Physics – Uspekhi **64** (10) 1067 – 1068 (2021) ©2021 Uspekhi Fizicheskikh Nauk, Russian Academy of Sciences

PERSONALIA

PACS number: **01.60.+q**

Vadim Veniaminovich Brazhkin (on his 60th birthday)

DOI: https://doi.org/10.3367/UFNe.2021.09.039058

October 24, 2021 will be the 60th birthday of the prominent Russian physicist, academician of the Russian Academy of Sciences (RAS), member of the Bureau of the Division of Physical Sciences of RAS, and doctor of physico-mathematical sciences Vadim Veniaminovich Brazhkin.

V V Brazhkin is a well-known specialist in the field of condensed matter physics, statistical physics, phase transition physics, and high-pressure physics and technology. He is known for his amazing efficiency, allowing him to productively work simultaneously in several areas of modern physics, and deep intuition, which, together with wide erudition and the ability to put forward nontrivial ideas, makes it possible to obtain world-class results. V V Brazhkin is the author of over 500 works well acknowledged and widely cited by specialists.

V V Brazhkin was born on October 24, 1961 in the town of Zlatoust in the Chelyabinsk region. After finishing school in 1978, he entered the Moscow Institute of Physics and Technology (MIPT) and graduated from there in 1984. That same year, he joined the postgraduate course at MIPT and, on leaving there and defending his candidate thesis in 1987, started working at the Institute for High Pressure Physics (IHPP) of the USSR Academy of Sciences. V V Brazhkin's further scientific activity was related to IHPP, where he has moved from junior research worker to director.

In 1982, while an MIPT student, V V Brazhkin began working at the Laboratory of Irreversible Polymorphic Transformations under the guidance of doctor of physico-mathematical sciences and head of this laboratory, Svetlana Vladimirovna Popova, who was then a well-known specialist in the field of phase transformations and high-pressure physics. This work was first of all related to the synthesis and investigation of superdense modification of silica (stishovite), carried out together with Sergei Mikhailovich Stishov.

Under the guidance of S V Popova, V V Brazhkin began studying phase transformations in disordered condensed matter (liquids, glasses, and amorphous solids) at high pressure. Originally, his task was to examine metastable crystal phases, but, in 1983, S V Popova visited Great Britain, where she got acquainted with Professor Gaskell, a specialist in metallic glasses. On arrival, S V Popova decided to develop the study of metallic glasses at IHPP and proposed that V V Brazhkin fabricate them under pressure. In the course of these studies, he began considering the behavior of glass-forming liquids under pressure. Since then, the analysis of liquids and glasses became one of the basic avenues of Vadim Veniaminovich'es scientific activity. He is one of the world leaders in this area. A new phenomenon — structure transformations in melts of elementary substances and simple compounds (I_2, Se, S, Te, Bi, $AlCl_3$, AsS, As_2S_3, B_2O_3, etc.) under pressure — was first discovered and examined in V V Brazhkin's studies. It has been established that these transformations are accompanied by abrupt changes in the structure and properties of liquids and that, in some substances, dielectric–metal transitions occur.

Vadim Veniaminovich Brazhkin

A series of fundamental studies of abrupt and smeared structure transformations in glasses and in amorphous solids (SiO_2, GeO_2, B_2O_3, P_2O_5, H_2O) was conducted under the guidance of V V Brazhkin. The logarithmic kinetics of such transformations, typical of relaxation phenomena in glasses, was discovered. Studies in this area, including those using computer simulation methods, have been carried out to date, and are one of the outstanding scientific approaches at IHPP.

