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 [III - USSR - 23 S & T]

PROBLEMS OF COMPUTERIZED MANAGEMENT SYSTEMS IN UZBEKISTAN

Tashkent PRAVDA VOSTOKA in Russian 19 Jun 76 p 2

[Text] The automation of management is a most acute problem at present. The rapid growth of the productive forces of this country has led to a sharp rise in the volume of scientific, engineering and economic data. Management personnel has swelled. In some sectors, it has increased to 10 and sometimes to 15 percent of the total number of workers.

This phenomenon became a brake on the development of the economy. The party and the government took the course of the automation of control. The Ninth Five-Year Plan period was a turning point in this respect. While 414 automated control systems were introduced in the country in the Eighth Five-Year Plan period, now there are about 2500 of them. About 70 various automated control systems were put in operation in the republic during the five-year plan period. Over 250 computers are now operating in the national economy of Uzbekistan and have a great economic effect.

The Tashkent Aviation Production Association imeni V. P. Chkalov was the first in the republic to incorporate the ASU [Automatic control system]. Now over ten various sytems and subsystems for controlling production are in operation here. Plane builders automated fully such labor intensive operations as accounting and the calculation of wages and saved about 1.5 million rubles. Tremendous benefits are produced by the ASU of production at the "Tashsel'mash" Plant, the Electronic Equipment Plant, the "Sredazkabel" and "Sredazelektroapparat" production associations, in the Sredneaziatskaya RR Administration, in ministries of geology, industrial construction materials, communications and health. The first stage of a large interindustrial automated system for plan calculations, the first in the country, was put in operation in the Uzbek SSR Gosplan, which solves 70 sets of problems. The Uzbek SSR Ministry of Power and Electrification placed in operation ahead of schedule the first industrial sector ASU in the power systems of the country. This system was awarded a gold medal at the Exhibition of Achievements of the National Economy. The introduction of the ASU made it possible for power workers to save over a million rubles per year.

The republic now has a powerful scientific-methodological center in the Institute of Cybernetics of the Academy of Sciences of the Uzbek SSR where about 2000 skilled specialists work.

The Institute of Cybernetics not only coordinates the work at individual enterprises, but also creates its affiliates in the oblasts so that territorial systems can be developed and incorporated locally. Interesting work in the area of social economic planning is being done in Tashkent, Samarkand and Angren.

In 1972, on the initiative of the Subject Commission, the Republic Council on Promoting Scientific-Engineering Progress at the CC CU Uzbekistan recommended the creation of scientific-production cooperation, the basic problem of which was the development and introduction of a republic ASU. Combining these creative forces produced good results. Scientific-production cooperation has already produced two stages of the republic ASU. The time for preparing the technical task and the draft of the plan was a year ahead of schedule.

But everything enumerated above is only the beginning. More complex problems are to be solved in theTenth Five-Year Plan period. At a recent meeting of the presidium of the Republic Council on Promoting Scientific Engineering Progress at the CC CPUzbekistan, reasons for delays in introducing the ASU in practice and what urgent problems are faced in this matter were discussed. In particular, the question was posed on raising the efficiency of the ASU and the efficient utilization of computers.

Facts show that thorough attention is still not being given everywhere to this matter. Thus, due to quarters for housing the computer not being prepared on time the computer stood idly for a long time at the Glavtashkentstroy, Uzglavlesprom, the ministries of meat and milk, food industry, procurement, the Namanaganskiy and Kashkadar'inskiy oblispolkoms, the Institute of Irrigation and Land Improvement of Agriculture, the "Uzgiprotyazhprom," the "Uzbeszoloto" Combine and the Chirchik Transformer Plant. The Ministry of Agriculture uses the computer on the average of 2 hours daily, while this indicator in the republic is 14.2 hours. Managers of some enterprises exhibit impermissible irresponsibility. A director of one sovkhoz in theBukharskaya Oblast ordered a computer, but did not bother with quarters for housing it, so that the computer was idle for about 2 years.

The caculations of the cost and efficiency of the ASU are not organized properly. According to the Glavtashkentstroy reports, the expenditures for the ASU were slightly over 114,000 rubles for 5 years, while actually over 3.8 million rubles were spent. The economic effect, as calculated by specialists, was over 2 million rubles, while according to statistical data it was only 100,000 rubles. Such facts are intolerable.

A trend toward solving local problems was shown which results in the loss of the main effect of introducing the ASU. Thus, the Ministry of Construction solves 38 problems by the automated method, but only 10 of them are on theministry level, while the remaining ones are on the trust level.

Or here is another example. The "Tashsel'mash" Plant has an automated system for production. A shop chief knows at any one time how many units and parts have been completed and how many more are needed. This is data needed by management. The system frees the working time of foremen, which was previously spent on daily planning. But how did this affect the production, especially its regularity, in the final account? Very little, because the material-equipment supply was not organized in a clear-cut manner.

It is also necessary to pay greater attention to the following problem. Some managers do not have the proper concept of the importance and the rôle of computers in production. It is not enough to just introduce computers in production; it is necessary first to organize their operation. Only then will the computer become a real help to the manager and will facilitate raising the productivity of management labor.

Other managers underestimate, in general, the importance of the control of automation. The ASU are being slowly introduced in ministries of agricultural construction; construction and operation of highways; and cotton cleaning industry.

Recommendations were made at the meeting of the presidium for eliminating the above-enumerated shortcomings and others. Special attention of ministries and department managers should be given to the systematic and comprehensive approaches to solving management problems.

To raise the efficiency of computers further, it is advisable to create collective use computer centers, since some organizations with computers cannot load them fully, while renting is hindered by departmental barriers. Collective use computer centers may service many enterprises and organizations on a contract basis.

To incorporate further a republic ASU, it is very important to develop a single method for processing and issuing data by all ministries, departments and enterprises.

The time is ripe for creating an ASU for technological processes, especially at enterprises of the cotton cleaning, chemical, metallugrical and food industries.

The republic has a fairly high number of computers; however, there are no centralized servicing facilities for computers and there is an acute shortage of spare parts. The time has come to create a large repair center in Tashkent.

The manufacture of nonstandard equipment and the preparation of testing facilities are not organized properly. Some ASU are incorporated in production without proper approval and finishing off which reflects on their operation.

Deviations from the operating rules for complicated equipment are allowed. The republic Gosbank and Stroybank offices and the Central Statistical Administration of the republic should strengthen their supervision of computer operations and bring order into it. There is also the problem of training ASU specialists. About 10,000 persons now work in this area, which is obviously not enough. There is a special scarcity of middle link specialists -- operators and programmers. Therefore, the presidium meeting recommended to the Government Committee on Technical Trade Education of the Uzbek SSR Council of Ministers that they organize technical trade schools for training operators and programmers, and to the Ministry of Higher and Secondary Special Education -- to expand cybernetic departments and, if possible, create an independent specialized institute. It is also necessary to think about retraining specialists.

The problems of developing a republic ASU in the Tenth Five-Year Plan period considered at the meeting of the presidium are of importance to the government. And each industrial manager must facilitate the solution of these problems in every possible way.

2291
CSO: 1870

GLUSHKOV DISCUSSES AUTOMATED CONTROL SYSTEMS

Moscow TRUD in Russian 15 Oct 76 p 2

/Interview with Academician V. M. Glushkov by Special Correspondent for TRUD V. Golovachev; date and place not given: "The ASU Should Be Profitable"/

/Text/ Man has been overwhelmed by an avalanche of information, and it is now clear that without automated control systems /ASU/ and without electronic computers /EVM/ further progress is impossible. The prominent Soviet scientist, Director of the Cybernetics Institute of the Ukrainian SSR Academy of Sciences Academician Viktor Mikhaylovich Glushkov discusses work to develop the ASU and the problems and difficulties encountered.

/Glushkov/ During the last five-year plan an especially large step was taken in the development of ASUs and their use in the economy. Many hundreds of automated control systems for technical processes and for whole enterprises began operation. A number of ministries initiated the first phases of industry-wide ASUs, and work was begun to develop territorial ASUs for cities, oblasts, and on the union republic scale. On the average, ASUs of differing levels will pay for themselves in 3.3 years. The economic impact from their utilization during the last five-year plan (resulting only from a reduction in personnel and the receipt of additional profits) amounted to billions of rubles.

/Question/ But surely there are ASUs that are inefficient and totally unprofitable?

/Answer/ I am convinced that there are no inefficient ASUs. If an ASU is uneconomical, this means that it is not an automated control system. It would appear that the EVM merely does the work of accountants or carries out some types of local computations, but this is not what we mean by the ASU. Of course, the use of expensive EVMs as large calculators not only is not advantageous, but also may be unprofitable. Unfortunately, there are many such instances. At times EVMs are introduced because they are "fashionable", without in-depth economic estimates or preparatory work. Given proper organization, the ASU should not so much automate calculations as raise the management system to a new, qualitatively higher level and perform basic production tasks.

/Question/ Still, it is not fully clear specifically how savings are obtained. Could you illustrate this with an example?

/Answer/ Different industries obtain different results by using ASUs. Let us take the petroleum industry as an example. The best methods of exploiting deposits are found with the help of an ASU. The ASU provides the most advantageous plan -- at what points to put the boreholes, where to pump in water, how to maintain pressure... As a result the coefficient of extraction of oil from the wells increases, and, then, the economic results are greater. They are easily computed by comparing two identical deposits, one which uses an ASU and one which doesn't.

At machine-building enterprises, which involve hundreds of interdependent contractors, the ASU helps to coordinate work, eliminate stoppages, and increase labor productivity.

The principal results in machine-building industries and in construction are obtained by solving synchronization problems. What does this mean? For example, a plant draws up its monthly plan. It is broken down by shops and sectors, specifying how many and which components each is to manufacture. However these plans are coordinated with an accuracy of within a month -- too large a unit of time. Therefore confusion frequently arises. You expect a component from a related shop, but at that moment it is working on another one. This results in stoppages and rush work. But when we introduce the ASU, we introduce planning by the shift, the hour, and even the minute. Scheduling by the minute is not a fantasy. It is now practiced, for example, by a number of L'vov enterprises. Of course, it is important not only to have a schedule, but also to monitor its implementation. Installed at each work place are special instruments that are connected to the computer center. When a stoppage occurs, the worker, by pressing a button, informs the computer center of the reason -- there is no component to process, or the appropriate tool is lacking, or a machine is out of order...

Thus we come to the concept of creating an information conveyor belt at the plant. It would connect all work places, would permit the turner or milling machine operator to calculate the plan by hours and minutes, and, most important, would provide him with everything he needs in the required amount of time. Initial experience has shown that the information assembly line increases labor productivity 1.5 to 2 times.

The information conveyor belt constitutes a fundamentally new concept. The uninterrupted technological process is preserved, but machines and equipment no longer form part of a single line. They are connected by information threads. The plan (based on the minute or the hour, depending on the type of production) takes into consideration the capabilities of each worker and the productivity of the machine. At the Kiev plant "Arsenal", this system made it possible to increase labor productivity by 1.6 times -- at the same areas and using the same equipment!

In addition to its economic impact, the ASU has results that cannot be measured in rubles. For example, we conducted an examination at a number of enterprises, and it turned out that more than 20 percent of the management's orders were not being carried out. With an ASU this is simply impossible.

/Question/ An important problem is the mechanization and automation of manual labor and labor-intensive operations. Millions of persons are engaged in them. On the scale of the national economy, this constitutes a bottleneck, which holds back the rate of growth of labor productivity. Does the introduction of the ASU influence the solution of this problem somehow?

/Answer/ Not somehow, but in the most direct possible manner. It is precisely here that the use of the ASU has the greatest impact. Specifically, many ASU plans provide for the mechanization of loading and unloading and auxiliary operations. For example, here is how work is organized at one of the machine-building plants. Under the shops, tunnels leading to mechanized warehouses have been driven. Along the rails moves a "mechanically guided" trolley. All components and materials are automatically delivered to the work place within the required time.

If automated machines with program control are provided and an ASU is employed, if the information conveyor belt is introduced, the result is an automated shop. There the worker has completely different functions -- the control functions. He becomes an operator-controller. The task of setting up fully automated output of this type has been assigned by the present five-year plan. A number of plants have already performed this task in certain shops with uniform and simple technology (electroplating shops, for example).

/Question/ In connection with this, we must not leave out the question of robots. Industrial robots are now appearing at plants and factories. Self-teaching machines with an artificial intellect are being developed... Could you tell us something about this?

/Answer/ Robots constitute one of the elements of the ASU. A great deal of work was performed in this area during the last five-year plan. Good scientific advance preparation made it possible to assign the concrete task of producing serial industrial robots during the present five-year plan. This is specifically mentioned in the "Basic Guidelines for the Development of the USSR Economy during 1976-1980". The robots that are being introduced today belong to the first generation. They are program-controlled general-purpose lifting and conveying machinery. They have neither vision nor hearing. The only thing they "know" is where a given component is and what operation they must perform with it -- lifting, moving, lowering.

In recent years we have been concerned with second generation robots -- with an artificial intellect, or with sensors.

What senses do robots have? Primarily sight and touch, and sometimes hearing. Although hearing is still too great a "luxury" for the robot, this kind of research exists. Individual units are being developed in the laboratory.

Thus, sight and touch. Sight consists of a television unit and a distance finder. The robot looks, and by processing the observed picture in his electronic "brain" he can make a determination as to what he is seeing. Let's say he can recognize a cube and a pyramid and other simple objects. Although, of course, it is still hard for him to recognize a telephone or a calendar.

An interesting detail: if, let's say, a robot cannot see well, he "understands" that he must pick up a lamp with his mechanical hand and illuminate the object from one side and then the other.

The robot's mechanical hand possesses the sense of touch. If the object is fragile and light, he will handle it carefully; if it is heavy, he will grasp it firmly and apply great force. These operations tax his electronic "brain". This will give you an idea of the difficulty of the task: half of the cells of the human brain are engaged in the recognition of visual images. That is, image recognition constitutes half of the human intellect, it would appear. Of course it is still too early to look upon the robot as a porter, but he already recognizes simple objects.

/Question/ Up to now we have been discussing achievements in the development and use of the ASU. However, it is known that not everything is going smoothly here. In your opinion, what problems must be solved to speed up progress in this area?

/Answer/ All ministries are now ordering ASUs. They are introduced first at one plant then at another, often without a prior overall plan that has been carefully thought out. Efforts are directed mainly toward the development of the so-called vertical systems: plant -- main administration -- ministry -- Gosplan. Extremely little attention is being paid to intersectorial ties, and it precisely there that we suffer the principal losses.

Let's say we have automated shipbuilding plants and have drawn up hourly plans and schedules. But the metallurgists supply them with metal on the basis of a semi-annual plan. It is obvious what the result will be!

This can be avoided if there is a nondepartmental state center which assumes the functions of general purchaser and is given the necessary powers. It should have comparatively powerful institutes. They will make careful calculations when drawing up detailed plans for the introduction of ASUs with an eye to their maximum effectiveness. And only after this has been done will the center issue the necessary orders for the development of a given ASU. Imagine what it would be like if the Ministry of Communications Equipment Industry existed but there were no Ministry of Communications (purchaser). Every city soviet would order its own telephone system and there would be no intercity telephone system. What is happening with ASUs is something analogous.

