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In memory of Gerogiĭ Vyacheslavovich Kurdyumov

July 6, 1996 was the last day in the life of Georgiĭ Vyacheslavovich Kurdyumov, a scientist of world renown, an outstanding experimental physicist, a major authority on the physics of metals, a full member of the Russian Academy of Sciences, a Hero of Socialist Labour, and a laureate of State Prizes.

Brought up in the famous school of physics led by Abram Fedorovich Ioffe, Kurdyumov was the acknowledged leader of metal physicists in our country. His name is associated with most major achievements in the physics of metals. These include the modern theory of phase transformations, research into the nature of hardening and softening of metals, the application of advanced physical methods of analysis to studies of the real crystal structure, and the development of new strong and high-temperature materials. Of these areas, a special place in Kurdyumov's scientific career was taken up by martensitic transformations, which, from a problem of topical interest for the metals science in the 1920s, has now grown into a broad field of solid-state physics.

Kurdyumov was born into the family of a priest in the town of Ryl'sk, Kursk region, on February 14, 1902. After he finished a unified labour school, he worked as a teacher, was among the founders of the Ryl'sk People's University, and chaired its council. In 1921, the Ryl'sk Education Board sent him to Petrograd to continue his education. He entered the Faculty of Physics and Mechanics the Petrograd University, from which he graduated in 1926. In 1923, Academician Ioffe invited him, along with a group of students, to do experimental work at the Leningrad Physicotechnical Institute (LPTI).

At the LPTI, still as a student, Kurdyumov completed his first research assignment in which he was to elucidate the atomic and crystal structure of quenched steel, using the then new X-ray diffractometry. And in a joint project with N Ya Selyakov and N T Gudtsov in 1924 – 1926, they found that the martensite forming from austenite when a steel specimen was quenched was a supersaturated solution of carbon in α-iron with a tetragonally distorted lattice. They also found that the degree of tetragonality was determined by the carbon content and independent of the cooling rate. These findings brought Kurdyumov to conclude that the transformation of austenite to martensite did not involve diffusion and to hypothesize that it proceeded via a regular rearrangement of atoms such that the resulting phase took up a regular orientation relative to the original phase. His hypothesis was confirmed in the now classical work by Kurdyumov and Sachs, which was carried out during his professional visit to Germany in 1930. Using single austenite crystals, the two scientists were able, for the first time ever, to observe that after quenching the phases took up a well-defined relative orientation (the Kurdyumov – Sachs relation). This work, which metal physicists throughout the world were quick to acclaim, marked the beginning of research into changes in the arrangement of atoms upon phase transformations in solids.

Georgiĭ Vyacheslavovich Kurdyumov

Kurdyumov made a huge contribution to the progress of physics in the Ukraine. In 1932, he moved to Dniepropetrovsk where he set up an X-ray laboratory and carried on the research into phase transformations he had started at the LPTI. Together with V I Danilov and B N Finkelshtein, he founded the Dniepropetrovsk Physico-Technical Institute, set up the Department of Metal Physics at the Dniepropetrovsk State University, and arranged and led the first All-Union conference on the application of X-rays to the study of

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metals, held in Dniepropetrovsk in 1936. In 1934, Kurdyumov was promoted to a professorship, and in 1939 he was elected a full member of the Ukrainian Academy of Sciences and a member of its Presidium. Kurdyumov was the founder (in 1945) and the first director of the Institute of Metal Physics in Kiev, now a major research center in physics in the Ukraine. Recently the institute was named after Kurdyumov, which is a just recognition of his services to science in the Ukraine.

The Dniepropetrovsk period in Kurdyumov's scientific career was extremely fruitful. Particular mention should be made of the studies he made together with his coworkers into the phase transformations in eutectoid copper alloys. It was found, that given a sufficiently high cooling rate, such alloys would undergo transformations which were similar, in terms of kinetic and structural features, to the austenite-to-martensite transformation. Following Kurdyumov's suggestion, all such transformations were named martensitic. From experimental studies into martensitic transformations in steel and non-ferrous metals, Kurdyumov defined them as follows: 'A martensitic transformation consists in a regular rearrangement of the lattice, in which the atoms do not exchange places but solely move relative to one another through distances not greater than interatomic distances.' This definition, which Kurdyumov formulated in 1936, holds even today as it properly reflects the main feature of the transformations — the cooperative character of atomic shifts.

It is known today that transformations taking place in non-metallic crystals are likewise of martensitic character. It is clear that martensitic transformations are a characteristic property of solids and show up whenever the driving force for the formation of a new phase is sufficiently great and the probability of diffusion transport is low. Such a situation arises upon the heavy supercooling of a high-temperature phase or at high pressures in combination with low temperatures. For example, it has been found that the martensitic mechanism is involved in the transformation of the graphite structures of carbon and boron nitride to high-pressure metastable phases with a wurzite-like lattice, which are intermediate structures in the formation of diamond and cubic boron nitride.

These and other studies have confirmed the exceptional fruitfulness of Kurdyumov's theory of martensitic transformations, which combined thermodynamic, kinetic, and structural approaches to phase transitions and has determined, for many years to come, the key areas of solid-state physics to be investigated.

In August 1941, Kurdyumov's Dniepropetrovsk Physico-Technical Institute was moved to Magnitogorsk because of the approaching hostilities, and its activities were now channeled to supporting the country's defence effort. Kurdyumov personally supervised work on improvements in tank armor and the development of steels for armor-piercing shells, and did much as the head of the Scientists' Committee for Assistance to the Front at the Magnitogorsk City Party Committee (although he was not a party member). In 1944, the Dniepropetrovsk FTI was moved to Moscow by a government decision where it was incorporated as an institute of metal science and metal physics into the Central Research Institute for Ferrous Metallurgy. Kurdyumov was director of this institute from 1944 to 1978.

Kurdyumov's activity as a scientist was widely acclaimed both in and outside the country. In 1946 he was elected a corresponding member and in 1953, as a full member of the USSR Academy of Sciences. In 1949 he was awarded a USSR State Prize of the first degree, and in 1984, a State Prize of the Ukraine. In 1969, Kurdyumov became a Hero of Socialist Labour. He was decorated with five Orders of Lenin and other orders. He was elected an honorary member by many foreign academic societies and received many medals bearing the names of outstanding scientists.

For all his high positions and worldwide fame, Kurdyumov remained invariably simple, readily accessible, and gentle. In a letter of birthday greetings, Academician L A Artsimovich wrote to Kurdyumov: 'If a contest were held for the academician who enjoys the highest sympathies and respect in the scientific community, you would, in all probability, be the only candidate for the gold medal. It is a rare occurrence to meet a person in whom truly outstanding services are combined with a heart as kind as yours.' Kurdyumov remained to the last day of his life a man worthy of imitation, surrounded by the love and respect of everyone who knew him.

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