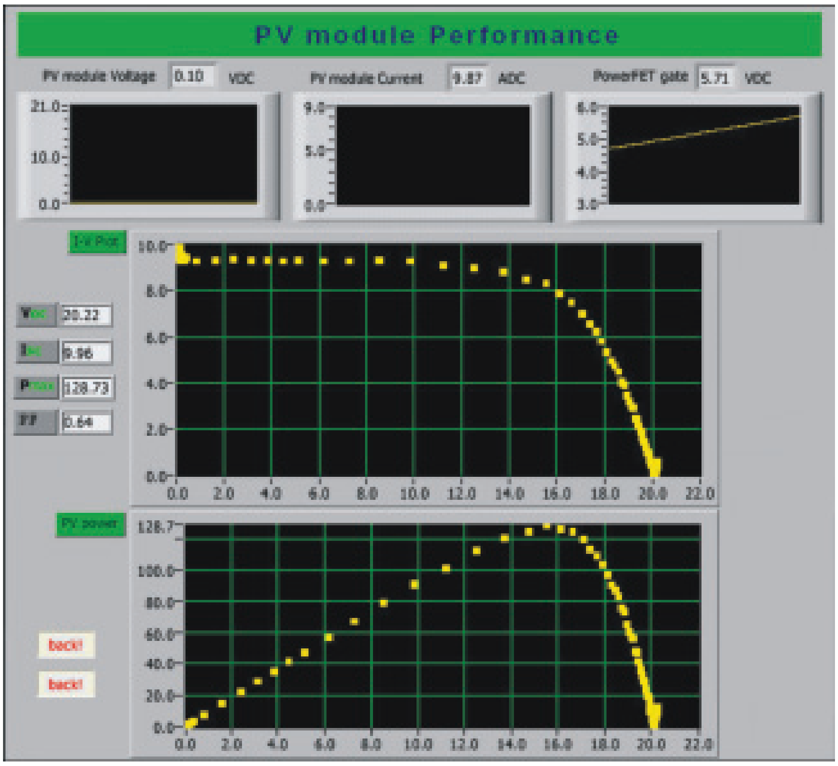

Fig.2. PC control station

Fig3. 10 kW grid-connected PV system

MADE IN BULGARIA WITH EUROPEAN SUPPORT

LASER Sounding of the Atmosphere for the European Lidar Network

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Application area: *Laser sounding of the atmosphere, research and mapping of large-scale aerosol layers, control of aerosol distribution in the atmosphere.*

„Laser Radars" laboratory of the Institute of Electronics at BAS, is the only lab in Bulgaria where methods and systems for laser sounding of the atmosphere (lidars) are developed and applied. Lidar sounding is based on extracting information on the atmospheric parameters by studying the interaction of emitted laser impulses with the atmosphere. Registering the backscatter profile with high-sensitive receivers, after processing the results under specific algorithms, qualitative and quantitative data on the atmospheric characteristics are obtained.

Lidar methods for measuring the aerosol content in the atmosphere are a powerful means of control and analysis of the environmental state. Aerosol lidars allow for real time tracing and mapping the movement of aerosol layers above extensive territories. Through lidar measurements information on the atmospheric parameters in a continuous row of points is obtained, which represents a significant advantage in studying large-scale objects and phenomena in the atmosphere.

In 2002, as part of the 5th Framework Program for Scientific Research of the European Community, „Laser Radars" laboratory participated in the project EARLINET „European Aerosol Research Lidar Network to Establish an Aerosol Climatology". The major objective of the project was to create a generally accessible, statistically reliable database for horizontal and vertical distribution of aerosol layers above Europe, accumulating results from measurements of a network of lidar stations, and using this database for achieving a better understanding of environmental problems due to the aerosols. The project unified the efforts of 22 lidar stations in 13 European countries. A profound program for quality control of the work of each lidar, as well as for unification of the applied algorithms for calculation of atmospheric parameters was carried out.

On behalf of Bulgaria 2 aerosol lidars participated in the project – one using a CuBr vapor laser and registration in photon counting mode of the laser impulses reflected by the atmosphere, and the other – with solid Nd: YAG laser and registration in analog mode of the reflected signals. The two lidars used a common algorithm for results processing and calculation of the coefficients of aerosol backscatter of the atmosphere and uploaded the data to a common database located on a server in the Institute of Meteorology in Hamburg, Germany. The sounding ranges of the two lidars were complementary to one another, as for the zone of overlapping precision control analysis was carried out based on comparison of results of simultaneous measurements. The two teams conducted a series of experiments under 3 of the EARLINET project subprograms:

– **WP 2 program** – Regular lidar measurements. The primary objective of the program was the establishment of a common database of measurements of profiles of the atmospheric aerosol backscatter coefficient. Measurements were conducted twice weekly, every Monday at noon when the sun is in zenith, and in the evening during sunset, and every Thursday at sunset. Both lidars participated in this program.

– **WP6 program** – Cyclic processes in the atmosphere. The planetary boundary layer of the atmosphere (PBL), linked with the energy exchange with the earth surface during the night and day cycle was the object of study under this program. Measurements under this program were carried out with the lidar using analog mode of signal registration.

– **WP7 program** – Observation of special phenomena. Such phenomena were observed at unusually high concentrations of aerosols in the troposphere. Their appearance is due to transportation of dust from Sahara over the Mediterranean Sea to Europe, volcanic eruptions, formation of smoke layers as a result of forest or industrial fires, intense photochemical smog, etc. The lidar using registration in photon counting mode, participated effectively in the studies of such aerosol layers, which in some cases were detected at significant altitudes – 4–6 km above the ground surface.

As it was mentioned above, thorough quality control of the work of each separate lidar, as well as unification of the applied algorithms for calculation of atmospheric parameters were the basis for the establishment of the European network of lidar stations and the creation of extensive, statistically reliable database on the horizontal and vertical distribution of the aerosol layers above Europe. The Bulgarian lidars from „Laser Radars" laboratory of the Institute of Electronics at BAS were successful in passing the tests for control, which was the essence of WP3 program of the EARLINET project. The inclusion of the two lidars in the joint studies under the project is a proof of their efficiency and acknowledgement of the quality of the applied algorithms, in line with the criteria of the European lidar network.

New Space Experiment of BAS

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Application area*: Space research, dosimetry in space and on aircraft, radiation environment dosimeter.*

On May 31, 2005 the Foton M2 capsule, housing a payload complement of 39 experiments in physical sciences, biology, fluid physics, exobiology, materials science and technology, was launched aboard a Soyuz-U rocket from Baikonur Cosmodrome in Kazakhstan, spending 15.6 days in Earth orbit. The results from the experiments were delivered to scientific teams in Russia and Europe for further processing and analysis. Together with colleagues from Germany the R3DB2 instrument, which measured the variation of the space radiation dose and flux at Photon M2 was developed in STIL–BAS.

The STIL–BAS participation in the Photon M2 experiments was the result of successful scientific competition together with colleagues from Germany organized by the European Space Agency in 2000. Two space experiments R3D-B(1) for Biopan 4 (2002) and R3D-B2 for Biopan 5 (2005) were developed. New not finished competition from 2004 will decide our participation in the Biopan 6 platform on Photon M3 satellite in 2006. Whole electronics, 256-channel space radiation spectrometer and the software for R3D-B2 are fully developed in STIL–BAS. The Bulgarian team under the electronic schematics of German colleagues also developed the 4-channel UV spectrometer. The Bulgarian team, which works for the development of the experiments, is the same as the authors of the article shown above. R3D-B2 is an active experiment on Biopan

5 platform, which accumulates the history of UV and space irradiation. These data will be delivered to other Biopan 5 participants for estimation of the radiation effects on the biological and other species.

