Preface

At the beginning of 1993, Scientific Committee for Combustion of Russian Academy of Sciences put forward the idea of organizing an international conference on combustion in Moscow in 1994 to be dedicated to the 80th birthday of Yakov Borisovich Zel’dovich (1914–1987), our great compatriot, an eminent scientist of modern times, a classic of science. The conference was conceived to demonstrate the crucial impact of the classical works of Zel’dovich on the development of the theory of combustion and explosion. The idea was favored by Presidium of the Russian Academy of Sciences, domestic and foreign research centers, and international science community.

The conference was co-organized by Institute of Structural Macrokinetics, Semenov Institute of Chemical Physics, Institute of Problems in Mechanics, Institute of Chemical Physics in Chernogolovka, and the Russian Section of the Combustion Institute. A representative Organizing Committee was set up, with participation of well-known scientists from many countries: Belgium, France, Germany, Italy, Japan, Poland, Portugal, Russia, Spain, United Kingdom, USA, and others. Academician Khariton, the doyen of domestic combustion and explosion science, was elected the Honorary Chairman of the Organizing Committee.

The conference was held September 12 through 17, 1994, at Voronovo resort of Ministry of Economy of the Russian Federation. Its technical program included 31 invited lectures and over 200 poster presentations at eight sessions:

- combustion kinetics
- ignition and steady-state flame propagation
- diffusion and heterogeneous combustion
- turbulent combustion
- unsteady combustion
- detonation
- combustion and detonation analogies
- intense shock waves and extreme states of matter.
Roundtable meetings were organized to discuss issues of current interest. Some 300 specialists participated in the Conference, including 60 scientists from abroad.

The conference was declared open by the Chairman of the Organizing Committee, Chairman of the Scientific Council on Combustion of the Russian Academy of Sciences, Corresponding Member of the Russian Academy of Sciences, Professor A. G. Merzhanov. In his opening speech, he told the audience about the role played by Academician Ya. B. Zel’dovich in the development of Soviet and international science and highlighted some traits of his extraordinary personality. “One is astonished by the broad Yakov Borisovich, which is not typical for classics”, said the speaker. “Chemical physics, physical chemistry, atomic physics, astrophysics, plasma physics, solid-state physics, and popular mathematics make up a far-from-complete list of the fields in which he demonstrated his talent. In his excellent papers on the theory of ignition and flame propagation, hydrodynamic theory of detonation and other numerous subjects, Ya. B. Zel’dovich proposed fundamental approaches to the development of modern combustion theory. It is surprising but true that, no matter what problems he addressed, Yakov Borisovich succeeded in obtaining groundlaying results. His papers carried new ideas so plentiful that they sufficed for further development by his followers.”

Yakov Borisovich was a person of unusual abilities. “Two of his traits so overwhelmingly impressed me personally”, said A. G. Merzhanov. “One of these was his fulminant comprehension. He grasped any idea by half a word. Talking to him was even boring: whatever you were going to say, he knew it in advance. And the other one was that he easily put his ideas in a clear and simple form. He always captured the audience, because everyone understood what he was saying. This is why each of his talks aroused a keen interest.”

Further on, A. G. Merzhanov told the story of founding the Scientific Council on Combustion of the Russian Academy of Sciences, originally chaired by Ya. B. Zel’dovich, and outlined the ideas underlying the organization of Zel’dovich Memorial, as the event was informally called.

Next, the Conference was addressed by Academician V. I. Gol’danskii, a friend and associate of Ya. B. Zel’dovich. Portraying Yakov Borisovich as a top-class scientist, for the novelty of his ideas and the significance of his results an indisputable representative of the Nobel-rank elite in physics and chemistry, V. I. Gol’danskii told the audience about the hardships that Yakov Borisovich suffered in his work. He quoted some documents in which attempts were made to throw doubt on the scientific achievements of Zel’dovich and his school and turned aside, emotionally but with good reasoning, the innuendoes and attacks of the antagonists. Time has proved that the contribution to international science made by Ya. B. Zel’dovich is immense.

Academician Yu. B. Khariton has sent a letter of welcome to the Conference, which was presented by Professor A. A. Brish, a colleague of Yakov Borisovich by the joint work on the Soviet nuclear weapons “on locaiton”. In his letter, Yu. B. Khariton exposes the rare gift of Zel’dovich for theoretical physics, as well as his ingenuity and
civic virtues. It is largely due to the efforts by Yakov Borisovich that the nuclear parity has been established and solutions to key problems in science and technology have been found, which contributed to the defensive preparedness of his country.

The plenary lecture 'Zel’dovich Ideas Developed by His Students and Followers' was delivered by Professor B. V. Novozhilov. The scope of the problems in combustion studied by Ya. B. Zel’dovich was incredibly diverse, and the methods of analysis that he proposed were efficient and fruitful. As a matter of fact, the modern theory of combustion and detonation is inseparably linked with the name of Zel’dovich. B. V. Novozhilov began his lecture with an overview of the works of Zel’dovich's closest students and focused on the analysis of the works of his followers. "Zel’dovich is still with us" — these were the last words of the lecture, in which B. V. Novozhilov summarized his conclusion that the ideas of Zel’dovich will survive and retain their importance in the further progress of science.