Now about the ministries that manufacture ASUs. They also manufacture their product in isolation, without concern for a uniform technical policy in this area. Engaged in the manufacture of ASUs are the Ministry of Instrument Making, the Ministry of the Radio Industry, and others. They do not "get together" with each other. Consequently, the manufacture of EVMs and ASUs should be put in "the same hands". This would yield great economic results.

/Question/ The state center of which you were talking, the sole purchaser, which works out the strategy for the development and introduction of ASUs, inevitably will interfere in the work of the industrial ministries. Conflicts will arise and the situation will become slippery...

/Answer/ That is a good question. For example, if an intersectorial ASU is set up to connect, specifically, a metallurgical plant with its purchasers, this would give the country gains of millions of rubles and the plant, possibly, losses. For example, the ASU says that it is essential to convert to a more economical shape. This means that it is necessary to stop the mill, change the rollers (this is very difficult), lose time, and decrease output... Of course, it is more convenient for the plant to keep turning out the exact same shape. Under these conditions it is difficult to force the ministry or plant to introduce an automated control system.

This means that somehow the economic levers must be changed and proposals for improving the management structure and the economic machinery must be worked out. The system should be rational: if it is good for the country, it should also be good for the plant and the ministry. Such proposals could be worked out by the state center of which we were talking. The powerful scientific research institutes (economic, legal, market conditions) with a suitable contingent of specialists with modern EVMs at their disposal would perform this work at a high level and could simulate different alternatives and conduct experiments. Proposals to improve management and the economic and administrative machinery would be reviewed, naturally, by competent organs according to an established procedure.

The same nondepartmental center could work out proposals for the standardization of economic documents. In the meanwhile there is no order here. Every enterprise and institution has its own type of documentation. This places serious obstacles in the path of introducing standardized ASUs.

No less important is the question of the technical base for the ASU. Unfortunately, we have a considerable lag in the development of peripheral equipment for the EVM itself. Manpower and resources are disproportionately allocated, and this also constitutes evidence of the absence of a single policy in this area.

As is obvious, there are many problems. Their solution is vitally necessary, for in many respects the rate of technical progress in the country and, in the end, the might of our native land depend on this.

8964
CSO: 1870

'EKRAN' SATELLITE IMPROVES TELEVISION RELAY

Moscow SOVETSKAYA ROSSIYA in Russian 6 Nov 76 p 2

[Article by B. Gerasimov]

[Text] Several days ago, 36,000 kilometers above the point where the 99th eastern meridian crosses the equator, the "Ekran" Soviet satellite established its new home. This is its constant port of call. The essence is in the geographic accuracy of the orbit's parameters. The period of rotation of the "Ekran" is 24 hours, i.e., the same as that of the earth around its axis.

The range of action of an earth television transmitting station is limited by the direct sight zone. No matter how high the antenna tower is built or the power of the transmitter is increased, the whole situation depends on the special features of the ultra shortwave propagation. It is extremely difficult to obtain good reception above 100 to 150 kilometers.

In the first stage of TV development, the range problem was resolved only by using expensive radio relay lines, building relay towers with complex equipment every several dozen kilometers.

"Such lines, however," explained V. A. Shamshin, deputy minister of the USSR Ministry of Communications, "are not economically expedient in many "blind" regions of Siberia, Central Asia and the Far East. Other, much more efficient communications principles were needed. From the very first space-flights, the question arose about the practical utilization of earth satellites for relaying TV programs. We recall our famous "Molniya" series which has been carrying on space service so well for about 10 years. These satellites were included in the single TV broadcasting system through the "Orbita" receiving stations.

The "Molniya" are brought out in high elliptical orbits with the apogee in the northern hemisphere. Because of this, the greater part of its orbit is over Soviet territory, and almost all regions of the country are in their zone of action. However, such a communications system requires fairly complicated ground equipment, since the "Molniya" moves continuously and reliable tracking systems are needed for receiving signals. These are special parabolic antennas with 12-meter diameter mirrors. Today, there are 70 such stations in the country. Each one of them has its own relay station that amplifies the signals received from the "Molniya" and delivers the TV program to nearby regions.

However, the duration of broadcasting by any "Molniya" satellite does not exceed 8 to 9 hours. The situation is not a matter of limited power resources, but of the special features of the orbit. The height of the satellite above the horizon is periodically reduced and then it disappears entirely beyond the boundaries of radio-visibility and flies above the southern hemisphere. To provide for continuous around-the-clock TV broadcasting, it is necessary to have at least two "Molniya" satellites. The satellites are brought out to about the same orbits, but with a certain time displacement. While one communications satellite "leaves" our territory, another one comes to replace it.

"It is very attractive," continued V. A. Shamshin, "to use stationary satellites in practice. This was the problem of developing the new "Ekran" satellite and its launching in the necessary orbit. The design of the satellite was solved in an original manner. Its power was increased several times compared to the "Molniya". The electric power plant abroad the satellite with its giant wings oriented continuously toward the sun became more powerful.

Now about the launching itself. To bring the satellite into the region of the equator from a space launcher in Baikonur is not a simple problem. Usually, the inclination of the orbit of the satellite is determined by the geographical latitude of the launching site. Therefore, Americans are in a much more favorable situation because their launching site is closer to the equator. This made it necessary for ballistic experts to go through a number of complicated dynamic maneuvers. First, the "Ekran" was brought out into a standard (reference) orbit, then an engine aboard the satellite was started and it changed over to a high elliptical path with a small inclination to the plane of the equator. A few more maneuvers after that and it moved to a circular orbit, "hanging" at a calculated point above the Indian Ocean. The satellite drift does not exceed half of a geographic degree.

The "Ekran" antenna is directed continuously toward the Soviet Union. The stationary position of the satellite makes it possible to simplify considerably the receiving stations of TV space transmission. Complex tracking antennas become unnecessary, and their sizes are reduced due to the high power of the space transmitter.

The "Ekran" satellite is now over the planet. First test transmissions were made from it on the eve of the Great October holiday. Communications by means of such a stationary satellite is a pledge of greater mass introduction of TV into our everyday life. This is especially true of remote regions where plants and factories, and petroleum and gas pipelines are still being built. Soon space TV will be available to the smallest settlements.

2291
CSO: 8144/0337

CAUSES OF CHANGES IN ARCTIC CLIMATE

Moscow VODNYY TRANSPORT in Russian 7 Sep 76 p 3

[Article by A. Mironov, special correspondent, Leningrad: "The Arctic Turns Its Face Toward the Sun"]

[Text] "There are contradictory opinions on how the climate is changing," A. Kash writes to the editors. "Some scientists assert that there is a global warming process taking place as the result of heating of the atmosphere. Others think that, on the contrary, universal cooling is beginning to occur on Earth because of the accumulation of dust in the atmosphere. However, those on both sides of the argument refer to the results of man's economic activities on our planet. . .

"I spent many years in the Arctic, on ships and in polar aviation. I am interested in what is happening in the high latitudes: is the climate there becoming milder or harsher?"

Other readers have asked the editors the same question. Their letters were the reason for a meeting with scientists at the Order-of-Lenin Arctic and Antarctic Scientific Research Institute.

"Let's look at the Arctic from the historical viewpoint: what do scientists know about it that can be regarded as accurate?" I asked N.A. Volkov, chief of the Ice Forecast Department, to talk about this.

In this scientist's opinion, at the present time it can be regarded as firmly established that in the middle of the 1920's there began a noticeable warming of the climate in the high-latitude regions of the Northern Hemisphere. This process reached its culmination at the beginning of the 1940's.

Arctic and mountain glaciers retreated rapidly, permafrost thawed, and the forests advanced onto the tundra, while birds, fish, and animals penetrated farther to the north into new habitats. Ice conditions were more favorable in the high-latitude seas. In the Greenland Sea, the ice area decreased by 15-20 percent. As a result, ice stopped appearing off the coasts of Iceland; as recently as the beginning of the century, this had hindered normal navigation and interfered with the fishing industry. In the Barents Sea, the southern boundary of the ice retreated to the north about 120 km. There was a significant reduction in the amount of ice in the Kara and Laptev Seas, as well as other regions of the northern ocean.

The overall picture was a remarkable one: the area covered by ice in the Arctic Ocean shrank by about one million square kilometers. Just imagine: this is comparable to the total area of the Ukraine, Belorussia, Georgia, Armenia, and Azerbaydzhan. Voyages that were previously simply unthinkable became possible. In a short period of time, the northern sea route was transformed into an important transportation artery. The wave of reduced iciness moved to the east, and for the first time in about 25 years the entire route through the Soviet Arctic seas was open.

In addition to N.A. Volkov, the other specialists who are concerned with questions of the cyclic nature of the Arctic climate include V.F. Zakharov, V.N. Kupetskiy, and V.Ye. Borodachev. As a result of their research, much has now been clarified. In the 1940's, of course, no one could imagine that the "peak" had been reached, after which a new climatic epoch was to follow. The first signs that cooling had begun were seen in that same decade, but no special importance was attached to them. The drop in temperature began first in northwestern Greenland. Then it spread to the central Arctic, the Kara and Laptev Seas, and (partially) the East Siberian Sea.

The scientists' research indicates that the reduction in air temperature continued for almost two decades in the Norway, Greenland, and Barents Seas. No such cooling was observed in the Chukchi Sea and the eastern part of the East Siberian Sea. Here there was even some slight warming and improved ice conditions.

A question arises: is the intensity of the cooling identical in the different regions? Is it a sequential process by which each new year is harsher than the preceding ones?

At the institute, I was shown some materials having to do with this subject. Within the boundaries of the Soviet Arctic, the greatest reduction in air temperature took place in the Kara Sea. Its average 5-year value for 1961-1965 was almost 3°

lower than for 1941-1945. In the Laptev Sea, the temperature fell by about 2° during this time, while in the East Siberian Sea there was a 1° decrease. The most significant cooling took place in the winter months. All of this indicates that the new climatic fluctuation changes in a complicated manner in both time and space.

The development of the cooling epoch did not necessarily mean difficult ice conditions all the time, the scientists emphasize. There are still years when the ice retreats far from the shores during the summer and does not hinder navigation. However, the number of such favorable years is inevitably decreasing.

What important changes in natural conditions are accompanying this cooling of the Arctic? Scientists -- V.F. Zakharov, in particular -- are studying this question very carefully. A few conclusions can already be drawn.

First of all, the period with positive air temperatures was shortened. Even for the Arctic periphery this was no more than 3-4 months a year, but at a number of places in the Kara and Laptev Seas it has been reduced by almost a month. Atmospheric pressure has increased; cloudiness has decreased. The climate has become more continental in nature. The facts make it undoubtable: the cooling has put an end to the improvement in ice conditions in the Arctic that lasted for almost a quarter of a century. We are now undergoing a return to that harsh situation that reigned in the Arctic at the turn of the century.

The most impressive consequence is the increase in the area and thickness of the ice cap. In the Greenland, Barents, Kara, Laptev, and East Siberian Seas alone, the area covered by ice has increased by 600,000 km^2. Therefore, ice has become a normal phenomenon where it was previously absent or appeared only rarely.

Observations show that the boundary of the pack ice to the north of the Siberian coastline is now considerably farther south than it was during the warming period. During the sailing season, the pack is now encountered ever more frequently in the shipping lanes, thus making navigation more difficult.

Ice formation in the Arctic seas is now beginning earlier in the year, and in some regions has moved up by 20-30 days. At the same time, the spring phenomena -- thawing, breakup, the disappearance of ice -- are delayed. In other words, the new climatic epoch has led to a significant expansion of the period of ice accumulation and a reduction in the length of the period when it is absent.

How do scientists explain the changes in the Arctic climate, and have they determined whether or not there is any pattern to them? There is still no unified opinion on this matter. Recently, however, the opinion of those who explain the cyclic nature of the fluctuations in the amount of ice in the Arctic seas in terms of Earth-Sun relationships has acquired more weight. Investigations have shown that an increase in ice corresponds to an observable decrease in solar activity.

This means that by the end of the 20th Century we should expect to see a further increase in the amount of ice in the Arctic. This white "armor" will apparently reach the same level that was observed at the turn of the century. At the beginning of the next century, when solar activity increases, the degree of cooling in the high latitudes will decrease. Thus, the present changes in climate find their explanation in the natural pattern of natural processes.

Certain practical conclusions follow from this. First of all, it may be possible to use the expected level of solar activity to predict the future state of various climatic elements -- the amount of ice, precipitation, runoff, air and water temperature -- with a lead time of up to a year or more. Such independent experimental predictions have been worked out annually for the last 7 years. They have yielded positive results.

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PHYSICS AND MATHEMATICS

PROPAGATION OF COHERENT OPTICAL PULSES IN A TWO-QUANTUM RESONANT MEDIUM TAKING INTO ACCOUNT CHANGES OF FREQUENCY AND PHASE CHARACTERISTICS

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/‾Text_7 In studying the evolution of powerful light pulses in media with resonant two-quantum interaction a number of non-linear processes have to be taken into account, resulting in a change of the frequency characteristics, which have to be subdivided into two classes. To the first class can be attributed the phase self-modulation of light waves and the Stark shift of "working" levels of particles of the medium in a radiation field; such effects "take" the carrier frequency of the pulse out of resonance with the medium. Effects of generation of harmonics and of parametric transformation of frequencies of the original pulses constitute the second class. The first class of phenomena is interesting basically, from the viewpoint of influence on the coherent effects,arising as the pulses pass though the medium; break-up into non-stationary subpulses, self-transparency etc. belong to them. On the other hand, the effects pertaining to the second class present also independent interest by themselves. There exist a considerable number of papers, experimental /‾10_7and theoretical /‾6,7,8_7 in which the generation of harmonics and the parametric transformation of frequencies was studied under the condition $\Delta\omega \gg \Delta\omega_1, \Delta\omega_2$ (see Annotation). In this case the state of the medium is practically unchanged. However, for observation of the coherent effects mentioned above /‾1-4_7 conditions are indispensable, under which the population difference of the "working" levels can be completely inverted, so that the state of the medium is greatly changed. Therefore the case $\Delta\omega < \Delta\omega_1, \Delta\omega_2$ must be considered , where the expansion in terms of powers of amplitudes of the light fields cannot be used in calculating the medium polarization. In the first place, of course, material equations must be obtained in which all the effects indicated above are accounted for. For this purpose we will use the standard system of quantum equations for the probability amplitudes a_k of finding a parti.le of the medium at the level k

$$i\frac{\partial a_K}{\partial t} = \sum_{\ell} e^{i\omega_{K\ell}t} V_{K\ell}\, a_\ell, \quad V_{K\ell} = -\frac{1}{\hbar}\mu_{K\ell}\sum_{m}\mathcal{E}_m e^{i\Phi_m} \quad (1)$$

where $\omega_{k\ell}, \mu_{k\ell}$ is the frequency and dipole moment of the transition $k \rightarrow \ell$ $(\mu_{12} = 0)$,

$$\Phi_m = \omega_m t - \kappa_m z + \varphi_m; \quad \omega_m, \kappa_m, \mathcal{E}_m, \varphi_m$$

are the frequencies, wave vectors, "slow" amplitudes and phases of the light waves; we have

$$\Phi_m = -\Phi_{-m}, \quad \omega_m = -\omega_{-m}, \quad \mathcal{E}_m = \mathcal{E}_{-m}.$$

If the condition $\Delta\omega < \Delta\omega_1, \Delta\omega_2$ is satisfied, the equation for a_ℓ $(\ell \neq 1,2)$ must be left exact; on the other hand the quantities a_ℓ $(\ell \neq 1,2)$ may be determined from (1) in the first order of the perturbation theory (smallness parameter $\sim \frac{\mu_{\ell k}\mathcal{E}_m}{\hbar\omega_{\ell k}}$);then from (1) we have

$$a_\ell = \frac{1}{\hbar}\sum_{\substack{m\\ p=1,2}} \frac{\mu_{\ell p}\mathcal{E}_m}{\omega_{\ell p} + \omega_m} e^{i(\omega_{\ell p}t + \Phi_m)} a_p; \quad \ell \neq 1,2 \quad (2).$$

The expression for the polarization P induced in the medium by the superposition of light waves has, of course, the form

$$P = \sum_{\ell,k} \mu_{\ell k} a_\ell^* a_k e^{i\omega_{\ell k} t} \tag{3}$$

and in the approximation adopted above

$$P = \sum_{\ell \neq 1,2} \left(\mu_{\ell 1} a_1^* a_\ell e^{i\omega_{\ell 1} t} + \mu_{\ell 2} a_2^* a_\ell e^{i\omega_{\ell 2} t} + \text{K.c.} \right) \tag{4}$$

Below we will consider two cases: $\omega_0 + \omega_s \approx \omega_{21}$ - two-photon absorption; $\omega_0 - \omega_s \approx \omega_{21}$ - combination interactio.

a) "Two-photon absorption".