The specific objectives of the R3D instrument are as follows:

To determine the radiation climate (UV and ionizing) outside of Photon M2 at Biopan by three independent and complementary procedures as follows:

1. Solar UV radiation outside of Photon M2 at the Biopan facility by use of an automatic electronic UV dosimeter, which measures irradiances in W/m2, physically weighed in accordance to the minimal erythematic response curve for the UV radiation;

2. Solar irradiation in the UV-C (<280 nm), UV-B (280–315 nm), UV-A (315–400 nm) and PAR (400–700 nm) channels with a four-channel filter dosimeter;

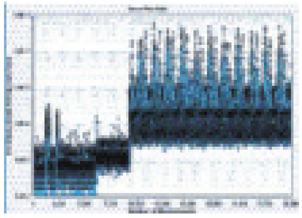
3. Cosmic ionizing radiation unit by use of an automatic competing and sometimes outmatching plastically electronic particle dosimeter, which measures in mGy/h and in particle/cm2 s as the two space radiation parameters;

4. Investigation of the global distribution of absorbed dose, dose equivalent and flux;

5. Global study of the dose composition under normal and disturbed conditions in space;

6. Verification and improvement of space dosimetry methods for long-duration space flights.

The saved in the flash memory data on the measured during the flight doses and fluxes were delivered to the Bulgarian team via Internet on July 7, 2005. Three most important periods, which are with 1-minute resolution, are well seen in the Figure.



The lowest doses and fluxes are in the left part of the figure and were obtained after the mounting of R3D-B2 in Biopan 5 facility.

They are comparable with the natural radiation background. Two maximums seen there are obtained during the two aircraft flights from Amsterdam to Moscow and from Moscow to Samara town in Russia. The doses in the left middle part of the figure are obtained after the integration of the Biopan 5 facility with the Photon M2 satellite, while the right side data are from the flight in the orbit around the Earth. The successive maximums there are in the result of crossing the South-Atlantic magnetic anomaly where the satellite crosses the inner radiation belt of the Earth containing high-energy protons.

In STIL–BAS some new space radiation instruments are under development. Some of them will continue investigations in near Earth orbits on the International Space Station, while other will measure the radiation environment around the Moon on Indian Chandrayaan 1 satellite and around Phobos – satellite of Mars during the Russian Phobos-Ground mission.

Metal-matrix Composite Materials for Local Reinforcement of Aluminum Parts

Assoc. Prof. Lenko Stanev

Institute of Metal Science „Acad. A. Balevski“, 67 Shipchensky Prohod Blvd., 1574 Sofia.

Application area: *machine building industry, electronics, car industry, military industry etc.*

The Institute of Metal Science (IMS) performs profound studies of the possibilities and conditions to produce and apply low cost metal-matrix composite materials (MMCs). The basis of these investigations is the development of squeeze casting technology widely used in the IMS research and applied investigations.

This technology is usually applied for the production of castings mainly from aluminum alloys of extremely high quality competing and sometimes outmatching plastically formed products.

Besides improving the material structure and properties, the characteristic high pressure applied during crystallization is recently used to produce composite materials by means of penetration „infiltration" of porous performs. The latter consist of ceramic fibers, whiskers, particles and skeleton structures made of metal and non-metal powder, metal or ceramic foams, etc.

The use of reinforcing short ceramic fibers, commonly applied for thermal insulation, enables one to produce MMCs at higher wear resistance and improved mechanical and technological properties. Moreover, the IMS investigations prove that the MMCs exploitation is admissible at temperatures higher than 300-350 degrees C and is found to be limiting for most of the aluminum alloys.

Furthermore, the composite materials retain high thermal conductivity and low density of the matrix aluminum alloys. The reinforcement of aluminum alloys by means of skeleton structures prepared from metal powders and foams based on iron and copper alloys allow for the production of composite materials with excellent tribological properties, high temperature resistance.

The basic advantage of the technique of producing such types of cast composites is that it allows for the reinforcement of some individual areas of the part, which undergo a specific impact. The reinforcement is realized by the composite incorporation within the volume of the part during production. For instance, the IMS experimental production offers castings of pistons for heavy-duty diesel engines simultaneously reinforced with two types of composites. Considering the area of the combustion chamber where the material undergoes cyclic high-temperature loadings, the aluminum alloy is reinforced by means of short ceramic fibers. Considering the area of intensive wear, i.e. the area between the first ring groove and the first piston ring, the material is reinforced by another composite „pseudo-alloy" which improves the wear resistance and the tribological properties of the matrix aluminum alloys. As a whole, the use of composite materials in pistons provides increase of engine life, improvement of combustion and decrease of toxic emissions in the air.

These composites can be used for local improvement of specific properties of the discussed aluminum parts and those of cylinder liners, connecting rods, brake disks, massive sliding bearings, etc.

Possibilities for the Application of Black Sea Deep-water Organogenic Mineral Sediments (Sapropels) in Organic Farming

Assoc. Prof. Georgi T. Georgiev, PhD
Acad. M. Popov Institute of Physiology of Plants, Acad. Georgi Bonchev Str., Bl. 21, 1113 Sofia

Application area: *Organic farming.*

The issue of feeding the population of the planet is a basic one of today's society. According to FAO data (2002), approximately 1000 million people live at nutrition levels under the minimum requirements, and about 800 million people of the world population suffers some form of underfeeding.

In connection with these data, in the second half of the previous century agrotechnology started to develop at a high rate through the application of a large number of organic and inorganic compounds. Because of the accumulation in the last decade of more and more evidence concerning the harmful impact of many chemical substances used in agriculture, today many investigators concentrate their efforts on finding natural chemical substances – alternatives to conventional growth regulators and pesticides.

The European legislation also focuses on the restriction of the use of synthetic chemical substances (fertilizers and pesticides) and on stimulating the development of alternative methods for the protection and growing of farm cultures (Council Regulation No 2092/91; Law on Environmental Protection No 137/1995). A large part of the agrarian legislation of the European Union (EU) has to do with the functioning of the Unified Internal Market of the Union and aims at ensuring the safety of foods in the whole community. It is directed towards protection of the health of people, animals and plants and preservation of the environment. In response to these requirements, production of various preparations made of natural components (biohumus, humustim, humuslife) that are in the process of finding an ever better reception on the internal market (Regulation No 22 / 04.07.2001) started in Bulgaria in the recent years.

As a reaction to the acute necessity of developing new technologies for the production and assessment of preparations applied in agriculture, and with the aim of obtaining ecologically pure products, a team from the Institute of Physiology of Plants at the Bulgarian Academy of Sciences investigated the impact of deep-water organogenic mineral sediments (DWOMS) on the growth and development of corn and some earthed-up cultures. DWOMS constitute sapropel, diatomite and coccolith slimes situated at depths between 200 and 2200 m at the bottom of the Black Sea. Their chemical composition in % is as follows: C_{org} – 3; SiO_2 – 3,15; CaO – 14,5; MgO – 2,73; Fe_2O_3 – 4,57; Al_2O_3 – 11,5; P_2O_3 – 1,32; TiO_2 – 0,4. In methanol-acetone-benzol (1:1:1) extract, the content of chemical elements (in %) is as follows:

Cu – 0,03; Cr – 0,0125; Mn – 0,0365; Zn – 0,0085; Mo – 0,0175; Co – 0,0155;

Ni – 0,0073; Li – 0,0025; Sr – 0,0061; V – 0,0088.

