SHORT COMMUNICATIONS

SPACE EXPLORATION: CONTINUITY AND NOVELTY*

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EVERY space flight is a natural continuation of the process of the conquest of outer space by mankind, of the extension of our knowledge of the universe. Thus, each space flight has the features of continuity. But at the same time each new flight involves extension and deepening of man's knowledge about the space. Therefore, it has also to face and solve new problems.

The Soviet-Indian space mission has its own face which distinguishes it from the previous international space missions: The crew of Malyshev, Strekalov and Sharma laid more stress on medical experiments for the millions of people on earth and also those who will be working in outer space in the future.

It is yet too early to dwell on the scientific results of the mission. But one thing is obvious: a lot of information has been obtained, which experts will have to deal with for months. The mission on board the *Soyuz T-11* spaceship will undoubtedly enrich our knowledge.

New Medical Experiments

It appears that cardio-vascular system of man first reacts to weightlessness. The system of space-based blood circulation control system was supplemented with a new method known as ballistic cardiography, as zero-gravity has allowed systolic energy on any part of the cosmonaut's body. Heart contractions are registered by piezoelectric transducers sensitive to pulsation of blood vessels and the adjoining tissues of the body.

Samples of cosmonauts' blood were taken and analysed in orbit for the first time. A few blood samples were conserved and brought back to earth for a more thorough examination.

It may seem ridiculous to presume that eyesight undergoes any metamorphosis in outer space. However, even though resting on established laws of optics, it also seems to be prone to strange phenomena. Cosmonauts say that even when they keep their bodies and eyes from moving, they can sometimes see a displacement of things they know are immobile. It is certainly an optical illusion, most probably caused by lack of coordination between the vestibular apparatus and eye movement mechanism, something that operates unfalteringly on the earth under the impact of the force of gravity. The experiment code-named Optokinez and developed by Indian experts is expected to cure this ailment known as the "movements-disease".

There was one experiment with a heavy Indian accent during which Rakesh Sharma did some Yoga exercises, with transducers registering the acitivity of various muscles of his body and the coordinating properties of his locomotor system. Man's ability to control his muscles and blood circulation could be of utmost importance in putting off the hazardous effects of weightlessness.

Although the mission focussed on medical experiments, we nevertheless tend to view them as auxiliary, as they were designed to make cosmonauts in orbit healthy and fit in their main work to learn more about the earth and the universe and promote the use of science in the national economy.

Study of India's resources

Of special importance for India was the observation of its territory and the coastal shelf zone from outer space as the vast resources of the Indian Peninsula have scarcely been prospected.

The Soviet-Indian crew studied fractures in India's territory, looking for polymetallic ores and other minerals, including oil and gas bearing formations. Mountains also interested the cosmonauts because of their vast glaciers in the Central Himalayas, as those immense stocks of pure water largely define the hydrological regime of the region. The rivers were observed to help combat environmental pollution.

It is highly probable that even the most carefully studied photographs of India's territory will contain information to be discovered by experts later. Instances exist when an expert examining some old photographs suddenly discovered an untapped secret. So every Indian and Soviet expert who is yet to study the data obtained by the *Soyuz T-11*'s crew can count on unexpected discoveries.

*By courtecy of the Information Department, USSR Embassy in India.

High quality crystal in Space

An important discovery was made in space technology during the first Soviet attempt to weld materials on board the *Soyuz-6* ship in 1969. In outer space, under zero gravity, the newly formed crystal lattices have much less irregularities in their structure as compared to the crystals formed on the earth. The high quality crystals are of immense importance for many branches of science and technology. Some quite unusual things may happen in weightlessness, even though lasting for a short while. Specialists have not been able to explain them so far. For example crystals have been fabricated both in orbital laboratories, and also in space rockets. In the space rockets crystal has to be fabricated quickly in less than 10 min during which near zero environment can be achieved. This process involves taking the sample upto 1500°C and then crystallizing. There were instances when a crystal "baked" so quickly proved to be much more perfect and had an almost ideal lattice structure which is difficult to obtain even in an orbital laboratory.

An experiment proposed and prepared by the Indians involved the study of the pervasive nature of crystal formation in weightlessness. It boiled down to creating such conditions under which the mixture of smelted silver and germanium cooled below the solidification point remained in its liquid form. Such an unusual state is called the supercooling of liquid. During fast cooling a supercooled liquid may develop into a substance with some very unusual qualities, such as "metallic glass".

In its significance the experiment is not inferior to those involving the crystals of cadmium, mercury and tellurium which have been repeatedly conducted by Soviet cosmonauts and their colleagues from socialist countries. In weightlessness all the three components of the mixture merge into a single compound without any problems which would be there on the Earth because of the considerable differences in the density of cadmium, tellurium and mercury. Crystals thus obtained effectively transform infrared and thermal rays into visible images. The technology was used to manufacture heat sensors—the devices allowing a physician to diagnose a disease at an early stage and take appropriate measures.

The Soviet-Indian cooperation in outer space and on the earth has good prospects for the future, with both nations taking more joint steps to promote mutual interests and those of the entire mankind.

VIBRATIONAL SPECTROSCOPIC STUDY OF THE STRUCTURAL PHASE TRANSITION IN $LiCsSO_4$

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DOUBLE sulphate crystals with the general formula $M'M''SO_4$ ($M', M'' = Li^+, K^+, Cs^+, Rb^+$) show many interesting phase transitions. $LiCsSO_4$ which belongs to this family shows a structural phase transition at 202 K, from the room temperature (18–23°C) orthorhombic Pcmn phase to a low temperature monoclinic $P2_1/n$ phase. In the low temperature monoclinic phase the SO_4 ions lose their plane of site symmetry. Investigations[1-4] on its elastic and thermal properties and structure have been carried out on this crystal to understand this phase transition. In this brief note we report for the first time some interesting Raman spectroscopic results on the phase transition in $LiCsSO_4$.

A Spex Ramalog double monochromator spectrometer was used with an Argon ion laser (4880 A, at 250 mw power) to record the polarized Raman spectra. In the room temperature Pcmn symmetry phase, all the Li^+, Cs^+ and SO_4^{2-} ions occupy Cs sites. In both phases of the crystal the number of formula units in the primitive unit cell is $Z = 4$. In the room temperature phase, the modes of the species A_g, B_{1g}, B_{2g} and B_{3g} are Raman active. In six polarisation settings of the crystal, the Raman spectra were recorded both in the external and internal mode frequency regions. This enabled the identification of all the phonon modes of the crystal belonging to various symmetry species. Table 1 shows the correlation diagram for the free, site and unit cell symmetry of SO_4 ions in the orthorhombic and monoclinic phases.

From the first correlation diagram, it is seen that at room temperature (D_{2h}^{16} symmetry), in the three A_g (aa, bb, cc) settings only one symmetric stretching mode (ν_1), only one of the two symmetric bending modes (ν_2), two of the asymmetric stretching triplet (ν_3) modes and two of the asymmetric bending triplet (ν_4) modes should be seen if there is no observable correlation splitting on account of $Z = 4$. The same number of Raman lines should be observed in the B_{2g}(ac) polarisation setting also. This is borne out fully since the spectra showed one ν_1 line (1018 cm^{-1}), one of the ν_2 lines (450 cm^{-1}) and two lines each of ν_3 and ν_4 modes (628 cm^{-1}, 650 cm^{-1}, 1124 cm^{-1}, 1158 cm^{-1}), in the