Substituting the expression for a_ℓ ($\ell \neq 1,2$) from (2) into the equations for a_1, a_2 from (1) and carrying out a number of uncomplicated transformations, we obtain

$$\begin{aligned} i\frac{\partial a_1}{\partial t} &= -\left(\sum_{m=1}^{4} \frac{\tau_{11}^{(m)}}{4\hbar} \mathcal{E}_m^2\right) a_1 - \left(\frac{\tau_{12}}{4\hbar}\mathcal{E}_0\mathcal{E}_s + \frac{\tau_{12}^{(3)}}{4\hbar}\mathcal{E}_3\mathcal{E}_4 e^{i\delta} + \right. \\ &\left. + \frac{\tau_{12}^{(1)}}{4\hbar}\mathcal{E}_0\mathcal{E}_1 e^{i\Theta_1} + \frac{\tau_{12}^{(2)}}{4\hbar}\mathcal{E}_s\mathcal{E}_2 e^{i\Theta_2}\right) e^{i\Delta} a_2 \\ i\frac{\partial a_2}{\partial t} &= -\left(\frac{\tau_{12}}{4\hbar}\mathcal{E}_0\mathcal{E}_s + \frac{\tau_{12}^{(3)}}{4\hbar}\mathcal{E}_3\mathcal{E}_4 e^{-i\delta} + \frac{\tau_{12}^{(1)}}{4\hbar}\mathcal{E}_0\mathcal{E}_1 e^{-i\Theta_1} + \right. \\ &\left. + \frac{\tau_{12}^{(2)}}{4\hbar}\mathcal{E}_s\mathcal{E}_2 e^{-i\Theta_2}\right) e^{-i\Delta} a_1 - \left(\sum_{m=1}^{4} \frac{\tau_{22}^{(m)}}{4\hbar} \mathcal{E}_m^2\right) a_2 \end{aligned} \tag{5}$$

Here the following designations have been introduced:

$$\begin{aligned} \tau_{ii}^{(m)} &= \frac{2}{\hbar}\sum_{\ell} \frac{\mu_{i\ell}^2 \omega_{\ell i}}{\omega_{\ell i}^2 - \omega_m^2}; \quad \tau_{12} = \frac{1}{\hbar}\sum_{\ell} \mu_{1\ell}\mu_{\ell 2}\left(\frac{1}{\omega_{\ell 2} + \omega_0} + \frac{1}{\omega_{\ell 2} + \omega_s}\right); \\ \tau_{12}^{(1)} &= \frac{1}{\hbar}\sum_{\ell} \mu_{1\ell}\mu_{\ell 2}\left(\frac{1}{\omega_{\ell 2} + \omega_1} + \frac{1}{\omega_{\ell 2} - \omega_0}\right); \quad \tau_{12}^{(2)} = \frac{1}{\hbar}\sum_{\ell} \mu_{1\ell}\mu_{\ell 2}\left(\frac{1}{\omega_{\ell 2} + \omega_2} + \right. \\ &\left. + \frac{1}{\omega_{\ell 2} - \omega_s}\right); \quad \tau_{12}^{(3)} = \frac{1}{\hbar}\sum_{\ell} \mu_{1\ell}\mu_{\ell 2}\left(\frac{1}{\omega_{\ell 2} + \omega_3} + \frac{1}{\omega_{\ell 2} + \omega_4}\right) \end{aligned} \tag{6}$$

$$\delta = \varphi_3 + \varphi_4 - \varphi_0 - \varphi_s - (K_3 + K_4 - K_0 - K_s)z, \quad \Theta_1 = \varphi_1 - 2\varphi_0 - \varphi_s - (K_1 - 2K_0 - K_s)z$$
$$\Theta_2 = \varphi_2 - 2\varphi_s - \varphi_0 - (K_2 - 2K_s - K_0)z, \quad \Delta = (\omega_0 + \omega_s - \omega_{21})t + \varphi_0 + \varphi_s .$$

In the system of equations (5) four waves have been accounted for: the fundamental waves with the amplitudes $\mathcal{E}_0$, $\mathcal{E}_s$, the harmonics $\mathcal{E}_1$, $\mathcal{E}_2$ with the frequencies $\omega_1 = 2\omega_0 + \omega_s$, $\omega_2 = 2\omega_s + \omega_0$, and the parametrically transformed waves $\mathcal{E}_3$, $\mathcal{E}_4$ with the frequencies ω_3, ω_4 satisfying the condition $\omega_3 + \omega_4 = \omega_0 + \omega_s$. Generally speaking, in the last case we have to do with an infinite number of waves but, as will be seen below, they fill a very narrow interval, so that they may be described by means of single common "envelopes" $\mathcal{E}_3(z,t)$, $\mathcal{E}_4(z,t)$. Substituting, further, the expression a_ℓ from (2) into (4) and carrying out cumbersome, uncomplicated operations, one can write down the final expression for the polarixation P:

$$P = [\tau_{12}\mathcal{E}_s P_1 + \tau_{12}^{(1)}\mathcal{E}_1(P_1\cos\Theta_1 - P_2\sin\Theta_1)]\cos\Phi_0 +$$
$$[\tau_{12}\mathcal{E}_s P_2 - \tau_{12}^{(1)}\mathcal{E}_1(P_1\sin\Theta_1 + P_2\cos\Theta_1)]\sin\Phi_0 + [\tau_{12}\mathcal{E}_0 P_1 +$$
$$+\tau_{12}^{(2)}\mathcal{E}_2(P_1\cos\Theta_2 - P_2\sin\Theta_2)]\cos\Phi_s + [\tau_{12}\mathcal{E}_0 P_2 - \tau_{12}^{(2)}\mathcal{E}_2(P_1\sin\Theta_2 -$$
$$P_2\cos\Theta_2)]\sin\Phi_s + \tau_{12}^{(1)}\mathcal{E}_0(P_1\cos\Theta_1 - P_2\sin\Theta_1)\cos\Phi_1 + \qquad (7)$$
$$+\tau_{12}^{(1)}\mathcal{E}_0(P_1\sin\Theta_1 + P_2\cos\Theta_1)\sin\Phi_1 + \tau_{12}^{(2)}\mathcal{E}_s(P_1\cos\Theta_2 - P_2\sin\Theta_2)\cdot$$
$$\cdot\cos\Phi_2 + \tau_{12}^{(2)}\mathcal{E}_s(P_1\sin\Theta_2 + P_2\cos\Theta_2)\sin\Phi_2 + \tau_{12}^{(3)}\mathcal{E}_3(P_1\cos\delta -$$
$$-P_2\sin\delta)\cos\Phi_4 + \tau_{12}^{(3)}\mathcal{E}_3(P_1\sin\delta + P_2\cos\delta)\sin\Phi_4 +$$
$$+\tau_{12}^{(3)}\mathcal{E}_4(P_1\cos\delta - P_2\sin\delta)\cos\Phi_3 + \tau_{12}^{(3)}\mathcal{E}_4(P_1\sin\delta + P_2\cos\delta)\sin\Phi_3 +$$
$$+\sum_{m=1}^{4}(\Delta\tau^{(m)}n + \delta\tau^{(m)})\mathcal{E}_m\cos\Phi_m; \quad P_1 = \mathrm{Re}[a_1^* a_2 e^{i\Delta}]; \; P_2 =$$
$$= \mathrm{Im}[a_1^* a_2 e^{i\Delta}]; \quad n = |a_2|^2 - |a_1|^2; \; \Delta\tau^{(m)} = \frac{1}{2}(\tau_{12}^{(m)} - \tau_{11}^{(m)}); \; \delta\tau^{(m)} =$$
$$= \frac{1}{2}(\tau_{12}^{(m)} + \tau_{11}^{(m)});$$

Using the definitions of P_1, P_2, n, the system of equations (5) may be reduced to the form

$$\frac{dP_1}{dt} = -\Delta\Omega P_2 - n\left(\frac{\tau_{12}^{(1)}}{4\hbar}\mathcal{E}_0\mathcal{E}_1\sin\theta_1 + \frac{\tau_{12}^{(2)}}{4\hbar}\mathcal{E}_s\mathcal{E}_2\sin\theta_2 + \frac{\tau_{12}^{(3)}}{4\hbar}\mathcal{E}_3\mathcal{E}_4\sin\delta\right)$$

$$\frac{dP_2}{dt} = \Delta\Omega P_1 - n\left(\frac{\tau_{12}}{4\hbar}\mathcal{E}_0\mathcal{E}_s + \frac{\tau_{12}^{(1)}}{4\hbar}\mathcal{E}_0\mathcal{E}_1\cos\theta_1 + \frac{\tau_{12}^{(2)}}{4\hbar}\mathcal{E}_s\mathcal{E}_2\cos\theta_2 + \right.$$

$$\left. + \frac{\tau_{12}^{(3)}}{4\hbar}\mathcal{E}_3\mathcal{E}_4\cos\delta\right) \qquad (8)$$

$$\frac{dn}{dt} = \left(\frac{\tau_{12}}{\hbar}\mathcal{E}_0\mathcal{E}_s + \frac{\tau_{12}^{(1)}}{\hbar}\mathcal{E}_0\mathcal{E}_1\cos\theta_1 + \frac{\tau_{12}^{(2)}}{\hbar}\mathcal{E}_s\mathcal{E}_2\cos\theta_2 + \frac{\tau_{12}^{(3)}}{\hbar}\mathcal{E}_3\mathcal{E}_4\cos\delta\right)\times$$

$$\times P_2 + \left(\frac{\tau_{12}^{(1)}}{\hbar}\mathcal{E}_0\mathcal{E}_1\sin\theta_1 + \frac{\tau_{12}^{(2)}}{\hbar}\mathcal{E}_s\mathcal{E}_2\sin\theta_2 + \frac{\tau_{12}^{(3)}}{\hbar}\mathcal{E}_3\mathcal{E}_4\sin\delta\right)P_1$$

where

$$\Delta\Omega = \frac{1}{2}\sum_{m=1}^{4}\Delta\tau^{(m)}\mathcal{E}_m^2 + \Delta\omega + \frac{\partial\varphi_{os}}{\partial t}\ ; \quad \Delta\omega = \omega_0 + \omega_s - \omega_{21};\ \varphi_{os} = \varphi_0 + \varphi_s$$

b) "Combination interaction"

In this case generation of the harmonics $\omega_1 = 2\omega_0 - \omega_s$ and $\omega_2 = 2\omega_s - \omega_0 > 0$ is possible , as well as parametric transformation of the frequencies ω_0 , ω_s into the frequencies ω_3 , ω_4 , satisfying the condition $\omega_3 + \omega_4 = \omega_0 - \omega_s$. Carrying out operations analogous to those of the preceding case, one can obtain the expression for the polarization P:

$$P = \left[\tau_{12}\mathcal{E}_s P_1 + \tau_{12}^{(1)}\mathcal{E}_1(P_1\cos\theta_1 - P_2\sin\theta_1)\right]\cos\Phi_0 + \left[\tau_{12}\mathcal{E}_s P_2 - \right.$$

$$\left. - \tau_{12}^{(1)}\mathcal{E}_1(P_1\sin\theta_1 + P_2\cos\theta_1)\right]\sin\Phi_0 + \left[\tau_{12}\mathcal{E}_0 P_1 + \tau_{12}^{(2)}\mathcal{E}_2(P_1\cos\theta_2 - \right.$$

$$\left. - P_2\sin\theta_2)\right]\cos\Phi_s + \left[-\tau_{12}\mathcal{E}_0 P_2 + \tau_{12}^{(2)}\mathcal{E}_2(P_1\sin\theta_2 + P_2\cos\theta_2)\right]\sin\Phi_s +$$

$$+ \tau_{12}^{(1)}\mathcal{E}_0(P_1\cos\theta_1 - P_2\sin\theta_1)\cos\Phi_1 + \tau_{12}^{(1)}\mathcal{E}_0(P_1\sin\theta_1 + P_2\cos\theta_1)\sin\Phi_1 + \tau_{12}^{(2)}\mathcal{E}_s\times \qquad (9)$$

$$\times(P_1\cos\theta_2 - P_2\sin\theta_2)\cos\Phi_2 - \tau_{12}^{(2)}\mathcal{E}_s(P_1\sin\theta_2 + P_2\sin\theta_2) + \tau_{12}^{(3)}\mathcal{E}_4(P_1\cos\delta - P_2\sin\delta)\times$$

$$\times\cos\Phi_3 + \tau_{12}^{(3)}\mathcal{E}_4(P_1\sin\delta + P_2\cos\delta)\sin\Phi_3 + \tau_{12}^{(3)}\mathcal{E}_3(P_1\cos\delta - P_2\sin\delta)\cos\Phi_4 +$$

$$+ \tau_{12}^{(3)}\mathcal{E}_3(P_1\sin\delta + P_2\cos\delta)\sin\Phi_4 + \sum_{m=1}^{4}(\Delta\tau^{(m)}n + \delta\tau^{(m)})\mathcal{E}_m\cos\Phi_m$$

Here:

$$\tau_{12} = \frac{1}{\hbar}\sum_{l} \mu_{1l}\mu_{l2}\left[\frac{1}{\omega_{l2}+\omega_0} + \frac{1}{\omega_{l2}-\omega_s}\right];\quad \tau_{12}^{(1)} = \frac{1}{\hbar}\sum_{l} \mu_{1l}\mu_{l2}\left[\frac{1}{\omega_{l2}+\omega_1} + \frac{1}{\omega_{l2}-\omega_0}\right],\quad \tau_{12}^{(2)} = \frac{1}{\hbar}\sum_{l} \mu_{1l}\mu_{l2}\left[\frac{1}{\omega_{l2}-\omega_2} + \frac{1}{\omega_{l2}+\omega_s}\right];$$

$$\tau_{12}^{(3)} = \frac{1}{\hbar}\sum_{l} \mu_{1l}\mu_{l2}\left[\frac{1}{\omega_{l2}+\omega_3} + \frac{1}{\omega_{l2}+\omega_4}\right]. \tag{10}$$

$$\theta_1 = (\varphi_1 - 2\varphi_0 + \varphi_s) - (k_1 - 2k_0 + k_s)z.\quad \theta_2 = (2\varphi_s - \varphi_0 - \varphi_2) - (2k_s - k_0 - k_2)z$$

$$\delta = (\varphi_3 + \varphi_4 - \varphi_0 + \varphi_s) - (k_3 + k_4 - k_0 + k_s)z$$

The remaining designations are the same as in (6) and (8). It is also easy to show that the equations for P_1, P_2, n coincide with the system (8), where now $\Delta\omega = \omega_0 - \omega_s - \omega_2$, $\varphi_{0s} = \varphi_0 - \varphi_s$, and the remaining quantities are determined by the relations (10).