During the period of 1997–2004, preliminary investigations on the impact of DWOMS on various farming cultures such as wheat, tomatoes, pepper, aubergine, oilbearing rose (Damask rose), etc. were made at a number of institutes in Bulgaria (Pushkarov Institute of Soil Science, the Agrarian University in Plovdiv, the Institute of Wheat and Sunflower – in the town of Dobrich). The results show that sea sapropels stimulate growth, speed up maturing and increase the yield of plants. They are also very appropriate for neutralizing acidity and increasing the humidity of soils.

Our investigations were made on 5 species of corn cultures – hard and ordinary wheat, autumn and spring barley, rye, triticale and oats, as well as on 2 species of earthed-up cultures – sunflower and cotton. The influence of sea sapropels was studied on the growth and the development of plants (germination, root formation, tillering, increase of the vegetative mass and content of chlorophyll and dissolvable protein in it, ear formation and yield). The opportunity of protection against unfavourable outside influences (low-temperature stress, overhumidification of the soil) was also studied.

The results show that sapropels stimulate germination and the growth of the root system. They increase the content of chlorophyll and dissolvable protein in the leaves, the number of stems in cultures with a compact area and the retardation of the flowering and the fruit sets of cotton. The favourable impact of sapropels during separate phases of development of the plants leads to an increase of crops with 15% to 18% at the average. Increased resistance has also been registered with respect to some unfavourable climatic factors.

Optimal concentrations for application in agriculture are established and the conclusion is made that sea sapropels are very suitable for creation of preparations (natural for organic farming and combined for conventional farming). They are also applicable for re-cultivation of soils that are rich in acid, poor in microelements and destroyed, as well as for enrichment of substrates, which is in conformity with the policy of the European Union with respect to agriculture, requiring search for alternative raw materials for improving the structure of soils with the aim of establishing ecological agricultural production.

Method for Torsional Impact on Working Environments. Torsion Generator Implementing the Method.

(Invention Patent 63583/31.05.2002 and PST BG01/00010/12.04.2001)

Additional info: www.demetra-geia.org

Application area: *aerospace technology; agriculture – forestry; biotechnology; chemical industry; construction technology; food – agro industry; industrial manufacture; materials technology; medicine, health; pharmaceuticals/ cosmetics; veterinary; waste management; BIOLOGICAL SCIENCES; ENERGY; ENVIRONMENT; environment protection.*

The invention is based on the theory of torsion fields. The torsion generator was developed by Bulgarian and Ukrainian scholars and specialists, and implements the method of torsion effect on working mediums. The method is implemented into a high-technology product for power transformation (conversion) through exertion of influence on the working fluid at a molecular level. In the process of torsion effect over the working fluid, definite number of hydrogen bonds is broken, which goes parallel with heat power release, which is the reason for the high conversion ratio – higher than 1 (one). The developed torsion generator is the only device in the world that carries into practice the opportunity to derive heat energy under a transformation ratio over 1. The process is not endothermic. The recovery of H-bonds takes place for account of the forces that play between the water molecule particles of opposite charges that are of about 20 Kj/mol. With this torsion generator the purification effect and other effects are provoked by the strongly expressed amplitude of torsion waves and the generated opposite polarization. A mechanical rupture of living microorganisms is observed. The principles of energy transformation and impact are based on the torsion effect, caused by material bodies rotating with high speed and under a large angular momentum, which is proportional to the mass of the bodies and to their angular speed. Torsion generator does not use any energy carriers at all – solid, liquid or gaseous. The only energy consumed is electricity needed to feed the water pressure pump of the generator. Torsion generators pose an alternative to all presently existing heat generators, and they are capable to fully replace all sources of energy and heat; they may be connected directly to the existing heat supply and hot water installations. Energy savings and other benefits for the households and the heat energy sector are substantial. These torsion generators offer great opportunities for wasteless treatment of wastewater. 'The method of torsion effect on working mediums and a torsion generator which implements the method' is patented in the Republic of Bulgaria and has a reserved priority for international patent protection and is patented in the countries from the European region, the Euro-Asian region, America, Canada, China, Japan, South Korea and many others. The invention and torsion generators have been presented and awarded with many charts and golden medals at many international exhibitions for innovations: Brussels, Tokyo, Moscow, Pittsburgh, Toulouse, Frankfurt, etc.

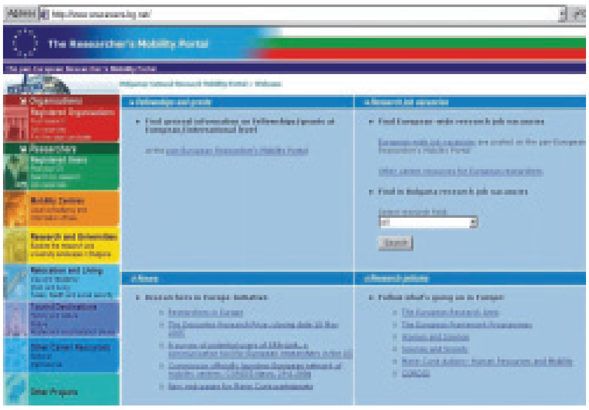
The invention is a high-tech breakthrough, which has no analogues in the world. The uniqueness of the method is the new principle for yield of heat energy, with transformation ratio over 1, as well as other different positive impacts. This is a new and innovative way for biological and physical treatment of fluids.

Main Advantages: – Environmentally friendly and clean energy transformation. – Renewable processes of energy transformation. – No conventional energy carriers are used – neither liquid, nor solid or gaseous. – High operational capacity. – Long-lasting duration (negligible wear-and-tear), and security of operation. – Quick return of the investments, considerably lower price of the heat energy derived, economically and socially effective and beneficial.

EQUAL IN EUROPEAN RESEARCH AREA

Bulgarian Researcher's Mobility Web Portal

http://www.eracareers-bg.net



In the European Union mobility is considered to be an original tool for transfer of knowledge at national and European levels and for enhancing the attractivity of Europe for scientific talents from all over the world. In the communiqué „A Mobility Strategy for the European Research Area" the European Commission anticipates creation of a European network of mobility centers ERA MORE to provide at pan-European level fast and effective supply of up-to-date information and practical assistance for arriving and departing researchers in all matters relating to their professional development and daily lives. The entrance point to information on separate European countries and their Network of Mobility Centres is the European portal – **http://europa.eu.int/eracareers**.

On November 5, 2004 within the European Day of the Entrepreneur the *Bulgarian Network of Research Mobility Centres* – **http://www.eracareers-bg.net** was officially set up in order to become an integral part of the European Network ERA MORE. The Bulgarian network consists of a National Centre, four Regional Centres and one Centre for intersectorial mobility of researchers. The Research Mobility Centres ensure detailed and up-to-date information and personalized services to researchers and their families on the following issues: visas and entry conditions, working opportunities and work permissions; salaries, taxes, pension rights; healthcare and social security; accommodation; the system of childcare and education; language courses for foreigners; Bulgarian culture and leisure opportunities; intellectual property rights.

The National Web Researcher's Mobility Portal offers access to practical information on administrative and legal problems of relocation from one country to another, as well as up-to-date information on cultural and family aspects, accommodation, schools, kindergartens, language courses, different kinds of insurance, rights and obligations.

The portal offers the following services:

– possibilities for research organizations to advertise their research vacancies and to look for suitable candidates;

– opportunity for researchers to publish their CVs in the database of the Portal.