While analyzing solid-phase crystal amorphization under pressure, V V Brazhkin was the first to obtain bulk phases of amorphous tetrahedral semiconductors (Si, G, $A_{III}B_V$). Bulk amorphous diamond-like carbon and nanographite states of carbon possessing high mechanical properties were obtained and examined in the study of fullerite C_{60} at high pressure. Solid-phase amorphization has been experimentally established to result from a decrease in the shear moduli of

Uspekhi Fizicheskikh Nauk **191** (10) 1127 – 1128 (2021)
Translated by M V Tsaplina

corresponding crystal lattices. The generality of the mechanisms of local lattice stability losses leading to melting and amorphization has been proved experimentally for silicon (Si). For several nonvitrescent molecular crystals (AsS, P_4Se_3, P_4S_3), real glasses were obtained under high pressure for the first time by quenching from melt.

V V Brazhkin performed a large series of studies investigating the effect of high pressure on the viscosity of liquids. The viscosity of many liquid oxides and halogenides undergoing phase transitions has been found to fall sharply under compression by several orders of magnitude, and liquid metal viscosity, to rise under pressure. New results were largely due to a successful application of a wide spectrum of new experimental methods such as *in situ* X-ray diffraction and X-ray radiography using synchrotron radiation.

The Frenkel line conception, named for the Soviet physicist Yakov Il'ich Frenkel (who made a great contribution to the modern notion of the physics of liquids) and which is now being intensely developed and widely acknowledged in the world literature devoted to the properties of fluids, should be specially emphasized. V V Brazhkin paid attention to the fact that molecule diffusion in gases is determined by free particle motion and interparticle collision processes (ballistic collisional regime), whereas in dense liquids diffusion is determined by activation hops of atoms or molecules (vibrational-hopping regime). A criterion was established to determine the line of change in the dynamic type in a supercritical fluid from the behavior of self-correlation functions of particle velocities, and, on this Frenkel line, the heat capacity of a liquid was found to decrease to a double Boltzmann constant per unit. It was also shown that, at points in the phase diagram below the Frenkel line in temperature, liquids exhibit transverse excitations, whereas, above the Frenkel line, longitudinal oscillations only may exist. This is responsible for the existence below the Frenkel line of positive sound dispersion vanishing above this line. The results obtained provide new insight into the very nature of the liquid state. Liquid was earlier assumed to possess a zero shear modulus, whereas now it can be said to demonstrate a finite shear rigidity at high frequencies, shear rigidity in gases being absent at any frequency.

The studies of transformations in liquids and glasses carried out by V V Brazhkin since 1986 have led, in fact, to the appearance of a new area in condensed state physics, which is now being intensely developed around the world. V V Brazhkin was a co-chair of the first international conference devoted to phase transformations in disordered media, attended by a majority of prominent specialists in this field from 19 countries.

V V Brazhkin's studies have been accorded wide recognition both in Russia and abroad and were repeatedly among the best achievements of RAS. In 2017, he was awarded the A G Stoletov Prize for a series of studies on phase transformations in liquids.

Vadim Veniaminovich successfully combines his scientific work with scientific-organizational and pedagogical activities. Since 2016, he has been director of IHPP RAS. The works of IHPP RAS scientists have been among the main achievements of RAS for the last 5 years. V V Brazhkin is a member of the Bureau of the Division of Physical Sciences of RAS, chair of the Presidium of Troitsk Research Center, chair of the Academic Council of IHPP RAS, and chair of the dissertation doctor council D002.097.01 at IHPP RAS. He is a member of editorial boards of the journals *Uspekhi Fizicheskikh Nauk* (*Physics–Uspekhi*), *Vestnik RAN* (*Herald of the Russian Academy of Science*), *Rasplavy* (*Melts*), and *Sverkhtverdye materialy* (*Journal of Superhard Materials*), and a member of the executive committee of the International Community for High Pressures, AIRAPT. For the last 30 years, V V Brazhkin has been a permanent organizer of the regular all-Russia conference of young scientists, Problems of Condensed State and High Pressure Physics.

Friends and colleagues heartily wish Vadim Veniaminovich all the best on his wonderful jubilee, which he celebrates in the prime of his life, and wish him sound health, happiness, and new achievements in science.

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