The formulas (8) represent a system of material equations without relaxation terms which can be, as usual, introduced phenomenologically into the right-hand members of (8). Applying the known procedure of obtaining "abridged" equations for the field amplitudes from Maxwell's equations and the expressions (7), (9) for the polarization P, we have

$$\begin{aligned}
\frac{\partial \mathcal{E}_0}{\partial z} &= -\alpha_0 P_2 \mathcal{E}_s + \frac{\omega_0}{\omega_1}\alpha_1 \mathcal{E}_1 (P_1 \sin\theta_1 + P_2 \cos\theta_1)\\
\frac{\partial \mathcal{E}_s}{\partial z} &= \mp \alpha_s P_2 \mathcal{E}_0 \pm \frac{\omega_s}{\omega_2}\alpha_2 \mathcal{E}_2 (P_1 \sin\theta_2 + P_2 \cos\theta_2)\\
\frac{\partial \mathcal{E}_1}{\partial z} &= -\alpha_1 \mathcal{E}_0 (P_1 \sin\theta_1 + P_2 \cos\theta_1)\\
\frac{\partial \mathcal{E}_2}{\partial z} &= \mp \alpha_2 \mathcal{E}_s (P_1 \sin\theta_2 + P_2 \cos\theta_2)\\
\frac{\partial \mathcal{E}_3}{\partial z} &= -\alpha_3 \mathcal{E}_4 (P_1 \sin\delta + P_2 \cos\delta)\\
\frac{\partial \mathcal{E}_4}{\partial z} &= \alpha_4 \mathcal{E}_3 (P_1 \sin\delta + P_2 \cos\delta)\\
\mathcal{E}_0 \frac{\partial \varphi_0}{\partial z} &= -(\beta_0 n + \gamma_0)\mathcal{E}_0 - \alpha_0 \mathcal{E}_s P_1 - \frac{\omega_0}{\omega_1}\alpha_1 (P_1 \cos\theta_1 - P_2 \sin\theta_1)\mathcal{E}_1\\
\mathcal{E}_s \frac{\partial \varphi_s}{\partial z} &= -(\beta_s n + \gamma_s)\mathcal{E}_s - \alpha_s \mathcal{E}_0 P_1 - \frac{\omega_s}{\omega_2}\alpha_2 (P_1 \cos\theta_2 - P_2 \sin\theta_2)\mathcal{E}_2\\
\mathcal{E}_1 \frac{\partial \varphi_1}{\partial z} &= -(\beta_1 n + \gamma_1)\mathcal{E}_1 - \alpha_1 \mathcal{E}_0 (P_1 \cos\theta_1 - P_2 \sin\theta_1)\\
\mathcal{E}_2 \frac{\partial \varphi_2}{\partial z} &= -(\beta_2 n + \gamma_2)\mathcal{E}_2 - \alpha_2 \mathcal{E}_s (P_1 \cos\theta_2 - P_2 \sin\theta_2)\\
\mathcal{E}_3 \frac{\partial \varphi_3}{\partial z} &= -(\beta_3 n + \gamma_3)\mathcal{E}_3 - \alpha_3 \mathcal{E}_4 (P_1 \cos\delta - P_2 \sin\delta)
\end{aligned} \tag{11}$$

$$\mathcal{E}_4 \frac{\partial \varphi_4}{\partial z} = -(\beta_4 n + \gamma_4)\mathcal{E}_4 - \alpha_4 \mathcal{E}_4 (P_1 \cos\delta - P_2 \sin\delta)$$

$$\alpha_{0,s} = \frac{2\pi\omega_{0,s}}{c} z_{12} N, \quad \beta_{0,s} = \frac{2\pi\omega_{0,s}}{c} \Delta z^{(0,s)} N$$

$$\gamma_{0,s} = \frac{2\pi\omega_{0,s}}{c} \delta z^{(0,s)} N.$$

Here $\alpha_i = \frac{2\pi\omega_i}{c} z_{12}^{(i)} N, \quad \beta_i = \frac{2\pi\omega_i}{c} \Delta z^{(i)} N, \quad \gamma_i = \frac{2\pi\omega_i}{c} \delta z^{(i)} N.$

In the equation (11) we have passed from the variables z,t to the variables z, $\tau = t - z/c$ and neglected the differences between the refractive indices and unity, which appears to be justified under the conditions of interest to us. In the general case the replacements $\frac{\partial}{\partial z} \to \frac{\partial}{\partial z} + \frac{\eta_i}{c}\frac{\partial}{\partial t}, \alpha_i \to \frac{\alpha_i}{\eta_i}, \beta_i \to \frac{\beta_i}{\eta_i}, \gamma_i \to \frac{\gamma_i}{\eta_i}$, $\omega_{0,s} \to \frac{\omega_{0,s}}{\eta_{0,s}}, \omega_{1,2} \to \frac{\omega_{1,2}}{\eta_{1,2}}$, must be made, where η_i is the linear part of the refractive index of the medium for the frequency ω_i. The upper signs in the system (11) correspond to "two-photon absorption", the lower ones to "combination interaction". Thus the systems of equations (8),(11) fully describe the evolution of light pulses moving through the medium under the conditions indicated above. We will now pass to the analysis of the obtained equations. In the general case the systems (8), (11) can be solved only numerically; therefore we will conduct below the analytical investigation of the most interesting special cases.

2. First we will clarify the influence of phase modulation and Stark level shift in the radiation field of the pulses. For this purpose we will disregard in (8) and (11) the quantities $\mathcal{E}_1, \mathcal{E}_2, \mathcal{E}_3, \mathcal{E}_4$ and the corresponding phases $\varphi_1, \varphi_2, \varphi_3, \varphi_4$. As a result the systems of equations for the field and the material variables may be written in the form

$$\frac{\partial \mathcal{E}_0}{\partial z} = -\alpha_0 P_2 \mathcal{E}_s$$

$$\frac{\partial \mathcal{E}_s}{\partial z} = \mp \alpha_s P_2 \mathcal{E}_0$$

$$\frac{\partial \varphi_{0s}}{\partial z} = -\left[(\beta_0 \pm \beta_s) n + (\gamma_0 \pm \gamma_s) + P_1 \frac{\alpha_0 \mathcal{E}_s^2 \pm \alpha_s \mathcal{E}_0^2}{\mathcal{E}_0 \mathcal{E}_s} \right]$$

$$\frac{dP_1}{dt} = -\Delta\Omega P_2 - \frac{P_2}{T_2} \qquad (12)$$
$$\frac{dP_2}{dt} = \Delta\Omega P_1 - \frac{z_{12}}{4\hbar}\mathcal{E}_0\mathcal{E}_s n - \frac{P_2}{T_2}$$
$$\frac{dn}{dt} = \frac{z_{12}}{\hbar}\mathcal{E}_0\mathcal{E}_s P_2$$

Here $\varphi_{0\pm} = \varphi_0 \pm \varphi_s$, T_2 is the time of phase relaxation;

$$\Delta\Omega = \frac{\Delta z^{(0)}}{2\hbar}\mathcal{E}_0^2 + \frac{\Delta z^{(s)}}{2\hbar}\mathcal{E}_s^2 + \Delta\omega + \frac{\partial\varphi_{0s}}{\partial\tau} \qquad \Delta\omega = \omega_0 \pm \omega_s - \omega_{21}$$

It is assumed that the pulse lengths are smaller than the relaxation time of the populations. The upper signs in the system (12) (and also everywhere below) correspond to the case $\omega_0 + \omega_s \approx \omega_{21}$ (two-photon absorption), the lower signs to the case $\omega_0 - \omega_s \approx \omega_{21}$ (combination interaction). For the investigation of the effects of phase modulation it is convenient to pass to new dimensionless functions and variables of the following form:

$$z \to \mathcal{H}_2 z \qquad \tau \to \tau(\tau_0\tau_s)^{-\frac{1}{2}} \qquad \mathcal{H}_2 = (\alpha_0\alpha_s)^{1/2}$$
$$A_1(z,\tau) = \frac{\alpha_0\mathcal{E}_s^2 \pm \alpha_s\mathcal{E}_0^2}{2(\alpha_0\alpha_s)^{1/2}\mathcal{E}_0\mathcal{E}_s} \qquad A_2(z,\tau) = \frac{z_{12}}{2\hbar}\mathcal{E}_0\mathcal{E}_s(\tau_0\tau_s)^{1/2} \qquad (13)$$
$$\Omega(z,\tau) = \Delta\Omega(\tau_0\tau_s)^{1/2} \qquad T = T_2(\tau_0\tau_s)^{-\frac{1}{2}} \qquad \alpha^{(\pm)} = \frac{\Delta z^{(0)}\omega_0 \pm \Delta z^{(s)}\omega_s}{z_{12}(\omega_0\omega_s)^{1/2}}$$

where τ_0 , τ_s are characteristic lengths of the initial pulses.

Substituting (13) into (12) and carrying out a number of transformations,we will obtain a system of equations of the form

$$\frac{\partial A_2}{\partial z} = -P_2 A_1 A_2$$
$$\frac{\partial A_1}{\partial z} = P_2(A_1^2 \mp 1) \qquad (14)$$
$$\frac{\partial\Omega}{\partial z} = -\alpha^{(\pm)} P_2 A_2 - \frac{\partial}{\partial\tau}(P_2 A_1)$$

$$\frac{\partial P_1}{\partial \tau} = -\Omega P_2 - \frac{P_1}{T}$$
$$\frac{\partial P_2}{\partial \tau} = \Omega P_1 - A_2 n - \frac{P_2}{T}$$
$$\frac{\partial n}{\partial \tau} = A_2 P_2$$

with the boundary conditions: $A_2(0,\tau) = a_2(\tau)$, $A_1(0,\tau) = a_1(\tau)$, $\Omega(0,\tau) = \Omega_0(\tau)$ and the initial conditions: $P_2(z,-\infty) = P_1(z,-\infty) = 0$, $n(z,-\infty) = -1$. The quantities $a_1(\tau)$, $a_2(\tau)$, $\Omega(\tau)$ are determined by prescribing $\mathcal{E}_0(0,\tau), \mathcal{E}_s(0,\tau), \varphi_{0s}(0,\tau), \omega_0, \omega_s$ and by the values of the matrix elements according to (13). From (14) it is seen that the quantities $A_1(z,\tau)$ and $A_2(z,\tau)$ are not independent, they are connected by the relation $A_2^2(A_1^2 \mp 1) = a_2^2(a_1^2 \mp 1)$ which physically represents the law of conservation of the difference of the numbers of quanta (two-photon absorption) and of the difference of the numbers of quanta (combination interaction) in the pulses $\mathcal{E}_0$ and $\mathcal{E}_s$ (law of Manley-Row /‾spelling uncertain_7). The first two equations of the system (14) may be integrated; introducing

$$\Phi(z,\tau) = \int_0^z P_2(z',\tau)dz'$$

we obtain easily:

1. Two-photon "absorption"

$$A_1(z,\tau) = \frac{a_1(\tau) - \mathrm{th}\,\Phi}{1 - a_1(\tau)\,\mathrm{th}\,\Phi}; \quad A_2(z,\tau) = a_2(\mathrm{ch}\,\Phi - a_1\,\mathrm{sh}\,\Phi) \tag{15}$$
$$\mathcal{E}_0^2(z,\tau) = \frac{2\hbar}{z_{12}}\left(\frac{\alpha_0}{\alpha_s}\right)^{1/2} A_2\left[A_1 + \sqrt{A_1^2 - 1}\right]$$
$$\mathcal{E}_s^2(z,\tau) = \frac{2\hbar}{z_{12}}\left(\frac{\alpha_s}{\alpha_0}\right)^{1/2} A_2\left[A_1 - \sqrt{A_1^2 - 1}\right]$$

2. "Combination interaction"

$$A_1(z,\tau) = \frac{a_1 + \mathrm{tg}\,\Phi}{1 - a_1 \mathrm{tg}\,\Phi}\,; \quad A_2 = a_2(\cos\Phi - a_1 \sin\Phi)$$
$$\mathcal{E}_0^2(z,\tau) = \frac{2\hbar}{\mathcal{P}_{12}} A_2\left[\sqrt{A_1^2+1} + A_1\right]; \quad \mathcal{E}_s^2(z,\tau) = \frac{2\hbar}{\mathcal{P}_{12}} A_2\left[\sqrt{A_1^2+1} - A_1\right] \qquad (16)$$

From the expression for A_1 (case 1) it follows that for
$a_1(\tau) \equiv 1$ we have $A_1(z,\tau) \equiv 1$. This corresponds to the
situation where the numbers of quanta in the initial pulses,
and consequently at any point z, are equal. In the case 2
such a situation, of course, does not take place. This
circumstance results in an essential difference in the phase
modulation effects in the case 1 and 2. We will examine
case 1 more in detail. If exact resonance $\left(\Delta\omega = 0,\ \frac{\partial \varphi_{0s}}{\partial \tau} = 0\right)$
took place initially and $a_1(\tau) \equiv 1$,
then the system (14) has a rigorous solution for $T \to \infty$
(the effect of T being finite was discussed by us in [4]
and the behavior of the pulses when $\Delta\omega \neq 0$ in paper [5]).
In this case the equation for $\Omega(z,\tau)$ is easily reduced to
the form

$$\frac{\partial \Omega}{\partial z} - \Omega = -\alpha^{(+)} A_2 \qquad (17)$$

with the boundary conditions $\Omega_0(\tau) = \frac{1}{2}\alpha^{(+)} a_2(\tau)$.
Using A_2 from (15), we easily obtain the solution of (17):

$$\Omega(z,\tau) = \frac{1}{2}\alpha^{(+)} A_2(z,\tau).$$

Substituting the value of $\Omega(z,\tau)$ in the equations for
P_1, P_2, n and solving them, we obtain

$$P_1 = \frac{\alpha^{(+)}}{2\left(1+\frac{\alpha^{(+)2}}{4}\right)}(\cos\Psi - 1),\ P_2 = \frac{1}{2}\left(1+\frac{\alpha^{(+)2}}{4}\right)^{-\frac{1}{2}}\sin\Psi;\ n = \left(1+\frac{\alpha^{(+)2}}{4}\right)^{-1}(1-\cos\Psi) - 1$$
$$\Psi = \left(1+\frac{\alpha^{(+)2}}{4}\right)^{1/2}\int_{-\infty}^{\tau} A_2\,d\tau. \qquad (18)$$

These solutions differ from the "degenerate" case
$(\omega_0 = \omega_3 = \omega,\ \omega_{21} \simeq 2\omega_0)$ solely by the renormalization of
the constants appearing in (17) and (18), i.e. the re-
sults of paper [1] are retained in full. Thus in the
situation considered the effects of non-linear frequency
shifts do not prevent the breakup of the original pulses
into subpulses, followed by their narrowing and power

increase. In the case when $a_1(\tau) \neq 1$ and, consequently, $A_1(z,t) \neq 1$ the system (14) is not analytically solvable. However, if the lengths of the original pulses are equal ($\tau_0 = \tau_s$, $\Delta\omega = 0$, $\frac{\partial \varphi_{01}(0,\tau)}{\partial \tau} = 0$), then $\frac{\Omega_0(\tau)}{a_1(\tau)} = const$ and the solutions of the material equations at the point $z = 0$ coincide with (18) with the accuracy to constants. This means that at the initial stage the evolution of a pulse proceeds practically in the same way as in the case $A_1 \neq 1$. Since the lengths of the subpulses, which are created (see [1-4]), are equal in both pulses, it is to be expected that the equality

$\frac{\Omega(z,\tau)}{A_1(z,\tau)} \approx const$ is approximately valid, i.e. that the results

quoted above should remain qualitatively valid. To obtain quantitative results (and also for an exact investigation of

the more complicated case ($\tau_0 \neq \tau_s$, $\frac{\partial \varphi_{0s}(0,\tau)}{\partial \tau} \neq 0$)) numerical integration of the equation system (14) is indispensable.