The activities of the Portal are expected to result in:

– encouraging the mobility of scientists and researchers in the process of construction and structuring of the European Research Area;

– increasing the attractivity of work in Bulgarian research organizations;

– making visits, stay and work of foreign scientists and researchers in Bulgaria easier;

– facilitating visits and work of Bulgarian researchers abroad;

– improving the mobility of researchers from the academic environment to industry and vice versa

BULGARIAN VIPs

Acad. ALEXANDER G. PETROV, DSc., PhD – Over 130 refereed original papers and more than 900 citations.

Mr. Alexander G. Petrov was born in 1948 in the town of Stara Zagora, Bulgaria. He gets secondary education at the High School „Ivan Vazov". In 1970 he graduates as a M.Sc. in Atomic Physics from the Faculty of Physics of Sofia University „St. Kliment Ohridski", Sofia, Bulgaria with a Master Thesis „Dielectric Properties of Nematic Liquid Crystals with Ellipsoidal Molecules". In 1974 Mr. Petrov defends his PhD degree in Physics with a PhD Thesis „Electric Polarization of Nematic Liquid Crystals: Dielectric and Flexoelectric Properties" at the Bulgarian Academy of Sciences, Sofia, where he defends his DSc degree with a Thesis „Molecular Physics and Biophysical Aspects of Lyotropic Liquid Crystalline State of Matter" in 1987.

Mr. Alexander G. Petrov has numerous honours, awards and professional services in his research field, including: Biennial Award in Physics of the Bulgarian Academy of Sciences in 2000; listed in „Who is Who in the World" and in „2000 Outstanding Scientists of the 20th Century"; 1999 Award of the National Council „Scientific Studies„ and the Ministry of Education and Science of Bulgaria. Another proof of high appreciation of Mr. Petrov's expertise is his membership in a number of Editorial, Advisory and Research Boards and Councils, including Member of the Editorial Council of the journal „Zhidkie Kristally", Ivanovo (2002); President of the Bulgarian Liquid Crystal Society since 2000; Member of the Research Board of Advisors of the American Biographical Institute since 1998; Member of the Administrative Council of the Union of Physicists in Bulgaria since 1992 and Vice President of the Union of Physicists in Bulgaria (1995–01); Advisory Editor of European Biophysics Journal since 1991; Member of the International Advisory Board of the Lyotropic Liquid Crystal Conference, Ivanovo (2000); Member of the Editorial Board, Europhysics News (1995–2000); Member of the Higher Attestation Commission of the Republic of Bulgaria (1994–97) etc.

At present Mr. Alexander Petrov is Director of the Institute of Solid State Physics – BAS (since 1999), Head of Biomolecular Layers Department, ISSP–BAS (since 1991) and a Full Member of the Bulgarian Academy of Sciences (since 2003).

His scientific career includes Professor, ISSP–BAS (since 1990); Associate Professor, ISSP–BAS (1984–90); Scientific Secretary of Sofia Liquid Crystal Group (1974–89); Assistant Professor, ISSP–BAS (1974–84).

His professional career in international terms includes guest professor positions and research grant activities in a number of scientific organizations: JSPS Fellowship, Japan (2002); NATO Expert Visitor, University of Buffalo (2001); Bulgarian Principal Investigator, NATO Linkage Grant with Nottingham University (1999–2001); Bulgarian Principal Investigator, Royal Society Collaborative Grant with Nottingham University (1996–1997); Bulgarian Principal Investigator, NATO Collaborative Research Grant with Sheffield Hallam University (1994–1996), etc.

The list of Mr. Petrov's publications includes over 130 refereed original papers on liquid crystal physics, membrane biophysics and biomolecular electronics in international journals and conference proceedings. Besides, he has Invited reviews in BBA-Biomembranes (2002); in EMIS Datareviews Series (2001); in European Biophysics Journal (1994) and in Mendeleev Journal of All-Union Chemical Society (1983) as well as a monographic review in Progress of Surface Science (1984), and a Monograph „The Lyotropic State of Matter: Molecular Physics and Living Matter Physics", Gordon & Breach Publishers, NY–L (1999).

The overall number of citations of his research results and scientific publications is over 900.

Corr. Mem. Prof. SOLOMON SALTIEL, DSc. – member of the National Science Fund

Solomon Saltiel is one of the internationally recognized Bulgarian physicists known with his achievements in the field of nonlinear optics. He was born in 1947 in Sofia. In 1973 he graduates from Moscow State University, where three years later he obtains a doctor's degree after successful PhD study in the group of one of the establishers of nonlinear optics Prof. S. A. Akhmanov. Since 1977. Solomon Saltiel works for Sofia University where he is a full-time professor now. In 2004 he is elected a corresponding member of the Bulgarian Academy of Sciences. S. Saltiel had several specializing visits (to University of California, Irvine; Laboratoire de Physique de Lasers, University of Paris-13; Nonlinear Physics Group, Australian National University).

Corresponding member Solomon Saltiel is the author and coauthor of more than 100 scientific papers. Most of them are published in prestigious scientific journals. He is a coauthor of 8 patents (5 in Bulgaria, 2 in Russia and 1 in France). His textbook *"Laser technique"* (coauthored with M. Nenchev) is the only textbook in Bulgarian on this subject. It has been used for more than 10 years in several universities as a main source for studying quantum electronics and laser technique. S. Saltiel and L. B. Meisner are authors of chapter 41 of the Russian edition of –Handbook of Lasers" edited by Nobel Prize holder A. M. Prohorov. S.Saltiel together with A. Sukhorukov and Yu. Kivshar are the authors of chapter 1 of vol. 47 of –Progress in Optics" published in August 2005. S. Saltiel is a coauthor of more than 15 invited talks at international conferences.

The most important achievements of S. Saltiel are in the direction of high order harmonic generation and prediction of new types cascaded nonlinear optical processes. The first experiments for the 4^{th} and 5^{th} harmonics generation in crystals are reported in his publications in 1974-1975 [1,2,3]. The Nobel Prize winner N. Bloembergen in his Nobel lecture discussed these two pioneer experiments. These experiments stimulated scientific competition among many scientific groups in the world. The competition continues even today. Harmonics with 150-200 order are obtained by means of contemporary femtosecond pentawatt lasers. During these early years S. Saltiel and coauthors prove that a higher order harmonics generation is inevitably accompanied by cascade nonlinear optical processes. They prove experimentally that high order harmonic generation processes are due to not only to direct processes based on high order nonlinearities, but also to multistep processes based on lower order nonlinearities. This is the beginning of the development of cascaded nonlinear optics.

Later in 1995-2003 S. Saltiel makes new important contributions to cascaded nonlinear optics. He investigates the possibility of manipulation of polarized light with cascaded nonlinear optics [4]. Nonlinear cascaded processes in special conditions can act as a nonlinear (intensity dependent) wave plate. The examples of application of this effect are mode-locking, pulse compression, pulse cleaning. Another contribution to cascaded nonlinear optics made by S. Saltiel and coauthors is the discovery of another method for producing high order nonlinear phase shift [5], that is based on cascading of several phase matched cascaded processes. It can yield higher nonlinear phase shift than the one based on direct nonlinear optical processes. The effect works in both centrosymmetric [5] and noncentrosymmetric media [6]. This new method for generation of nonlinear phase shift makes strong impact on the investigation of propagation of solitary waves. An essential indication of international impact of the works of S. Saltiel is the invited review paper that was just published: *S. Saltiel, A. Sukhorukov, and Y. Kivshar*, –Multistep parametric processes in nonlinear optics", [at http://arxiv.org/abs/nlin.PS/0311013]

Another area of nonlinear optics, where Prof. *S. Saltiel works successfully, is measurement of cubic nonlinear susceptibilities.* Constructed by S. Saltiel nonlinear interferometer [7] based on phase conjugation mirrors in 1989 was practically the first measuring device that is able to measure simultaneously the magnitude and phase of cubic nonlinear susceptibilities. In other words, the third order susceptibility is totally characterized by determining both real and imaginary parts. The interferometer is reproduced in several leading scientific institutions (in USA, Belgium and Israel) and is described in the chapter –Interferometry" in "The Optics Encyclopedia" and in the book –Optical Interferometry" – Academic Press, 2003.