The Ignition and Steady-State Flame Propagation session was addressed by Professors A. G. Merzhanov and N. Peters (Germany). In 1990, A. G. Merzhanov was the first winner of the Zel’dovich Gold Medal awarded by the Combustion Institute and Russian Academy of Sciences for outstanding contributions to the development of combustion theory. A. G. Merzhanov summarized the results of the studies of combustion regimes in which the flame propagation velocity is determined by a nonequilibrium state of the matter in the wave. These are states characterized by incompleteness of chemical conversion and occurrence of intermediate temperatures (lower than those predicted by the laws of thermodynamics). The speaker overviewed three classes of nonequilibrium flame propagation: with formation of a physical or imaginary combustion front (so-called combustion regimes of the second kind), with strong self-inhibition of heat release, and with pronounced chemical stages.

N. Peters made a presentation on the kinetic foundations of the Zel’dovich–Frank-Kamenetski (ZFK) theory of thermal flame propagation, in which he compared the classical results with the current views for the case of predicted laminar flame propagation in a methane–air mixture. He showed that taking into account the multistage nature of combustion chemistry leads to a layered flame structure similar to that predicted by the ZFK theory but with several reaction zones. The author proposed an alternative (kinetic) explanation of flammability limits, based on an analysis of the processes taking place in the intermediate reaction layers of the flame structure.

The Diffusion and Heterogeneous Combustion session included presentations by Professors A. P. Aldushin (Russia), T. Hirano (Japan), L. A. Klyachko (Russia),
The turbulent combustion session was opened by the presentation of a review by Professor R. Bilger (Australia), a winner of the 1992 Zel'dovich Gold Medal. The review addressed the problems of closure of the equations of turbulent motion in combustion theory. In the author's opinion, "Turbulent combustion will never be an exact science, however, and the validity of models will not be established by consistent mathematical deduction from a fundamental law. Models are mere hypotheses and can only be disproved by showing they are inconsistent with basic laws such as the Navier-Stokes and species conservation equations or that they are inconsistent with experiment." The author has proposed a new approach to closing the turbulent reacting flow equations which yields results agreeing with experimental facts.

Professor A. Kuhl (USA) made an interesting presentation "Gasdynamic Model of Turbulent Combustion in an Explosion" focused on turbulent mixing and afterburning of the products of an atmospheric explosion of a high explosive. The study involved direct numerical integration of two-dimensional gasdynamic equations for an inviscid, nonconductive fluid. Convective mixing of the reactants has been shown to play a key role in high-Reynolds-number turbulent combustion.

Professors R. Borghi (France) and V. P. Karpov (Russia) addressed topics in premixed turbulent combustion.

The unsteady combustion session included presentations made by Professors B. Matkowsky (USA), P. Clavin (France), L. Deluca (Italy), G. Joulin (France), E. Oran (USA), and V. Zarko (Russia). The presentation by B. Matkowsky was titled "In the Footsteps of Zel'dovich: Nonlinear Evolution of the Zel'dovich and Other Cellular Flame Instabilities" and included some results of mathematical modeling of adiabatic and nonadiabatic cellular flames. Various issues in combustion instability were addressed in the presentations by G. Joulin, "On the Mechanism of Wrinkling for Expanding Premixed Flames", and L. DeLuca, "Intrinsic Stability Boundaries for Condensed Fuel Combustion". Dynamics of transient combustion processes was the subject of presentations by P. Clavin ("Analytical Studies of Unsteady Effects in Combustion Phenomena"), V. Zarko ("Simulation of Transient Solid Propellant Combustion"), and E. Oran ("Numerical Simulation of Unsteady Combustion"). E. Oran demonstrated the enormous power of modern computers as a research tool in solving problems in nonpremixed gas combustion and multifront structure of detonation waves. "In one of my last conversations with Professor Zel'dovich", she said, "he told me how excited he was that he had a chance now to use the supercomputer in Paris. I think that he believed, as I do, that we can use these new tools in a way to help us
understand the basic physics of flames and detonations."

The Detonation session was the most representative in terms of the number of participants and poster presentations. Invited lectures on various topics in detonation were given by Professors J. Shepherd (USA), S. M. Frolov (Russia), R. Klein (Germany), V. V. Mitrofanov (Russia), J. Lee (Canada), and I. Gupta (USA). Professor V. V. Mitrofanov, a leading Russian expert in gaseous detonation, gave a lecture titled "Gas Detonation Mechanism in View of Today", which attracted a large audience. The speaker paid tribute to the groundlaying role of Zel'dovich in the development of the contemporary detonation theory and analyzed current views on the mechanisms of initiation and propagation of detonations.

The Combustion and Detonation Analogies and Intense Shock Waves and Extreme States of the Matter sessions were included into the program to emphasize the broad scope of Zel'dovich's scientific interests. Adsorption and catalysis, heat transfer, magnetohydrodynamics, phase transitions, self-oscillatory processes, shock waves in solids were among the topics highlighted by the invited lectures and poster presentations in these sessions. The invited lectures on the "Analogies" included those presented by Professors E. Rumanov (Russia) and S. Wojcicki (USA), and the "Intense Shock Waves" session highlights were the lectures delivered by Professors V. V. Fortov (Russia) and N. A. Inogamov (Russia).

A brief review cannot adequately reflect the contents of numerous poster presentations, as well as the air of the poster sessions. In everybody’s opinion, the sessions were successful, and the format of poster presentation was quite effective.

The topics for round-table discussions were selected based on written suggestions made by the participants. The discussions were held on: High Explosives, co-chaired by R. Cheret (France) and V. I. Pepekin (Russia), Fire and Explosion Safety, by W. Kaufmann (USA) and P. Wolanski (Poland), and Ecology of Combustion, by S. S. Novikov (Russia) and T. Just (Germany).

This volume, Volume 1, includes invited plenary lectures and some materials of roundtable discussions. Volume 2 includes extended abstracts of poster presentations.

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