4. To investigate the generation of harmonics and the parametric transformation of frequencies, we will examine the case of degenerate two-photon resonance: $\omega_0 = \omega_3 = \omega$, $\mathcal{E}_0 = \mathcal{E}_s = \mathcal{E}_0(z,\tau)$, $\theta_1 = \theta_2$. Then the generation of the third harmonic $\omega_1 = \omega_2 = 3\omega_0$ and the parametric transformation $\omega_3 + \omega_4 = 2\omega_0$ is possible. The system of equations (8) assumes in this case the form

$$\frac{dP_1}{d\tau} = -\Delta\Omega P_2 - n\left(\frac{\tau_{12}^{(1)}}{4\hbar}\mathcal{E}_0\mathcal{E}_1 \sin\theta + \frac{\tau_{12}^{(2)}}{4\hbar}\mathcal{E}_3\mathcal{E}_4 \sin\delta\right)$$

$$\frac{dP_2}{d\tau} = \Delta\Omega P_1 - n\left(\frac{\tau_{12}^{(0)}}{4\hbar}\mathcal{E}_0^2 + \frac{\tau_{12}^{(1)}}{4\hbar}\mathcal{E}_0\mathcal{E}_1 \cos\theta + \frac{\tau_{12}^{(2)}}{4\hbar}\mathcal{E}_3\mathcal{E}_4 \cos\delta\right) \tag{19}$$

$$\frac{dn}{d\tau} = \left(\frac{\tau_{12}^{(0)}}{\hbar}\mathcal{E}_0^2 + \frac{\tau_{12}^{(1)}}{\hbar}\mathcal{E}_0\mathcal{E}_1\cos\theta + \frac{\tau_{12}^{(2)}}{\hbar}\mathcal{E}_3\mathcal{E}_4\cos\delta\right)P_2 + \left(\frac{\tau_{12}^{(1)}}{\hbar}\mathcal{E}_0\mathcal{E}_1\sin\theta + \frac{\tau_{12}^{(2)}}{\hbar}\mathcal{E}_3\mathcal{E}_4\sin\delta\right)P_1$$

$$\tau_{12} \rightarrow \tau_{12}^{(0)} = \frac{1}{\hbar}\sum_l \frac{\mu_{1l}\mu_{l2}}{\omega_{l1} + \omega_0}$$

The quantity $\Delta\Omega$ is determined in the same way as in (8), taking into account the light waves indicated above. The equations for the fields and phases may be rewritten in the form

$$\begin{aligned}
\frac{\partial \mathcal{E}_0}{\partial z} &= -2d_0 P_2 \mathcal{E}_0 + \frac{d_1}{3}\mathcal{E}_1 (P_1 \sin\theta + P_2 \cos\theta) \\
\frac{\partial \mathcal{E}_1}{\partial z} &= -d_1 \mathcal{E}_0 (P_1 \sin\theta + P_2 \cos\theta) \\
\frac{\partial \mathcal{E}_3}{\partial z} &= -d_3 \mathcal{E}_4 (P_1 \sin\delta + P_2 \cos\delta) \\
\frac{\partial \mathcal{E}_4}{\partial z} &= -d_4 \mathcal{E}_3 (P_1 \sin\delta + P_2 \cos\delta)
\end{aligned} \qquad (20)$$

$$\begin{aligned}
\mathcal{E}_0 \frac{\partial \varphi_0}{\partial z} &= -(\beta_0 n + \gamma_0)\mathcal{E}_0 - 2d_0 P_1 \mathcal{E}_0 - \frac{d_1}{3}(P_2\cos\theta - P_2 \sin\theta)\mathcal{E}_1 \\
\frac{\partial \theta}{\partial z} &= \Delta K + [(3\beta_0 - \beta_1)n + 6d_0 P_1 + (3\gamma_0 - \gamma_1)] + d_1 \frac{\mathcal{E}_1^2 - \mathcal{E}_0^2}{\mathcal{E}_1 \mathcal{E}_0}(P_1\cos\theta - P_2\sin\theta) \\
\frac{\partial \delta}{\partial z} &= \Delta K' + [(2\beta_0 - \beta_3 - \beta_4)n + 4d_0 P_1 + (2\gamma_0 - \gamma_3 - \gamma_4)] - \frac{d_3 \mathcal{E}_4^2 + d_4 \mathcal{E}_3^2}{\mathcal{E}_3 \mathcal{E}_4} \times \\
&\times (P_1 \cos\delta - P_2 \sin\delta) + \frac{2}{3} d_1 \frac{\mathcal{E}_1}{\mathcal{E}_0}(P_1\cos\theta - P_2 \sin\theta). \quad \Delta K = 3K_0 - K_1,\ \Delta K' = 2K_0 - K_3 - K_4
\end{aligned}$$

In the first place it is easy to ascertain that in the case when $\mathcal{E}_0(z,\tau)$ does not depend on time and $\Delta\omega \gg \Delta\omega_1, \Delta\omega_2$ (i.e. $\Delta\Omega = \Delta\omega$, $n=-1$), from (19), (20) follow results obtained for the generation of the third harmonic with the help of the perturbation theory in terms of field amplitudes. And from (19) follows

$$\begin{aligned}
P_1 &= \frac{\tau_{12}^{(1)}}{4\hbar\Delta\omega}\mathcal{E}_0\mathcal{E}_1 \sin\theta, \quad P_2 = -\frac{\tau_{12}^{(0)}}{4\hbar\Delta\omega}\mathcal{E}_0^2 - \frac{\tau_{12}^{(1)}}{4\hbar\Delta\omega}\mathcal{E}_0\mathcal{E}_1\cos\theta \\
n &= -1 \qquad \mathcal{E}_3(z,\tau) = \mathcal{E}_4(z,\tau) = 0
\end{aligned} \qquad (21)$$

Substituting (21) into (20) we obtain easily $(d_1 \tau_{12}^{(0)} = 3d_0 \tau_{12}^{(1)})$

$$\frac{\partial \mathcal{E}_0}{\partial z} = -3\,\frac{\alpha_0 \tau_{12}^{(1)}}{4\hbar\Delta\omega}\,\mathcal{E}_0^2\mathcal{E}_1 \sin\theta$$
$$\frac{\partial \mathcal{E}_1}{\partial z} = 3\,\frac{\alpha_0 \tau_{12}^{(1)}}{4\hbar\Delta\omega}\,\mathcal{E}_0^3 \sin\theta \tag{22}$$
$$\frac{\partial \theta}{\partial z} = \Delta K - 3\alpha_0\,\frac{(3\mathcal{E}_1^2-\mathcal{E}_0^2)\mathcal{E}_0}{\mathcal{E}_1}\,\frac{\tau_{12}^{(1)}}{4\hbar\Delta\omega}\cos\theta - \alpha_1\tau_{12}^{(1)}\mathcal{E}_1^2 - (6\alpha_0\tau_{12}^{(0)} - \alpha_1\tau_{12}^{(1)})\mathcal{E}_0^2$$

The last equation may be written, with the help of (22), in the form

$$\frac{\partial \theta}{\partial z} = \Delta K + \operatorname{ctg}\theta\,\frac{\partial \ln(\mathcal{E}_0^3\mathcal{E}_1)}{\partial z} - \frac{1}{4\hbar\Delta\omega}\left[6\alpha_0\tau_{12}^{(0)} - \alpha_1\tau_{12}^{(1)}\right]\mathcal{E}_0^2 - \frac{\alpha_1\tau_{12}^{(1)}}{4\hbar\Delta\omega}\,\mathcal{E}_1^2 \tag{23}$$

In ΔK the quantity $3(\gamma_0-\beta_0)-(\gamma_1-\beta_1)$ is included, which represents the linear contribution to the refractive index. The equations (21)-(23) agree with the results of paper [7].

Further we will consider the case of strong interaction with the medium

$$\Delta\omega < \Delta\omega_\lambda, \Delta\omega_e$$

a) $\alpha_0 \gg \alpha_1$; inthis case, obviously, the generation of the third harmonic may be left out of consideration. Such a situation may arise, if between the levels 1,2 a level ℓ exists, optically linked with 1,2 and satisfying the condition $|\omega_{2\ell}-\omega_0| \ll \omega_0$; then the quantity $\alpha_0 \approx \frac{\omega_0}{|\omega_{2\ell}-\omega_0|}\alpha_1 \gg \alpha_1$.

At the same time, however, also the quantities α_3, α_4 increase sharply so that a strong parametric rearrangement of the initial frequency is possible in a narrow interval, where $\alpha_3, \alpha_4 \gg \alpha_0$. To assess such an effect, we will examine the increase of $\mathcal{E}_3(z,t)$, $\mathcal{E}_4(z,t)$ at distances z, where the reverse influence of $\mathcal{E}_3, \mathcal{E}_4$ on the quantity $\mathcal{E}_0(z)$ may be disregarded. Omitting in (19) the terms containing $\mathcal{E}_1$, $\mathcal{E}_2$, $\mathcal{E}_3$, $\mathcal{E}_4$, we have the known [3,4] solution ($\Delta\Omega = 0$)

$$P_1 = 0 \quad P_2 = \frac{1}{2}\sin\Psi \ , \quad \Psi = \frac{\tau_{12}^{(0)}}{2\hbar}\int^{\tau} \mathcal{E}_0^2(z,\tau')\,d\tau' \tag{24}$$

Assuming also that $\delta K \cdot z_0 < 1$, i.e. $\delta(z_0) = \pi$, and substituting (24) into the equations for $\mathcal{E}_3, \mathcal{E}_4$, we obtain from (24)

$$\frac{\partial \mathcal{E}_3}{\partial z} = \frac{1}{2}(\alpha_3 \alpha_4)^{1/2} \mathcal{E}_3 \sin\Psi \tag{25}$$
$$\alpha_4 \mathcal{E}_3^2 - \alpha_3 \mathcal{E}_4^2 = f(\tau) = 0$$

Since [3,4] $\sin\Psi = \frac{2(\operatorname{ctg}\frac{\Psi_0}{2} + \alpha_1 z)}{[1 + (\operatorname{ctg}\frac{\Psi_0}{2} + \alpha_1 z)^2]}$, we have, after integrating (25)

$$\mathcal{E}_3^2(z,\tau) = \mathcal{E}_3^2(0,\tau)\{1 + 2\alpha_0 z[\sin\Psi_0 + \alpha_0 z(1-\cos\Psi_0)]\}^f \tag{26}$$
$$f = \frac{1}{2}\left(\frac{\alpha_3\alpha_4}{\alpha_0^2}\right)^{1/2} \qquad \Psi_0 = \Psi(0,\tau)$$

where $\mathcal{E}_3^2(0,\tau)$ is the level of spontaneous noise of the considered frequency at the entrance into the medium. If the condition $\alpha_3, \alpha_4 \gg \alpha_0$, i.e. $f \gg 1$ (see above) is satisfied, then

$$\mathcal{E}_3^2(z,\tau) = \mathcal{E}_3^2(0,\tau)\exp\{(\alpha_3\alpha_4)^{1/2}[\sin\Psi_0 + \alpha_0 z(1-\cos\Psi_0)]z\} \tag{27}$$

parametric transformation

This means a possibility of essential growth of the quantities $\mathcal{E}_3^2(z,\tau)$, $\mathcal{E}_4^2(z,\tau)$ as z increases. Here $\mathcal{E}_3^2$, $\mathcal{E}_4^2$ attain their largest values, where $[\sin\Psi_0 + \alpha_0 z(1-\cos\Psi_0)]$ is maximum, i.e. the generation of pulses with the frequencies ω_3, ω_4 is of impulsive nature.

b) $\alpha_3, \alpha_4 < \alpha_0 \leq \alpha_1 < \Delta K$. This is the usual situation in gases, when the above-mentioned "resonance" in the matrix elements $\alpha_3, \alpha_4, \alpha_0$ is absent. In this case in (20) only the equations for $\mathcal{E}_0$, $\mathcal{E}_1$, θ are to be kept, which allows the approximate solution

$$\mathcal{E}_1^2(z,\tau) \simeq \frac{9}{4}\left(\frac{\alpha_1}{\Delta K}\right)^2 \mathcal{E}_0^6(z,\tau)\left[P_1\cos\left(\theta_0 + \frac{\Delta K}{2}z\right) - P_2\sin\left(\theta_0 + \frac{\Delta K}{2}z\right)\right]^2$$

where θ_0 is determined from the relations $\operatorname{tg}\theta_0 = -\frac{\Delta\Omega^{(0)}}{\mathcal{E}_{4}^{(0)}}\operatorname{tg}\frac{\Psi_0}{2}$, $\Psi_0 = \frac{\mathcal{E}_4^{(0)}}{2\hbar}\int_{-\infty}^{t}\mathcal{E}_0^2(0,t)\,dt$. Since $P_1 \lesssim 1$, $P_2 \lesssim 1$, we have $\mathcal{E}_1^2(z,\tau) \lll \mathcal{E}_0^2(z,\tau)$, i.e. the generation of the third harmonic plays the role of small losses and does not essentially affect the coherent two-quantum effects [1-4]. But if $\alpha_1 \lesssim \alpha_0$, $\Delta K \to 0$, then the power transferred into the third harmonic may turn out to be considerable. To investigate this situation we put $\Delta K \approx 0$. Combining the first two equations with the sixth equation in the system (20), a relation of the following form can be obtained:

$$\frac{\partial}{\partial z}(\mathcal{E}_0^3 \mathcal{E}_1 \cos\theta) = -[(3\beta_0-\beta)n]\mathcal{E}_1\mathcal{E}_0^3 \sin\theta + \frac{3}{\beta}\mathcal{E}_0^2\frac{\partial \mathcal{E}_1^2}{\partial z} + \Delta K \mathcal{E}_1 \mathcal{E}_0^3 \sin\theta$$
$$+ \frac{\beta}{4}(\mathcal{E}_0^2-\mathcal{E}_1^2)\left[\beta\frac{\partial \mathcal{E}_0^2}{\partial z} + \frac{1}{9}\frac{\partial \mathcal{E}_1^2}{\partial z}\right] \qquad \beta = \frac{d_1}{d_0} \qquad (28)$$