One of the most cited works of Prof. S. Saltiel are those connected with the investigation of the process of photo darkening of semiconductor doped glasses. The interest to these materials is connected with the search of nonlinear materials with fast cubic nonlinearities. Unfortunately the effect of photo darkening was an accompanying effect that had to be investigated in order to find out the applicability of these media. S. Saltiel and coauthors not only make detailed experiments, but also provide a model that explains the photo darkening effect.

One of the most recent research interests of Prof. S. Saltiel is connected with the effect of generation of cross-polarized wave in cubic crystals. In recent experiments S.Saltiel's nonlinear optics group in collaboration with the group of prof. Etchepare (ENSTA, France) prove that cross-polarized wave with efficiency 10-20 % can be generated in crystal BaF2. This effect was used to –clean" femtosecond pulses, which is extremely important for the application of femtosecond pulses in high intensity light –matter interactions. The –femtosecond cleaner" was patented in France.

The works of Prof. S. Saltiel have more than 600 citations. Some of them are in books and invited review papers. He is a reviewer of Optics Communications, Optics Letters, Journal of Optical Society of America, and Optics Express. S. Saltiel is a member of the editorial board of Bulgarian Journal of Physics and member of the Executive committee of Bulgarian Science Fund.

S. Saltiel works constantly in the education field. He was supervisor of 6 post-graduate students that defended their doctoral theses successfully. Other three students are currently working on their dissertations under S. Saltiel's supervision. Since 1982 S. Saltiel reads the course –Laser technique". It means he had more than 200 students. All students attending his course –Laser technique" attend also student exercise lab where they perform 10 experimental problems. Since 2003 S. Saltiel offers a new course –Photonic structures" specially prepared for Master degree education in the Faculty of Physics of Sofia University. Prof. S. Saltiel was invited twice to read lectures: in 2002 in University of St. Andrews, Scotland and in Tel Aviv University in May 2005.

What is characteristic for Prof. S. Saltiel is his active and very productive collaboration with many groups from all over the world. It is seen from the list of coauthors of his publications [8] he is working in collaboration with:

a) Laboratoire de Physique de Lasers, University Paris-13 – in the field of laser spectroscopy with subwavelength thick cells.

b) Nonlinear Physics Group, Australian National University – in the field of generation of solitary waves with cascaded processes and harmonic generation in two dimensional photonic crystals

c) ENSTA/Laboratoire Optique Applicee – Ecole Politechnique, France – in the field of cross-polarized wave generation in cubic crystals and possibility for contrast enhancement of femtosecond pulses;

d) School of Physics and Astronomy, University of St. Andrews, U.K. – in the field of efficient second harmonic generation in the blue and UV region

e) Department of Physics, University of Wisconsin – Milwaukee – in the field of third harmonic generation in nanoparticles.

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Assoc. Prof. TANIA IVANOVA, PhD – Space Researcher

Dr. Tania Ivanova is one of the pioneers of the space research in Bulgaria, qualified engineer and scientist, participating in the development of experimental methods, systems and scientific equipment for space investigations onboard rockets, satellites and space stations. The contributions of more than 35-year activity of Dr. Ivanova are mainly in two fields of science – Space Physics and Space Biotechnology.

Space Physics

Dr. Ivanova was involved in the first Scientific Group of Space Physics, created at the Presidium of the Bulgarian Academy of Sciences (BAS) by acad. Kiril Serafimov in 1969. Space research in Bulgaria started with exploration of the ionosphere – an important area of space on which life on the Earth depends. Bulgarian science created a powerful school in the direct measurements of ionosphere plasma parameters by instruments mounted onboard space satellites and rockets and obtained world popularity in this field. Dr. Ivanova was one of the engineers who developed the first Bulgarian space equipment, P1 device, for space plasma parameters measurement (ion and electron temperatures and density). After P1 successful launch and work onboard the Intercosmos-8 satellite, Bulgaria became the 18th Space Country in the world in 1972 (according to the UN convention accepted in 1968).

Later Dr. Ivanova participated in different scientific teams for design, production, testing, launching and data processing of 12 space probe instruments for direct measurement of the ionosphere plasma structural parameters by means of Spherical Ions Traps (SIT) and Lengmuir Probe (LP). These scientific instruments flied onboard different spacecrafts: satellites Intercosmos-12,14,19 and geophysical rockets Vertical-3,4,6,7,10 on the Intercosmos Program. The contribution of Dr. Ivanova was in the improvement of these instruments by using specialized electron elements, ingenious technical solutions increasing the measurement accuracy and making them more informative.

Dr. Ivanova participated in the development of the space program and equipment for the flight of the first Bulgarian cosmonaut Georgi Ivanov carried out onboard the SOYUZ-33 spacecraft in 1979. After this historical flight Bulgaria ranked sixth in the world as a space country with its own cosmonaut.

Dr. Ivanova was the head of a research group for the development of the Plasma Complex Equipment P6-SIT, P7-LP, launched onboard the Intercosmos-Bulgaria-1300 satellite on a program, created on the occasion of the 1300th anniversary from the establishment of the Bulgarian state in 1981. The objective of this scientific program was to study the ionosphere-magnetosphere interaction and to carry out remote sensing of the Earth from Space using two satellites equipped with Bulgarian scientific equipment.

After her participation in these significant scientific and technical developments which allowed obtaining our own scientific data and Bulgarian contribution to the space exploration Dr. Ivanova became PhD in Physics with thesis entitled „Direct Probe Measurement of the Space Plasma Parameters" and later – Associated Professor on „Near Earth Space Physics" at the Central Laboratory for Space Research – BAS.

Space Biotechnology

Dr. Ivanova is Principal Investigator of the SVET Space Greenhouse project – the first and the only in the world automated plant growth facility for conducting long-term experiments onboard the MIR Orbital Station (OS) in the period 1990–2000.

Dr. Ivanova started working in the field of space biotechnology on a Joint research project with the Institute of Biomedical Problems, Moscow, within the framework of Intercosmos Program in 1984. The main objective of this project was to develop an automated greenhouse system for higher plant growth that provides precise measurements and adequate environmental control in order to achieve optimal plant environment and to develop biotechnology for plant growth under microgravity.

A new department „Space Biotechnology" was founded in 1987 at the Space Research Institute – BAS under the direction of Dr. Ivanova. She was the head of a team assigned a task to develop and produce the first in the world at that time automated plant growth facility – the SVET Space Greenhouse (SG). The Bulgarian side provided financial support of the R&D work and the Russian side – the acceptance testing, equipment launch, crew training and all activities on leading the space experiments from the Earth.

The Bulgarian SVET SG was launched onboard the Crystal module docked to the MIR OS on June 10, 1990. The same year the first successful two-mount vegetable plant experiments were carried out in order to provide a vitamin addition to the food of the space crew.