In the general case (28) is not integrable, but for $\Delta k = 0$ and at distances z, when $\mathcal{E}_1^2 < \mathcal{E}_0^2$ (or for $\beta \ll 1$) we find approximately

$$\cos\theta = -\frac{\beta}{8}\,\frac{[\mathcal{E}_0^4(0,\tau) - \mathcal{E}_0^4(z,\tau)]}{\mathcal{E}_0^3\mathcal{E}_1} \qquad (29)$$

Substituting (29) into the second equation of the system (20) we easily obtain

$$\frac{\partial \mathcal{E}_1^2}{\partial z} = \frac{d_1\beta}{8}\,\frac{[\mathcal{E}_0^4(0,\tau) - \mathcal{E}_0^4(z,\tau)]}{\mathcal{E}_0^2\mathcal{E}_1}\sin\Psi \qquad (30)$$

Here we have put for simplicity $P_1 = 0$, regarding the Stark constants as small and we have used the expression for P_2 from (18). If we now substitute in the right-hand side of (30) the expression for $\mathcal{E}^2(z,t)$ [and?] $\sin\Psi(z,\tau)$, without taking into account the influence of the third harmonic [1]:

$$\mathcal{E}_0^2(z,\tau) = \mathcal{E}_0^2(0,\tau)[1+2d_0 z\{\sin\Psi_0 + d_0 z(1-\cos\Psi_0)\}]^{-1}, \quad \sin\Psi(z,\tau) =$$
$$= 2\left(ctg\frac{\Psi_0}{2} + 2d_0 z\right)\left[1+\left(ctg\frac{\Psi_0}{2}+2d_0 z\right)^2\right]^{-1}$$

then we have, after an elementary integration,

$$\mathcal{E}_1^2(z,\tau) = \frac{1}{4}\left(\frac{d_1}{d_0}\right)^2 \mathcal{E}_0^2(0,\tau)\frac{(d_0 z)^2[\sin\Psi_0 + d_0 z(1-\cos\Psi_0)]^2}{1+2d_0 z[\sin\Psi_0 + d_0 z(1-\cos\Psi_0)]} \qquad (31)$$

third harmonic

From (31) it is seen that the characteristic change of the time structure of $\mathcal{E}_1^2(z,\tau)$, accompanying an advancement into the depth of the medium, is practically of the same form as that of the fundamental-frequency pulses $\mathcal{E}_0^2(z,\tau)$ (it is determined by the peculiarities of the denominator in (31). For this reason considerable generation of the third harmonic is possible in the form of subpulses which narrowing in time and increasing their power. Qualitatively these results should remain valid also in the general case, considered above, of the interaction of two different light pulses $\mathcal{E}_a$, $\mathcal{E}_c$ with the medium. A complete investigation of the effects indicated may be carried out by way of numerical integration of the systems of equations (8), (11) with prescribed boundary conditions. In conclusion the author expresses his sincere gratitude to B. Ya. Zel'dovich and Ye. A. Yukov for valuable advice and useful discussions on the results of this work. It should be noted that the influence of the Stark shift of levels and of the change of populations on the generation of the third harmonic under stationary conditions has been considered in a paper of V. I. Anikin, B. D. Gor' et al. [3].

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ACCOUNT OF BELORUSSIAN SCIENTISTS DISCUSSED

Minsk SOVETSKAYA BELORUSSIYA in Russian 23 Oct 76 p 3

[Text] The Presidium of the USSR Academy of Sciences has discussed the report "Basic Trends and Perspectives of Scientific Research Development of the Belorussian Academy of Sciences." President of the Belorussian Academy of Sciences N. A. Borisevich and Vice President of the USSR Academy of Sciences Academician V. A. Kotel'nikov gave a report at the meeting.

The vice president of the USSR Academy of Sciences, Academician Yu. A. Ovchinnikov; Academicians R. V. Khokhlov, B. S. Sokolov and M. S. Gulyarov; and Academician G. I. Marchuk, vice president of the USSR Academy of Sciences and chairman of the Siberian Department of the USSR Academy of Sciences took part in discussing the report.

They spoke of the great successes and achievements by Belorussian scientists in past years, their significant contribution in developing Soviet science, and the conditions for research trends in working out problems important to the country's national economic development in increasing the results of scientific research. The experiment of the Belorussian Academy of Sciences in organizing unified automated centers for processing research results and in creating experimental-design production bases was approved.

A. T. Korotkevich, head of the Department of Science and Educational Institutions of the Central Committee of the Belorussian Communist Party, reported to the meeting of the Presidium.

CSO: 1870

SCIENTISTS AND SCIENTIFIC ORGANIZATIONS

INTERVIEW WITH ACADEMICIAN ABID SADYKOV

Tashkent PRAVDA VOSTOKA in Russian 24 Oct 76 p 3

[Interview with Academician Abid Sadykov: "The Main Paths of Research"]

[Text] Answering the questions of a correspondent of the Uzbek Information Agency was Abid Sadykov, president of the Uzbek Academy of Sciences, academician of the USSR Academy of Sciences and Hero of Socialist Labor.

[Question] The 25th CPSU Congress, in defining the basic directions of scientific development, recommended that the scientists isolate the main element of their activity in order to further raise the quality and effectiveness of the research. How is this problem being solved in the institutions of the Uzbek Academy of Sciences?

[Answer] During the current year, several new promising lines of cotton have been turned over for state varietal testing. At present a large detachment of scientists representing a whole series of scientific institutions of the academy is engaged in research related to the development of new varieties of the main agricultural crop and the basis of the republic economy.

We have begun our talk with precisely this subject for good reasons. The biology and chemistry of cotton and the problems of the cotton complex are precisely that leading element and the particularly important main path of scientific research for us. The successes achieved here are generally known. We have merely to recall the "Tashkent" cotton varieties which have now been regionized in the republic and which were developed at the Institute for Experimental Plant Biology. The annual economic effect from their introduction into production exceeds 300 million rubles.

However, at present this is already a question of the past. Our plant breeders are carrying out extensive work to develop new high-yielding varieties which are resistent to agricultural pests and diseases, particularly wilt, and with predetermined properties. The testing being conducted makes it possible to establish several very promising, prospective lines such as "Tashkent-4," "Uzbekistan-3," "Ekspress-2," "AN-403," and "AN-505".... There is no doubt that the scientists will carry out the tasks posed for them by the party congress, that is, producing highly effective varieties for the production workers, making it possible for the cotton growers of the republic in this five-year plan to successfully cross the long-sought 6 million mark.

The elaboration of the problems related to the production and processing of cotton is a central but far from sole main direction of scientific search. During the Tenth Five-Year Plan, there will be further development of the fundamental and applied research both in the traditional areas for us such as mathematics and astronomy, geology and the chemistry of natural compounds, as well as in other major areas of modern science such as bio-organic chemistry, nuclear physics, mechanics, cybernetics, seismology and social sciences. The subject plan of the Uzbek Academy of Sciences for 1976-1980 includes over 190 subjects on important scientific and technical problems. Some 146 of them have been defined by quotas of the State Committee of the USSR Council of Ministers on Science and Technology. Of the 342 planned fundamental theoretical developments, one-half is to be done as a component part of the subjects of the USSR Academy of Sciences.

Development is being carried out successfully on the republic automated national economic management system, RASU, and original automated control systems for the economic sectors. The mechanics and cybernetics scientists have provided great help to construction workers, having established the possibility of using progressive spatial structural elements under the conditions of increased seismicity. Effective research in national economic and scientific terms is being carried out by geologists in forecasting mineral deposits, and in studying the earth's crust and upper mantle, and by botanists in studying and enriching the pastures. In the area of social sciences, joint research is to be carried out by the scientists of the Central Asian republics and Kazakhstan, and they are preparing collective general works on history, philosophy and literary criticism.

[Question] In what manner are fundamental and applied research related in the activities of the institutions of the republic Academy of Sciences? What is being done in practice for raising the economic return from the research and accelerating the introduction of scientific developments into production?

[Answer] We well remember the words of the General Secretary of the CPSU Central Committee, Comrade L. I. Brezhnev, said in the Accountability Report at the 25th Party Congress: "The practical introduction of new scientific ideas is at present as important a task as their development." And also that there is nothing more practical than a good theory, and that a heavy flood of scientific and technical progress will dry up if it is not constantly fed by fundamental research.

These ideas for us have now become an unswerving guide for action. The above-given figures from the five-year plan of the academy give the actual ratio of fundamental and applied research, that is, approximately two to one. In our view, such a ratio for today's conditions is optimal. The scientific research program outlined for the 5 years is free of minor, unimportant subjects, and the forces and means are concentrated on large-scale scientific problems.

There has been an increase in the amount of research under economic contracts with the enterprises and organizations. In the present year alone, 4 million rubles worth of such contracts have been concluded.

In the past five-year plan, the institutions of the Uzbek Academy of Science turned over to the national economy around 300 developments. The overall economic effect calculated from the introduced developments was over a billion rubles. Each ruble spent on scientific research is now returned to the national economy with a manifold yield. However, behind the general "good" figures, we can also see our shortcomings and the possibilities for a further rise in efficiency. We do not close our eyes to the fact that some of our scientific institutions are working without the proper results, the research is being drawn out excessively, and they are not concerned with the practical use of the scientific developments.

The way to eliminate such shortcomings is to strengthen the tie between science and production, and to establish the closest contacts with the production collectives and economic organizations which are immediately interested in the research results. Precisely this way has been selected by the republic scientists, having established a decisive policy of improving the quality and raising the effectiveness of the scientific research.

The Cybernetics Institute, in the aim of accelerating the development of automated control systems, has developed sectorial laboratories in Samarkandskaya and Namanganskaya oblasts, as wlll as in the city of Angren, and has organized a special design bureau for automatic control systems, having concentrated the major forces of the specialists at it. A special design bureau has also been created at the Electronics Institute, and this has accelerated the realization of many scientific ideas. The Nuclear Physics Institute has organized the production of isotopes for medical and scientific research purposes. The institutions of the republic Academy of Sciences have concluded more than 150 contracts for collaborating with the enterprises and organizations not only in Uzbekistan, but also far beyond it. Together with the republic planning bodies, comprehensive special programs are being worked out on cotton growing, solar power, and the development of fertilizer production.

Certainly, such work necessitates definite expenditures and the involvement of additional resources. The republic Academy of Sciences has turned to a number of ministries and departments with a proposal to share the funds, and to organize joint laboratories and experimental bases in the aim of quickly carrying out the urgent scientific tasks related to the acceleration of scientific and technical progress in the various national economic sectors. We are convinced that this initiative in the interests of the common cause will gain further appeal.

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SCIENTISTS AND SCIENTIFIC ORGANIZATIONS

NOMINATIONS FOR USSR ACADEMY OF SCIENCES MEMBERSHIP

Moscow IZVESTIYA in Russian 9 Dec 76 pp 3-4

[Article by A. P. Aleksandrov, President, USSR Academy of Sciences and Academician; and G.K. Skryabin, acting chief scientific secretary, Presidium of the USSR Academy of Sciences, Corresponding Member, USSR Academy of Sciences: "From the Academy of Sciences, Union of Soviet Socialist Republics"]

[Text] The USSR Academy of Sciences in accordance with Paragraph 23 of its decree reports the names of candidates for active member (academician) and corresponding member of the USSR Academy of Sciences submitted on the basis of the announcement in IZVESTIYA on 22 (23) October 1976 by councils of scientific establishments and higher educational institutions, state and social organizations, and academicians and corresponding members of the Academy of Sciences:

Candidates for Active Member (Academician)

Division of Mathematics

Andrey Vasil'yevich Bitsadze, Corresponding Member, USSR Academy of Sciences (AN SSSR); Aleksandr Alekseyevich Borovkov, Corresponding Member AN SSSR; Nikolay Panteleymonovich Buslenko, Corresponding Member AN SSSR; Nikolay Petrovich Vekua, Academician, Georgian Academy of Sciences; Izrail' Moiseyevich Gel'fand, Corresponding Member AN SSSR; Boris Vladimirovich Gnedenko, Academician, Ukrainian Academy of Sciences; Ashraf Iskenderovich Guseynov, Academician, Azerbaydzhan Academy of Sciences; Mkhitar Mkrtichevich Dzhrbashyan, Academician, Armenian Academy of Sciences; Yuriy Leonidovich Yershov, Corresponding Member, AN SSSR; Ibragim Ibishevich Ibragimov, Academician, Azerbaydzhan Academy of Sciences; Mikhail Mikhaylovich Lavrent'yev, Corresponding Member AN SSSR; Aleksey Fedorovich Leont'yev, Corresponding Member AN SSSR; Andrey Andreyevich Markov, Corresponding Member AN SSSR; Dmitriy Yevgen'yevich Men'shov, Corresponding Member AN SSSR; Yuriy Alekseyevich Mitropol'skiy, Academician, Ukrainian Academy of Sciences; Sergey Petrovich Novikov, Corresponding Member AN SSSR: Vladimir Petrovich Platonov, Academician, Belorussian Academy of Sciences; Aleksey Vasil'yevich

Pogorelov, Corresponding Member AN SSSR; Aleksandr Andreyevich Samarskiy, Corresponding Member AN SSSR; Tashmukhamed Aliyevich Sarymsakov, Academician, Uzbek Academy of Sciences; Sagdy Khasanovich Sirazhdinov, Academician, Uzbek Academy of Sciences; Lyudvig Dmitriyevich Faddeyev, Doctor of Physicomathematical Sciences, professor; Georgiy Sever'yanovich Chogoshvili, Academician, Georgian Academy of Sciences; and Sergey Vsevolodovich Yablonskiy, Corresponding Member AN SSSR.

Division of General Physics and Astronomy

Gasan Mamed Bagir ogly Abdullayev, Corresponding Member AN SSSR; Aleksey Alekseyevich Abrikosov, Corresponding Member AN SSSR; Zhores Ivanovich Alferov, Corresponding Member AN SSSR; Elevter Luarsabovich Andronikashvili, Academician, Georgian Academy of Sciences; Aleksey Fedorovich Bogomolov, Corresponding Member AN SSSR; Nikolay Aleksandrovich Borisevich, Corresponding Member AN SSSR; Semen Yakovlevich Braude, Academician, Ukrainian Academy of Sciences; Boris Konstantinovich Vaynshteyn, Corresponding Member AN SSSR; Boris Iyeremiyevich Verkin, Academician, Ukrainian Academy of Sciences; Lev Petrovich Gor'kov, Corresponding Member AN SSSR; Mitrofan Stepanovich Zverev, Corresponding Member AN SSSR; Vladimir Yevseyevich Zuyev, Corresponding Member AN SSSR; Yuriy Moiseyevich Kagan, Corresponding Member AN SSSR; Leonid Veniaminovich Keldysh; Vladimir Alekseyevich Krat, Corresponding Member AN SSSR; Yevgeniy Mikhaylovich Lifshits, Corresponding Member AN SSSR; Vladimir Vasil'yevich Migulin, Corresponding Member AN SSSR; Eval'd Rudol'fovich Mustel', Corresponding Member AN SSSR; Yuriy Andreyevich Osip'yan, Corresponding Member AN SSSR; Georgiy Anatol'yevich Amolenskiy, Corresponding Member AN SSSR; Boris Ivanovich Stepanov, Academician, Belorussian Academy of Sciences; Iosif Samuilovich Shklovskiy, Corresponding Member AN SSSR; and Yakov Shebselevich Shur, Corresponding Member AN SSSR.

Division of Physicotechnical Problems of Power Engineering

Aleksandr Pavolovich Vanichev, Corresponding Member AN SSSR; Igor' Alekseyevich Glebov, Corresponding Member AN SSSR; Dmitriy Georgiyevich Zhimerin, Corresponding Member AN SSSR; Nikolay Stepanovich Lidorenko, Corresponding Member AN SSSR; Ivan Ivanovich Novikov, Corresponding Member AN SSSR; Valeriy Ivanovich Subbotin, Corresponding Member AN SSSR; and Zinoviy Fedorovich Chukhanov, Corresponding Member AN SSSR.

Division of Mechanics and Control Processes

Vsevolod Sergeyevich Avduyevskiy, Corresponding Member AN SSSR; Petr Mikhaylovich Alabuzhev, Doctor of Technical Sciences, professor; Oleg Mikhaylovich Belotserkovskiy, Corresponding Member AN SSSR; Konstantin Davydovich Bushuyev, Corresponding Member AN SSSR; Lev Aleksandrovich Galin, Corresponding Member AN SSSR; Eduard Ivanovich Grigolyuk, Corresponding Member AN SSSR: Viktor Dmitriyevich Kupradze, Academician, Georgian Academy of Sciences; Viktor Petrovich Makeyev, Corresponding Member AN SSSR; Dmitriy Yevgen'yevich Okhotsimskiy, Corresponding Member AN SSSR; Georgiy Stepanovich Pisarenko, Academician, Ukrainian Academy of Sciences; Khalil Akmedovich

Rakhmatulin, Academician, Uzbek Academy of Sciences; Georgiy Petrovich Svishchev; Corresponding Member AN SSSR; Gorimir Gorimirovich Chernyy, Corresponding Member AN SSSR; Nikolay Vasil'yevich Cherskiy, Corresponding Member AN SSSR; and Aleksandr Sergeyevich Yakovlev, Corresponding Member AN SSSR.

Division of General and Technical Chemistry

Nikolay Sergeyevich Yenikolopov,Corresponding Member AN SSSR; Viktor Aleksandrovich Kabanov, Corresponding Member AN SSSR; Vasiliy Vladimirovich Korshak, Corresponding Member AN SSSR; Mikhail Mikhaylovich Koton, Corresponding Member AN SSSR; Viktor Mikhaylovich Nikitin, Doctor of Chemical Sciences, professor; Sagid Raufovich Rafikov, Corresponding Member AN SSSR; and Viktor Nikolayevich Tsvetkov, Corresponding Member AN SSSR.

Division of Physicochemistry and the Technology of Inorganic Materials

Valentin Borisovich Aleskovskiy, Corresponding Member AN SSSR; Viktor Vyacheslavovich Kafarov, Corresponding Member AN SSSR; Askar Minliakhmedovich Kunayev, Corresponding Member AN SSSR: Boris Nikolayevich Laskorin, Corresponding Member AN SSSR; Vladimir Aleksandrovich Malyusov, Corresponding Member AN SSSR: Georgiy Aleksandrovich Nikolayev, Corresponding Member AN SSSR: Igor' Mikhaylovich Pavlov, Corresponding Member AN SSSR: Nikolay Nikolayevich Sirota, Academician, Belorussian Academy of Sciences; Aleksey Tikhonovich Tumanov, Corresponding Member AN SSSR; and Mikhail Mikhaylovich Shul'ts, Corresponding Member AN SSSR.

Division of Biochemistry, Biophysics, and Chemistry of Physiologically-Active Compounds

Il'ya Vasil'yevich Berezin, Corresponding Member AN SSSR; Semen Yefimovich Bresler, Doctor of Chemical Sciences, professor; Mikhail Vladimirovich Vol'kenshteyn, Corresponding Member AN SSSR; Vitaliy Iosifovich Gol'danskiy, Corresponding Member AN SSSR; Aleksandr Abramovich Krasnovskiy, Corresponding Member AN SSSR; Aleksandr Mikhaylovich Kuzin, Corresponding Member AN SSSR; and Ivan Aleksandrovich Terskov, Corresponding Member AN SSSR.

Division of Physiology

Ezras Asratovich Asratyan, Corresponding Member AN SSSR; Natal'ya Petrovna Bekhtereva, Corresponding Member AN SSSR: Ivan Andreyevich Bulygin, Academician, Belorussian Academy of Sciences; Leonid Grigor'yevich Voronin, Corresponding Member AN SSSR; and Oleg Georgiyevich Gazenko, Corresponding Member AN SSSR.

Division of Geology, Geophysics and Geochemistry

Dmitriy Pavlovich Grigor'yev, Doctor of Geological-Mineralogical Sciences, professor; Nikolay Porfir'yevich Yermakov, Doctor of Geological-Mineralogical

Sciences, professor; Vilen Andreyevich Zharikov, Corresponding Member AN SSSR; Lev Nilolayevich Ovchinnikov, Corresponding Member AN SSSR; Yekaterina Aleksandrovna Radkevich, Corresponding Member AN SSSR; Aleksandr Borisovich Ronov, Corresponding Member AN SSSR; Nikolay Panteleymonovich Semenenko, Academician, Ukrainian Academy of Sciences; Lev Vladimirovich Tauson, Corresponding Member AN SSSR; Aleksey Ivanovich Turgarinov, Corresponding Member AN SSSR; and Nikolay Ivanovich Khitarov, Corresponding Member AN SSSR.

Division of History

Yulian Vladimirovich Bromley, Corresponding Member AN SSSR; Al'bert Zakharovich Manfred, Doctor of Historical Sciences, professor; Petr Vladimirovich Milogradov, Doctor of Historical Sciences, professor; Dmitriy Alekseyevich Ol'derogge, Corresponding Member AN SSSR; and Sergey Leonidovich Tikhvinskiy, Corresponding Member AN SSSR.

Division of Philosophy and Law

Georgiy Aleksandrovich Aksenenok, Corresponding Member AN SSSR; Sergey Nikitich Bratus', Doctor of Juridical Sciences, professor; Fedor Ivanovich Kozhevnikov, Doctor of Juridical Sciences, professor; and Mikhail Solomonovich Strogovich, Corresponding Member AN SSSR.

Candidates for Corresponding Member

Division of Mathematics

Sergey Ivanovich Adyan, Doctor of Physicomathematical Sciences, professor; Vladimir Igoryevich Arnol'd, Doctor of Physicomathematical Sciences, professor; Nikolay Sergeyevich Bakhvalov, Doctor of Physicomathematical Sciences, professor; Vladimir Grigor'yevich Boltyanskiy, Corresponding Member, USSR Academy of Pedagogical Sciences; Anatoliy Georgiyevich Vitushkin, Doctor of Physicomathematical Sciences, professor; Sergey Konstantinovich Godunov, Doctor of Physicomathematical Sciences, professor; Aleksey Alekseyevich Dezin, Doctor of Physicomathematical Sciences, professor; Nikolay Vladimirovich Yefimov, Doctor of Physicomathematical Sciences, professor; Yevgeniy Petrovich Zhidkov, Doctor of Physicomathematical Sciences, professor; Yuriy Ivanovich Zhuravlev, Doctor of Physicomathematical Sciences, professor; Vladimir Yevgen'yevich Zakharov, Doctor of Physicomathematical Sciences; Il'dar Abdullovich Ibragimov, Doctor of Physicomathematical Sciences, professor; Vladimir Aleksandrovich Il'in, Doctor of Physicomathematical Sciences, professor; Anatoliy Alekseyevich Karatsuba, Doctor of Physicomathematical Sciences, professor; Nikolay Pavlovich Korneychuk, Correponding Member, Ukrainian Academy of Sciences; Lev Nikolayevich Korolev, Doctor of Physicomathematical Sciences, professor; Aleksey Ivanovich Kostrikin, Doctor of Physicomathematical Sciences; Mark Aleksandrovich Krasnosel'skiy, Doctor of Physicomathematical Sciences, professor; Lev

Dmitriyevich Kudryavtsev, Doctor of Physicomathematical Sciences, professor; Andrey Gennad'yevich Kulikovskiy, Doctor of Physicomathematical Sciences, professor; Aleksandr Fedorovich Lavrik, Doctor of Physicomathematical Sciences, professor; Mikhail Valer'yanovich Maslennikov, Doctor of Physicomathematical Sciences, professor; Viktor Pavlovich Maslov, Doctor of Physicomathematical Sciences, professor; Vladimir Mikhaylovich Millionshchikov, Doctor of Physicomathematical Sciences, professor; Valentin Petrovich Mikhaylov, Doctor of Physicomathematical Sciences, professor; Valentin Nikolayevich Monakhov, Doctor of Physicomathematical Sciences, professor; Ol'ga Arsen'yevna Oleynik, Doctor of Physicomathematical Sciences, professor; Valentin Vladimirovich Petrov, Doctor of Physicomathematical Sciences, professor; Viktor Aleksandrovich Pliss, Doctor of Physicomathematical Sciences, professor; Aleksey Ivanovich Prilepko, Doctor of Physicomathematical Sciences, professor; Yuriy Grigor'yevich Reshetnyak, Doctor of Physicomathematical Sciences, professor; Boris Alekseyevich Rogozin, Doctor of Physicomathematical Sciences, professor; Yuriy Leonidovich Rodin, Doctor of Physicomathematical Sciences, professor; Yuriy Anatol'yevich Rozanov, Doctor of Physicomathematical Sciences, professor; Viktor Vladimirovich Rusanov, Doctor of Physicomathematical Sciences, professor; Oleg Vasil'yevich Sarmanov, Doctor of Physicomathematical Sciences, professor; Aleksey Georgiyevich Sveshnikov, Doctor of Physicomathematical Sciences, professor, Boris Aleksandrovich Sevast'yanov, Doctor of Physicomathematical Sciences, professor; Yakov Grigor'yevich Sinay, Doctor of Physicomathematical Sciences; Anatoliy Vladimirovich Skorokhod, Corresponding Member, Ukrainian Academy of Sciences; Yuriy Mikhaylovich Smirnov, Doctor of Physicomathematical Sciences, professor; Ivan Denisovich Sofronov, Doctor of Physicomathematical Sciences; Vitautas Antanovich Statulyavichus, Academician, Lithuanian Academy of Sciences; Sergey Borisovich Stechkin, Doctor of Physicomathematical Sciences, professor; Petr Lavrent'yevich Ul'yanov, Doctor of Physicomathematical Sciences, professor; Nikolay Nikolayevich Chentsov, Doctor of Physicomathematical Sciences, and Al'bert Nikolayevich Shiryayev, Doctor of Physicomathematical Sciences, professor.

Division of General Physics and Astronomy

Tateos Artem'yevich Agekyan, Doctor of Physicomathematical Sciences, professor; Vladimir Moiseyevich Agranovich, Doctor of Physicomathematical Sciences, professor; Yevgeniy Borisovich Aleksandrov, Doctor of Physicomathematical Sciences; Semen Aleksandrovich Al'tshuler, Doctor of Physicomathematical Sciences, professor; Aleksandr Fedorovich Andreyev, Doctor of Physicomathematical Sciences; Sergey Ivanovich Anisimov, Doctor of Physicomathematical Sciences, professor; Neon Aleksandrovich Armand, Doctor of Technical Sciences; Vladimir Aleksandrovich Afanas'yev, Doctor of Technical Sciences, professor; Vadim Vasil'yevich Afrosimov, Doctor of Physicomathematical Sciences, professor; Sergey Aleksandrovich Akhmanov, Doctor of Physicomathematical Sciences, professor; Sergey Vasil'yevich Bogdanov, Doctor of Physicomathematical Sciences, professor; Aleksey Mikhaylovich Bonch-Buryevich, Doctor of Physicomathematical Sciences, professor; Aleksandr

Alekseyevich Boyarchuk, Doctor of Physicomathematical Sciences; Vladimir Borisovich Braginskiy, Doctor of Physicomathematical Sciences, professor; Vladimir L'vovich Broude, Doctor of Physicomathematical Sciences, professor; Fedor Vasil'yevich Bunkin, Doctor of Physicomathematical Sciences, professor; Viktor Sergeyevich Vavilov, Doctor of Physicomathematical Sciences, professor; Oleg Anatol'yevich Val'dner, Doctor of Technical Sciences, professor; Boris Aleksandrovich Vorontsov-Vel'yaminov, Corresponding Member, USSR Academy of Pedagogical Sciences; Mikhail Dmitriyevich Galanin, Doctor of Physicomathematical Sciences, professor; Al'bert Abubakirovich Galeyev, Doctor of Physicomathematical Sciences; Viktor Mikhaylovich Galitskiy, Doctor of Physicomathematical Sciences, professor; Vsevolod Feliksovich Gantmakher, Doctor of Physicomathematical Sciences; German Grigor'yevich Getmantsev, Doctor of Physicomathematical Sciences, professor: Yevgeniy Aleksandrovich Grebenikov, Doctor of Physicomathematical Sciences, professor; Yuriy Vasil'yevich Gulyayev, Doctor of Physicomathematical Sciences, professor; Aleksandr Viktorovich Gurevich, Doctor of Physicomathematical Sciences, Yuriy Nikolayevich Demkov, Doctor of Physicomathematical Sciences, professor; Lev Nikolayevich Deryugin, Doctor of Technical Sciences, professor; Andrey Nikolayevich Didenko, Doctor of Physicomathematical Sciences, professor; Mordukh Il'ich Yelinson, Doctor of Physicomathematical Sciences, professor; Mark Yefremovich Zhabotinskiy, Doctor of Technical Sciences, professor; Ivan Stepanovich Zheludev, Doctor of Physicomathematical Sciences, professor; Boris Vsevolodovich Zhigalovskiy, Doctor of Technical Sciences, professor; Nikolay Vladimirovich Zavaritskiy, Doctor of Physicomathematical Sciences; Georgiy Aleksandrovich Zaytsev, Doctor of Physicomathematical Sciences, professor; Boris Petrovich Zakharchenya, Doctor of Physicomathematical Sciences, professor; Vitaliy Anatol'yevich Zverev, Doctor of Physicomathematical Sciences, professor; Aleksandr Grigor'yevich Zel'dovich, Doctor of Technical Sciences, professor; Nikolay Viktorovich Zernov, Doctor of Technical Sciences, professor; Yuriy Aleksandrovich Izyumov, Doctor of Physicomathematical Sciences, professor; Lyatif Mukhtar ogly Imanov, Adacemician, Azerbaydzhan Academy of Sciences; Vladimir Sergeyevich Imshennik, Doctor of Physicomathematical Sciences; Vladimir L'vovich Indenbom, Doctor of Physicomathematical Sciences, professor; Sergey Petrovich Kapitsa, Doctor of Physicomathematical Sciences, professor; Samuil Aronovich Kaplan, Doctor of Physicomathematical Sciences, professor; Nikolay Semenovich Kardashev, Doctor of Physicomathematical Sciences; Nikolay Vasil'yevich Karlov, Doctor of Physicomathematical Sciences, professor; Andrey Aleksandrovich Kolomenskiy, Doctor of Physicomathematical Sciences, professor; Yevgeniy Ivanovich Kondorskiy, Doctor of Physicomathematical Sciences, professor; Ivan Mikheyevich Kopylov, Doctor of Physicomathematical Sciences; Samuil Borisovich Kormer, Doctor of Physicomathematical Sciences, professor; Leonid Sergeyevich Korniyenko, Doctor of Physicomathematical Sciences, professor; Anatoliy Vasil'yevich Korshunov, Doctor of Physicomathematical Sciences, professor; Vladimir Aleksandrovich Krasil'nikov, Doctor of Physicomathematical Sciences, professor; Grant Yegorovich Kocharov, Doctor of Physicomathematical Sciences, professor; Arian Il'ich Kuz'min, Doctor of Physicomathematical Sciences, professor; Arkadiy Dmitriyevich Kuz'min, Doctor of Physicomathematical