Dr. Ivanova was the head of the scientific team created the second modification SVET-2 SG on the MIR-NASA Program. Several long-term experiments with different plant species were carried out by international crews in the period 1995–2000. The objective of the experiments – to grow plants through a full life cycle and to achieve plant reproduction under microgravity – was reached. The effectiveness and reliability of the technical and biotechnological methods and means used in the Bulgarian developed SVET SG were proved. The contribution of Dr. Ivanova to the establishment of the new scientific trend „Space Horticulture" is considerable. It was proved that there were no „stoppers" for normal plant development under weightlessness and that plants grown onboard can be used for providing crews with food and for air purification in the future manned missions.

The SVET Space Greenhouse project has been discussed in the international scientific community as one of the most prestigious carried out onboard the MIR OS. The space experiments conducted using this facility and the unique results in the Fundamental Gravitational Biology field are described and discussed by Dr. Ivanova in her book "A Greenhouse Above the Sky", published in 2002.

Nowadays Dr. Ivanova is the head of a scientific team developing a new generation SVET-3 Space Greenhouse for future use on European international programs. The current work is supported by the National Science Fund of the Ministry of Education and Science for 2003.

Dr. Ivanova has more than 160 publications, predominantly papers, reported at space congresses and conferences. She was a representative of Bulgaria in the AEROSPACE Program Committee at the EC. Dr. Ivanova is a Member of the Executive Council of the Bulgarian Academy of Sciences, a Member of the Expert Scientific Council on Geophysics at the High Attestation Commission, a Member of the New York Academy of Sciences, etc.

For her exceptional achievements and personal contribution to the space research in Bulgaria Dr. T. Ivanova has received 12 awards from the Bulgarian and Russian Governments as: Medal for Scientific Achievements „Cyril and Methodius" – 1st degree (1984) and Medal of Honor of the Bulgarian President Georgy Parvanov (2004).

SVETLIN NAKOV – the second winner of the Award „John Atanassoff"

Mr. Svetlin Ivanov Nakov was born in 1980 in the town of Veliko Tarnovo, where he finishes secondary education at the High-School of Mathematics and Natural Sciences. In 2003 he graduates as a B.S. in Computer Science from the Faculty of Mathematics and Informatics at the University of Sofia „St. Kliment Ohridski", Sofia, Bulgaria.

In 2004 Svetlin Nakov wins the Award of the Bulgarian President „John Atanassoff" for Contribution to the Development of Information and Computer Technologies and Information Society. In 2003 he is awarded with the National Scholarship „John Atanassoff" for Computer Science Research of the Evrika Foundation. Mr. Nakov has a respectable number of medals and prizes from national and international contests, Olympiads in informatics and programming.

At present Svetlin Nakov is a director of the National Academy for Software Development, since March 2004 he is a chairman of the Bulgarian Association of Software Developers, and since October 2000 - a Part-time Computer Science Lecturer at the University of Sofia „St. Kliment Ohridski".

Svetlin has a solid professional experience as a software developer, master and senior software engineer as well as IT and linguistics consultant and lecturer.

His computer science and software engineering skills include object-oriented programming and modeling; Internet technologies and Web-programming; distributed systems and multi-tier architectures; high-quality programming code construction; relational databases and database design; network security, PKI and cryptography; multithreading and synchronization as well as data structures and algorithms.

The programming languages used by Mr. Svetlin Nakov are Java, C#, C, C++, SQL, Delphi, Pascal, PHP, JavaScript, Lisp, Prolog, Basic, Logo

His expertise in software technologies includes Microsoft .NET Framework and related technologies – C#, Windows Forms, ASP.NET, ADO.NET, XML Web-services, Remoting, Sockets, Multithreading, Regular expressions; Java, J2EE and related technologies – JDK, JDBC, Java Beans, Servlets, JSP, RMI, EJB, JNDI, AWT/Swing, Sockets, Multithreading, Applets, JNI; Tomcat, JBoss, OC4J, WebLogic; Struts; Ant; Database access – Oracle, MS SQL Server, MS Access, MySQL; SQL, PL/SQL, ODBC, JDBC, ADO, ADO.NET, Stored procedures, Transaction; Web programming – CGI, Servlets, JSP, Struts framework, PHP, XOOPS CMS, ASP.NET; Web design and client-side scripting – HTML, DHTML, CSS, JavaScript; Mobile development – WAP, WML, WMLScript ; Internet protocols – TCP/IP, HTTP, HTTPS, SMTP, POP3, FTP; Socket programming – Winsock, Java sockets, .NET sockets; Windows programming – Win32 API, COM, ActiveX, ODBC, ADO; XML programming – DOM, SAX, DTD, XSchema, XPath, XSL/XSLT; PKI, Digital certificates and signatures – Java Cryptography Architecture, JCE, etc.

In 2004 Faber Publishing, Veliko Tarnovo publishes his book „Internet Programming with Java". Up to now Mr. Nakov has a serious number of publications in the fields of his professional interests as an author or co-author. Some of his symposium and seminar reports are „FineArtsDict – Software for Creating and Maintaining Bilingual Computer Explanatory Dictionaries"; „ArtsSemNet: From Bilingual Dictionary to Bilingual Semantic Network"; „ArtsSemNet: A Bilingual Semantic Network for Bulgarian and Russian Fine Arts Terminology"; „Technique of Semantics for Automatic Hyponym Chains Extraction from Terminological Dictionaries" and „Information Technologies Helping the Linguist-Explorer".

Mr. Nakov has published a number of articles in electronic and printed magazines in the field of Java Servlets, Web-applications, and Web Programming with Java Server Pages. He has a series of 5 articles about Digital Documents Signing in Java-based Web Applications, as well as a series of 8 articles about Internet Programming with Java.

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AWARDS

Bulgarian Mathematical Olympic team won six medals at the 46th International Olympiad in Mexico (IMO – July 2005). Each of the six high school students, members of our national team, won a medal. **Golden prizes** were awarded to **Rosen Kralev** (with maximum points – 42) and **Alexander Lishkov** from Sofia High School of Mathematics (SHSM). **Tzvetelina Tzeneva** and **Ivan Dimitrov** from SHSM and **Veselin Dimitrov** from National High School of Natural Sciences and Mathematics won **silver medals** and bronze medal was awarded to **Dimitar Simeonov** from Plovdiv High School of Mathematics.

Leaders of the Bulgarian national team are Emil Kolev and Nikolai Nikolov from the Institute of Mathematics and Informatics at the Bulgarian Academy of Sciences (BAS)

Our national team on biology won one gold medal and two bronze medals at the XVI International Biology Olympiad for high school students in Beijing (IBO – July 2005). Kaloyan Tzanov from the National High School of Natural Sciences and Mathematics brought home gold medal; his schoolmate **Sergei Aleksandrov** and **Yordan Radev** from High School of Mathematics in Yambol were awarded bronze medals.

Bulgarian student participants brought distinctions from the Balkan Olympiad on Chemistry in Bucurest (June 2005). Svetoslav Anachkov from High School of Natural Sciences and Mathematics (HSNSM) in Kyustendil and **Boris Chichanov** from HSNSM in Sofia won gold medals; **Nikolai Vaklev** from NHSNSM in Sofia and **Ivan Ivanov** from HSNSM in Kyustendil received silver medals.

Bulgaria won the team and individual titles at the **Third International Olympiad in Linguistics** in Leiden, Netherlands. The last-year winner in the individual round **Ivan Dobrev**, a high school student from Rousse, ranked first with 95 points from possible 100. He also got special award for best-solved problem. **Tzvetomila Mihailova** and **Ivailo Grozdev** from Varna took the third place. 13 teams from 9 countries took part in the competition.