Sciences, professor; Anatoliy Ivanovich Larkin, Doctor of Physicomathematical Sciences, professor; Vladilen Stepanovich Letokhov, Doctor of Physicomathematical Sciences; Arnol'd Gennad'yevich Lundin, Doctor of Physicomathematical Sciences, professor; Leonid Mikhaylovich Lyamshev, Doctor of Physicomathematical Sciences, professor; Artur Afanas'yevich Mak, Doctor of Physicomathematical Sciences, professor; Gleb Ivanovich Makarov, Doctor of Physicomathematical Sciences, professor; Boris Aleksandrovich Mamyrin, Doctor of Physicomathematical Sciences, professor; Sergey Leonidovich Mandel'shtam, Doctor of Physicomathematical Sciences, professor; Mikhail Yakovlevich Marov, Doctor of Physicomathematical Sciences; Alla Genrikhovna Masevich, Doctor of Physicomathematical Sciences, professor; Viktor Vasil'yevich Matveyev, Doctor of Technical Sciences, professor; Gennadiy Andreyevich Mesyats, Doctor of Technical Sciences, professor; Andrey Leonovich Mikaelyan, Doctor of Technical Sciences, professor; Mikhail Mikhaylovich Miroshnikov, Doctor of Technical Sciences, professor; Mikhail Nikolayevich Mikheyev, Doctor of Technical Sciences, professor; Vasiliy Ivanovich Moroz, Doctor of Physicomathematical Sciences, professor, Andrey Antonovich Nemiro, Doctor of Physicomathematical Sciences, professor; Igor' Dmitriyevich Novikov, Doctor of Physicomathematical Sciences; Leonid Moiseyevich Ozernoy, Doctor of Physicomathematical Sciences; Vadim Semenovich Panasyuk, Doctor of Technical Sciences, professor; Yuriy Nikolayevich Pariyskiy, Doctor of Physicomathematical Sciences; Georgiy Aleksandrovich Pakholkov, Doctor of Technical Sciences, professor; Vsevolod Yur'yevich Petrun'kin, Doctor of Technical Sciences, professor; Leb Petrovich Pitayevskiy, Doctor of Physicomathematical Sciences, professor; Valeriy Leonidovich Pokrovskiy, Doctor of Physicomathematical Sciences, professor; Matvey Samsonovich Rabinovich, Doctor of Physicomathematical Sciences, professor; Yuriy Petrovich Rayzer, Doctor of Physicomathematical Sciences, professor; Sergey Glebovich Rautian, Doctor of Physicomathematical Sciences, professor; Emmanuil Iosifovich Rashba, Doctor of Physicomathematical Sciences, professor; Karl Karlovich Rebane, Academician, Estonian Academy of Sciences; Vadim Robertovich Regel', Doctor of Physicomathematical Sciences, professor; Vladislav Georgiyevich Repin, Doctor of Technical Sciences, professor; Igor' Aleksandrovich Rosselevich, Doctor of Technical Sciences, professor; Mikhail Mikhaylovich Rusinos, Doctor of Technical Sciences, professor; Anri Amvros'yevich Rukhadze, Doctor of Physicomathematical Sciences, professor; Solomon Meyerovich Ryvkin, Doctor of Physicomathematical Sciences, professor; Dmitriy Dmitriyevich Ryutov, Doctor of Physicomathematical Sciences; Anatoliy Ivanovich Savin, Doctor of Technical Sciences; Viktor Pavlovich Silin, Doctor of Physicomathematical Sciences, professor; Igor' Il'ich Sobel'man, Doctor of Physicomathematical Sciences, professor; Nikolay Nikolayevich Sobolev, Doctor of Physicomathematical Sciences, professor; Andrey Vladimirovich Sokolov, Doctor of Technical Sciences, professor; Arseniy Aleksandrovich Sokolov, Doctor of Physicomathematical Sciences, professor; Anatoliy Stepanovich Sonin, Doctor of Physicomathematical Sciences, professor; Vitaliy Ivanovich Stafeyev, Doctor of Physicomathematical Sciences, professor; Igor' Pavlovich Stepanenko, Doctor of Technical Sciences, professor; Boris Mikhaylovich Stepanov, Doctor of Physicomathematical Sciences, professor; Mikhail Mikhaylovich Suschinskiy, Doctor of Physicomathematical Sciences, professor;

Sergey Ivanovich Syrovatskiy, Doctor of Physicomathematical Sciences; Rashid Aliyevich Syunyayev, Doctor of Physicomathematical Sciences; Valer'yan Il'ich Tatarskiy, Doctor of Physicomathematical Sciences; Boris Arkad'yevich Tverskoy, Doctor of Physicomathematical Sciences, professor; Yakov Petrovich Terletskiy, Doctor of Physicomathematical Sciences, professor; Igor' Mikhaylovich Ternov, Doctor of Physicomathematical Sciences, professor; Vasiliy Ivanovich Tikhonov, Doctor of Technical Sciences, professor; Kirill Borisovich Tolpygo, Corresponding Member, Ukrainian Academy of Sciences; Aleksandr Markovich Trokhan, Doctor of Technical Sciences, professor; Yevgeniy Akimovich Turov, Doctor of Physicomathematical Sciences, professor; Immanuil Lazarevich Fabelinskiy, Doctor of Physicomathematical Sciences, professor; Abram Borisovich Fradkov, Doctor of Technical Sciences, professor; Moisey Semenovich Khaykin, Doctor of Physicomathematical Sciences; Velior Petrovich Shabanskiy, Doctor of Physicomathematical Sciences; Kusiyel' Solomonovich (Shlemovich) Shifrin, Doctor of Physicomathematical Sciences, professor; Aleksey Petrovich Shotov, Doctor of Physicomathematical Sciences, professor; and Vol'f Bentsionovich Shteynshleyger, Doctor of Technical Sciences, professor.

Division of Physicotechnical Problems of Power Engineering

Vyacheslav Yevgen'yevich Alemasov, Doctor of Technical Sciences, professor; Viktor Petrovich Belyakov, Doctor of Technical Sciences, professor; Leon Mikhaylovich Biberman, Doctor of Technical Sciences, professor; Irakli Grigor'yevich Gverdtsiteli, Corresponding Member, Georgian Academy of Sciences; Sergey Dmitriyevich Grichin, Doctor of Technical Sciences, professor; Kamo Seropovich Demirchyan, Doctor of Technical Sciences, professor; Sergey Petrovich Izotov, Doctor of Technical Sciences; Oleg Dmitriyevich Kazachkovskiy, Doctor of Physicomathematical Sciences, professor; Nikolay Vasil'yevich Kolomoyets, Doctor of Technical Sciences, professor; Aleksandr Dmitriyevich Konopatov, Doctor of Technical Sciences, professor; Mikhail Gerogiyevich Kruglov, Doctor of Technical Sciences, professor: Sergey Nikolayevich Kritskiy, Doctor of Technical Sciences, professor; Vyacheslav Alekseyevich Kuznetsov, Doctor of Physicomathematical Sciences, professor; Vladimir Il'ich Levitov, Doctor of Technical Sciences, professor; Aleksandr Ivanovich Leont'yev, Doctor of Technical Sciences, professor; Valentin Yakovlevich Likhushin, Doctor of Technical Sciences, professor; Nikolay Aleksandrovich Malyshev, Doctor of Technical Sciences; Grigoriy Froimovich Muchnik, Doctor of Technical Sciences, professor; Petr Stepanovich Neporozhniy, Doctor of Technical Sciences, professor; Boris Sergeyevich Petukhov, Doctor of Technical Sciences, professor; Igor' Borisovich Rubashov, Doctor of Physicomathematical Sciences, professor; Ashot Arakelovich Sarkisov, Doctor of Technical Sciences, professor; Konstantin Pavlovich Seleznev, Doctor of Technical Sciences, professor; Viktor Alekseyevich Sidorenko, Doctor of Technical Sciences; Nikolay Nikolayevich Tikhodeyev, Doctor of Technical Sciences, professor; Lev Nikolayevich Usachev, Doctor of Physicomathematical Sciences, professor; Nikolay Sidorovich Khlopkin, Doctor of Technical Sciences; Valentin Yevgen'yevich Chelnokov, Doctor of Technical Sciences; Shafik Chokinovich Chokin, Academician, Kazakh Academy of Sciences; Vladimir

Vasil'yevich Shashkin, Doctor of Technical Sciences, professor; Sergey Borisovich Shikhov, Doctor of Physicomathematical Sciences, professor; and Eval'd Emil'yevich Shpil'rayn, Doctor of Technical Sciences, professor.

Division of Mechanics and Control Processes

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Division of Oceanology, Atmospheric Physics and Geography

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Division of History

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Siberian Department

Gennadiy Ignat'yevich Gritsko, Doctor of Technical Sciences, professor; Aleksandr Sergeyevich Isayev, Doctor of Biological Sciences; Gennadiy Pavlovich Kurbatkin, Doctor of Physicomathematical Sciences; Mikhail Vladimirovich Kurlenya, Doctor of Technical Sciences; Gennadiy Alekseyevich Mikhaylov, Doctor of Physicomathematical Sciences, professor; Yuriy Nikolayevich Rudenko, Doctor of Technical Sciences; Ryurik Konstantinovich Salyayev, Doctor of Biological Sciences; and Yevgeniy Ivanovich Shemyakin, Doctor of Technical Sciences, professor.

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USSR ACADEMY OF SCIENCES ANNOUNCES MEMBERSHIP VACANCIES

Moscow IZVESTIYA in Russian 23 Oct 76 p 5

[Article by the president of the USSR Academy of Sciences, Academician A. P. Aleksandrov, and the acting chief scientific secretary of the Presidium of the USSR Academy of Sciences, A. V. Fokin: "From the Academy of Sciences of the Union of Soviet Socialist Republics"]

[Text] The USSR Academy of Sciences, including the Siberian Department and the Far East and Urals Scientific Centers, in accordance with Paragraphs 21 and 22 of its decree hereby advertises the available vacancies for active member (academician) and corresponding member of the USSR Academy of Sciences in the following specialties:

	Active Member	Corresponding Member
DIVISION OF MATHEMATICS		
"Mathematics"	3	3
DIVISION OF GENERAL PHYSICS AND ASTRONOMY		
"Physics, Astronomy"	2	--
"Radiophysics, Radioengineering, Electronics"	1	2
"Physics"	--	4
"Astronomy, Radioastronomy, Astrophysics"	--	1
DIVISION OF PHYSICOTECHNICAL PROBLEMS OF POWER ENGINEERING		
"Power Engineering"	1	3
DIVISION OF MECHANICS AND CONTROL PROCESSES		
"Mechanics"	1	2
"Machine-Building"	--	1
"Control Processes"	--	1

DIVISION OF GENERAL AND TECHNICAL CHEMISTRY		
"High Molecular Compounds"	1	1
"Physical Chemistry"	--	1
DIVISION OF PHYSICOCHEMISTRY AND THE TECHNOLOGY OF INORGANIC MATERIALS		
"Physicochemistry and the Technology of Inorganic Materials"	1	2
"Inorganic Chemistry"	--	1
DIVISION OF BIOCHEMISTRY, BIOPHYSICS AND THE CHEMISTRY OF PHYSIOLOGICALLY-ACTIVE COMPOUNDS		
"Biological and Chemical Physics"	1	--
"Cell Biology"	--	1
"Physiology of Microorganisms"	--	1
"Chemistry of Physiologically-Active Compounds"	--	2
DIVISION OF PHYSIOLOGY		
"Physiology"	1	1
DIVISION OF GENERAL BIOLOGY		
"Genetics"	--	1
"Parasitology"	--	1
"General Biology"	--	1
"Biology of Inland Waters"	--	1
DIVISION OF GEOLOGY, GEOPHYSICS AND GEOCHEMISTRY		
"Geochemistry, Mineralogy"	1	--
"Geochemistry"	--	1
"Regional Geology"	--	2
"Geology, Combustible Minerals"	--	2
"Geology, Seismology"	--	1
"Mining Sciences"	--	1
DIVISION OF OCEANOLOGY, ATMOSPHERIC PHYSICS AND GEOGRAPHY		
"Hydrology"	--	1
"Physical Geography"	--	1

DIVISION OF HISTORY		
"General History"	1	2
"USSR History"	--	4
"Eastern Studies"	--	1
DIVISION OF PHILOSOPHY AND LAW		
"Law"	1	1
"Philosophy"	--	1
"Psychology"	--	1
DIVISION OF ECONOMICS		
"Economics"	--	3
DIVISION OF LITERATURE AND LANGUAGE		
"Literature"	--	1
SIBERIAN DEPARTMENT		
"Rock Mechanics"	--	1
"Power Engineering"	--	1
"Biology"	--	1
"Atmospheric Physics"	--	1

Scientists who have enriched science by works of prime scientific significance are elected active members (academicians) of the Academy of Sciences in accordance with Paragraph 16 of the Decree of the USSR Academy of Sciences.

Scientists who have enriched science by noted scientific works are elected corresponding members of the Academy of Sciences in accordance with Paragraph 17 of the Decree of the USSR Academy of Sciences.

The chief duty of active members and corresponding members of the USSR Academy of Sciences in accordance with Paragraph 32 of the Decree of the USSR Academy of Sciences, is to enrich science by new achievements and discoveries by personally carrying out scientific research, organizing collective development of leading scientific problems, and providing scientific leadership in this effort.

Active members and corresponding members of the USSR Academy of Sciences actively help to introduce scientific achievements into the national economy and utilize them in cultural construction, carry out work on preparing and increasing the qualifications of scientific cadres, are obligated to fulfill missions of the USSR Academy of Sciences and the appropriate divisions, and participate in the work of general meetings of appropriate divisions.

Active members (academicians) and corresponding members of the Academy of Sciences who are elected to vacancies separately provided for the Siberian Department will carry out work in Siberian institutions; those elected to vacancies provided for the Far East and Urals Scientific Centers will carry out work in scientific institutions of the appropriate centers of the USSR Academy of Sciences.

Councils of scientific institutions and higher educational establishments, state and social organizations, and active and corresponding members of the Academy of Sciences are permitted to report in writing within 1 month of publication date, enclosing the proper justification, the names of candidates for active and corresponding members of the USSR Academy of Sciences as indicated in the published specialties (Paragraph 23 of the Decree).

It is necessary to submit the following documents (in duplicate) for the candidates for active member (academician) and corresponding member of the USSR Academy of Sciences: presentation (decision) of councils, state and social organizations or a letter with appropriate justifications concerning a candidate's promotion; autobiography; individual sheets for cadre registration; list of scientific works (form No 3); characteristics of candidate's production-social activities; and three copies of a 4.5x6 cm photograph.

Designated material will be submitted to this address: 117901 GSP-1 Moscow B-71, Leninskiy Prospekt 14, Academy of Sciences USSR.

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