At the 18th International Young Physicists' Tournament (July 14-21, 2005, Winterthur, Switzerland) in the World Year of Physics and in the country where A. Einstein worked, the Physics team of the American College successfully represented Bulgaria. 25 teams from 23 countries from all over the world – Europe, North and South America, Asia, Africa and Australia – took part in it. The tournament is a tradition of many years, and its high level is universally acknowledges. The team of the American College in Sofia for the third year in succession won the right to represent Bulgaria and perfectly coped with the task, winning the third prize. The team included Yavor Kostov, Miloslava Evtimova, Kalin Dimitrov, Velin Dzhidzhev and Yordan Ivanchev, and the coaches were Krasimira Chakarova and Vanya Angelova.

On April 27, 2005 Bulgarian Academy of Sciences /BAS/ got the grand prize of the Bulgarian Industrial Association /BIA/– „Ikarus" statuette. It was granted for the series of research products with direct application in nuclear power engineering, lasers, methods of casting constructive details, etc., adopted in Bulgarian and foreign companies. Prof. Naum Yakimov, chief research secretary of BAS, accepted the award.

The following teams working at different institutes of BAS were awarded Jubilee diplomas and Silver Badges of Honour of BIA:

A team of 5 scientists headed by acad. N. Sabotinov from the Institute of Solid State Physics (ISSP) – for development, patenting and implementation of a copper bromide vapour laser, the article being sold in 11 most developed countries in the world with realization of over 2,5 million US dollars up to now;

A team of 7 scientists headed by acad. Yanko Arsov from the Institute of Metal Science – for the developed new technologies for shaped mouldings from heat-resistant steel and aluminium alloys, implemented in Bulgaria and abroad;

A team of 12 scientists headed by Corresponding member, doctor of technical sciences St. Vodenicharov from the Institute of Metal Sciences – for developing a program for monitoring of degradation and embrittlement of the vessels of the 5th and 6th units of NPP "Kozlodui" with financial effect of US$ 734 000;

A team of 3 scientists headed by senior research associate Dr. A. Yanev from the Institute of Electronics – for the developed and implemented super high frequency amplifiers admitted for use in the Ministry of Defence;

A team consisting of prof. Dr. Ivan Daskalov and senior research associate Nikolay Mudrov from the Centre of Biomedical Engineering – for development of microprocessor non-invasive devices for non-stop control of breathing activity, used in production of medical devices.

The awards were bestowed at a special ceremony on the occasion of the 25th anniversary of the establishment of the Bulgarian Industrial Association.

Prize winners from National Competition „Young Talents 2005" of „National Science Fund" at the Ministry of Education and Science National Competition

PROJECT, PRIZE	**SENDER**- name, surnames	**SCHOOL** – address

Participation in the European Competition of Young Talents 2005 – Moscow, Russia

First place NATURAL SCIENCES MT -2 Mechanics of Overshootin	Sonya Atanasova Hadzhieva	SHSM – Sofia High School of Mathematics „P. Hilendarski" Sofia, 61, Iskar Str.
Second place NATURAL SCIENCES MT -6 Fuel Element Based on Processes in Living Organisms	Hristo Nikolaev Kolev, Denis Mario Mitev	HSNSM – High School of Natural Sciences and Mathematics „Acad. Iv. Gyuzelev" Gabrovo-5300, 2, Elin Pelin Str. HSNSM - Blagoevgrad
Third place NATURAL SCIENCES MT -11 RZ CAS Star. Hypothesis of the third satellite	Petar Georgiev Todorov	IV Language High School „F. J. Curie"- Varna -9010, „Pochivka" Str.

Participation in Regional Competition of Young Talents 2005 - Sofia

INFORMATION TECHNOLOGIES MT -1 MATHGRAPH – mathematical laboratory	Aleksandar Petkov Goranov	HSNSM „Yane Sandanski" Gotze Delchev, 4, Skopie Str.
NATURAL SCIENCES MT -5 Simulations in Physics. Virtual Aid for Teaching Physics in IX-X grades	Bozhidar Ivaylov Stefanov	Secondary School „Ivan Vazov" Pleven –5800, 46, Ivan Vazov Str.

NATURAL SCIENCES МТ -9 Number Systems	Milena Stefanova Georgieva, Aleksandar Kirilov Daskalov	SHSM „P. Hilendarski" Sofia, 61, Iskar Str.

Participation in International Science School July 6-23, 2005 Serbia, Petnitza

NATURAL SCIENCES МТ -3 Evaluation and Measuring of GSM Radiation Everyone Can Do Oneself	Snezhana Tasheva Tasheva	SHSM „P. Hilendarski" Sofia, 61, Iskar Str.
NATURAL SCIENCES AND INFORMATION TECHNOLOGIES МТ -13 Is King's Crown Gold?	Vladimir Andreev Andreev	HSNSM „Exarch Antim I" Vidin – 3700, „Exarch Yosif" Str. VII primary school Vidin
	Boyan Plamen Ivanov,	VII primary school Vidin
	Valentin Lyubchov Zhivin,	VII primary school Vidin
	Lyubomir Nikolov Vanyov	
NATURAL SCIENCES МТ -14 Investigation of the Solar System with Digital Devices	Hristo Stoev Stoev	Varna Marine High School „Sv. N. Chudotvoretz" Varna – 9000, „Narodni buditeli" Blvd

Participation in Summer School in Astronomy Rozhen

NATURAL SCIENCES МТ -10 Developing a Model of a Martian Base	Yavor Deyanov Dimitrov Neda Simeonova Barzinska Daniel Milenov Minchev Valeri Sashkov Vasilev	Vocational High School of Building, Architecture and Geodesy „V. Levski" Varna, 189 Slivnitza Str.

Encouraging Awards:

MATHEMATICS МТ-4 Inequalities for R, (R) and P and Their Applications	Sonya Atanasova Hadzhieva	SHSM „P. Hilendarski" Sofia, 61 Iskar Str.
NATURAL SCIENCES МТ -8 Ozone in the Atmosphere and Its Protection	Iva Neycheva Angelova Ana Ivanova Koleva Krasen Detelinov Dimitrov	Secondary School „V. Levski" Sevlievo – 5400, „Gladstoun" Str. Vocational High School of
INFORMATION AND COMMUNICATION TECHNOLOGIES МТ -12The Future of Architecture in Varna, Oldenburg (Germany), Pleben (France) – Meeting of Their Past as the Present	Nikolay Nikolaev Kolev Kristina Gospodinova Sheytanova Nikoleta Petrova Pavlova Dian Andonov Radev	Building, Architecture and Geodesy „V. Levski" Varna, 189 Slivnitza Str.

RECENT PUBLICATIONS OF BULGARIAN SCIENTISTS

ARTICLES

Title: **Characterization of Lactobacillus Helveticus Strains Isolated from Bulgarian Yoghurt, Cheese, Plants and Human Faecal Samples by Sodium Dodecilsulfate Polyacrylamide Gel Electrophoresis of Cell-wall Proteins, Ribotyping and Pulsed Field Gel ...**

Authors: Dimitrov, Zhechko jechkoelby@yahoo.com, Michaylova, Michaela 1) Mincova, Svetlana 1)

Source: International Dairy Journal; Vol. 15, 10 (Oct. 2005), 998-1005

Author Affiliations: 1) LB-Bulgaricum Plc., ELBY Research Development and Production Center, 12-A Malashevska str., Sofia 1202, Bulgaria

Title: **SU(3)-Instantons and G₂, Spin(7)-Heterotic String Solitons.**

Authors: Ivanov, Petar 1) fn10854@fmi.uni-sofia.bgIvanov, Ivanov Stefan 1) ivanovsp@fmi.uni-sofia.bg

Source: Communications in Mathematical Physics; Vol. 259, 1 (Oct. 2005), 79-102

Author Affiliations: 1) Faculty of Mathematics and Informatics, University of Sofia "St. Kl. Ohridski", 5, James Bouchier Blvd, 1164 Sofia, Bulgaria

Title: **Energy Barrier for Protein Adhesion and Crystal Nucleation on Flat Alien Substrates.**

Authors: Tsekova, Daniela S.1) dtsekova@phys.uni-sofia.bg, Savov, Varban 1)

Source: Protein & Peptide Letters; Vol. 12, 6 (Dec 2005), 541-546

Author Affiliations: 1) Faculty of Physics, Sofia University St. "Kliment Ohridski", 5, James Bouchier Blvd., 1164 Sofia, Bulgaria.

Title: **Biodegradation of Monochloroacetic Acid Used as a Sole Carbon and Energy Source by Xanthobacter Autotrophicus GJ10 Strain in Batch and Continuous Culture.**

Authors: Torz M; Beschkov V.

Source:

Author Affiliations: Bulgarian Academy of Sciences, Institute of Chemical Engineering, Acad. G. Bonchev Str., Bl. 103, 1113 Sofia, Bulgaria.

Biodegradation. [Biodegradation]; Vol. 16, 5 (Oct. 2005), 423-433.

Title: **Local Well-Posedness and Orbital Stability of Solitary Wave Solutions for the Generalized Camassa-Holm Equation.**

Authors: Hakkaev, Sevdzhan 1) shakkaev@fmi.shu-bg.net, Kirchev, Kiril 2)

Source: Communications in Partial Differential Equations; Vol. 30, 5/6, (Sep. 2005), 761-781

Author Affiliations: 1) Faculty of Mathematics and Informatics, Shumen University, Shumen, Bulgaria2) Institute of Mathematics and Informatics, Bulgarian Academy of Sciences, Sofia, Bulgaria

Title: **Instability Zones of a Periodic 1D Dirac Operator and Smoothness of its Potential.**

Authors: Djakov, Plamen 1) djakov@fmi.uni-sofia.bg, Mityagin, Boris 2) mityagin.1@osu.edu

Source: Communications in Mathematical Physics, Vol. 259, 1, (Oct. 2005), 139-183

Author Affiliations: 1) Department of Mathematics, Sofia University, 1164 Sofia Bulgaria2) Department of Mathematics, The Ohio State University, 231 West 18th Ave., Columbus 43210 USA

Title: **Experimental and Modelling Investigation of Learning a Fast Elbow Flexion in the Horizontal Plane.**

Authors: Raikova RT; Gabriel DA; Aladjov HTs

Source: Journal of Biomechanics. [J Biomech]; Vol. 38, 10, (Oct. 2005), 2070-2077.

Author Affiliations: Centre of Biomedical Engineering, Bulgarian Academy of Sciences, Academician G. Bonchev Street, Bl.105, 1113 Sofia, Bulgaria.

Title: **Reorganization of Lipid Nanocapsules at Air-water Interface Part 2. Properties of the Formed Surface Film.**

Authors: Minkov I; Ivanova T; Panaiotov I; Proust J; Saulnier P

Source: Colloids and Surfaces. Colloids Surf B Biointerfaces; Vol. 44, 4, (Sep. 2005), 197-203.

Author Affiliations: University of Sofia, Laboratory of Biophysical Chemistry, 1, James Bouchier Blvd., 1126 Sofia, Bulgaria.

E V E N T S

October 5-9, 2005
East-European Symposium
CENTRAL AND PERIPHERAL SYNAPTIC TRANSMISSION
Sozopol, Bulgaria
Address:
Institute of Physiology,
Bulgarian Academy of Sciences
1113 Sofia, Bulgaria
Tel: +359-2-979-2151
Fax: +359-2-71-91-09
www.bio.bas.bg/~ees cpst/

October 7-11, 2005
Forth International Conference
CULTURE, RELIGIONS AND TRADITIONS OF THE PEOPLES
Blagoevgrad, Bulgaria
South-West University „Neofit Rilski"
Address:
P.O Box 29, 1303 Sofia
International Academy „Homo Perfectus Integralis"
Phone: (+359 73) 885 516
E- mails: iahpi conference@mail.bg
dkd@aix.swu.bg

October 13-14, 2005
Scientific Conference with International Participation
FOOD SCIENCE, ENGINEERING AND TECHNOLOGIES 2005
University of Food Technologies, Plovdiv
Address:
University of Food Technologies- Plovdiv
26, Maritza Blvd.,
4002 Plovdiv, Bulgaria
e-mail: vihvp@hiffi-plovdiv.acad.bg
rector@hiffi-plovdiv.acad.bg

October 19-20, 2005
Jubilee Scientific Conference with International Participation
STATE-OF-THE-ART AND PROBLEMS
OF AGRICULTURAL SCIENCE AND EDUCATION
60th anniversary of Agricultural University - Plovdiv
Address:
Agricultural University- Plovdiv
12, Mendeleev Str.,
4000 Plovdiv
www.au-plovdiv.bg

October 27-29, 2005
7th WSEAS International Conference on
MATHEMATICAL METHODS and COMPUTATIONAL TECHNIQUES IN ELECTRICAL ENGINEERING (MMACTEE '05)
Sofia, Bulgaria
Address:
Technical University of Sofia, Institute of Mathematics and Informatics,
Bulgarian Academy of Sciences,
info@wseas.org

October 28-29, 2005
Scientific Conference
THE WORLD ECONOMY IN GLOBALIZATION

on the occasion of the 15th anniversary of the Specialty of
International Economic Relations
in Varna University of Economics
Address:
Varna University of Economics,
Department of International Economic Relations,
room H-108
77, Knyaz Boris I Blvd.
9002 Varna, Bulgaria
Phones: +359- 52- 660-434, 660-221
e-mail: mio2005@ue-varna.bg

November 3-4, 2005
International Symposium
„MODERN TECHNOLOGIES, EDUCATION AND PROFESSIONAL
PRACTICE IN GEODESY AND RELATED FIELDS"
Address:
House of Science and Techniques
108, Rakovski Str., 1000 Sofia
e-mail: milev@bas.bg
Tel: +3592 987 58 52; 003592 870 04 06
Fax: 003592 9879 360
http://www.gis-sofia.bg/sgzb/index.html

November 10-11, 2005
XV International Conference
TRANSPORT 2005
Todor Kableshkov School of Transport, Sofia
Address:
Todor Kableshkov Higher School of Transport
158, Geo Milev Str.,
1574 Sofia
Phones: (+359 02) 9709 335
(+359 02) 9709 384
E- mail: conference@vtu.bg
http://www.vtu.bg/conference/

November 10-12, 2005
Anniversary Conference
60 years UNIVERSITY OF ROUSSE „ANGEL KANCHEV"
Address:
University of Rousse „Angel Kanchev"
8, Studentska str.,
7017 Rousse, Bulgaria
Phones: +359 82 888 441; +359 82 888 766;
+359 82 888 248; +35982 888 379
E- mails: vivanov@ru.acad.bg
gspopov@ru.acad.bg
gag@ru.acad.bg

November 17-19, 2005
International Scientific Conference
ECONOMICS OF FREE TIME
Blagoevgrad, Bulgaria
Address:
International Scientific Conference
Faculty of Economics,
South-West University „Neofit Rilski"
2, Krali Marko Str.,
2700 Blagoevgrad
Phone: +359 73 885 952
E-mail: economics_management@abv.bg