

Proceedings of the Nineteenth Lomonosov
Conference on Elementary Particle Physics



PARTICLE PHYSICS
at the Year of 150th Anniversary of
the Mendeleev's Periodic Table of
Chemical Elements

Editor

Alexander I. Studenikin

 World Scientific

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The volume of these proceedings is devoted to a wide variety of items, both in theory and experiment, of particle physics such as electroweak theory, fundamental symmetries, tests of standard model and beyond, neutrino and astroparticle physics, hadron physics, gravitation and cosmology, physics at the present and future accelerators.

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Faculty of Physics of Moscow State University



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Editor

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Faculty of Physics
Interregional Centre for Advanced Studies**



Mikhail Lomonosov
1711-1765

**NINETEENTH
LOMONOSOV
CONFERENCE
ON
ELEMENTARY
PARTICLE
PHYSICS**

Moscow, August 22-28, 2019

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**THIRTEENTH
INTERNATIONAL
MEETING
ON PROBLEMS
OF INTELLIGENTSIA**
“The Heritage and Future of the
Intelligentsia”

Moscow, August 28, 2019

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FOREWORD

The 19th Lomonosov Conference on Elementary Particle Physics was held at the Moscow State University (Moscow, Russia) on August 22–28, 2019 under the patronage of academician Victor Sadovnichy, the Rector of the Moscow State University.

The conference was organized by the Faculty of Physics of the Moscow State University in cooperation with the Joint Institute for Nuclear Research (Dubna) and the Institute for Nuclear Research of the Russian Academy of Sciences. The conference was supported by the Ministry of Science and Higher Education of Russia and the Russian Foundation for Basic Research. A reasonable support in organizing of the event was provided by the Interregional Centre for Advanced Studies and the Bruno Pontecorvo Neutrino and Astrophysics Laboratory (MSU).

One of the goals of the conference was to bring together scientists, both theoreticians and experimentalists, working in different fields. The conference has produced a high interest in the world scientific community and the organizers received a lot of applications to present a talk at the conference from scientists all over the world. The amount of applications reasonably surpassed the capacity to allocate oral talks within the six working days of the conference, therefore, 22 parallel sessions were organized at the conference. The physics programme of the 19th Lomonosov Conference includes reviews and original talks on a wide range of items such as neutrino and astroparticle physics, electroweak theory, fundamental symmetries, tests of Standard Model and beyond, heavy quark physics, non-perturbative QCD, quantum gravity effects, physics at the future accelerators. In total there were more than 400 participants from 31 countries with 221 talks including 90 plenary (25–20 min) and 125 sessions (20–10 min) talks and 6 poster presentations. A special Round Table discussion on “Frontiers in Particle Physics” was held during the closing day of the conference.

The 19th Lomonosov Conference was dedicated to the 150th anniversary of the Mendeleev’s Periodic Table of Chemistry Elements. The United Nations General Assembly proclaimed 2019 as the International Year of the Periodic Table of Chemical Elements. The discovery of the periodic law of changing the chemical and physical properties of elements is an important milestone in the knowledge of the fundamental laws of matter and marked the beginning of the modern stage of development of the microworld concept. This anniversary at the conference was celebrated by a special session.

As early as in 1983 the first of the series of conferences (from 1992 called the “Lomonosov Conferences”) was held at the Department of Theoretical Physics of the Moscow State University (June 1983, Moscow). The second conference was held in Kishinev, Republic of Moldavia, USSR (May 1985).

After the four years break this series was resumed on a new conceptual basis for the conference programme focus. During the preparation of the third conference (that was held in Maykop, Russia, 1989) a desire to broaden the programme to include more general issues in particle physics became apparent. During the conference of the year 1992 held in Yaroslavl (Russia) it was proposed by myself and approved by many participants that those irregularly held meetings should be transformed into regular events under the title “Lomonosov Conferences on Elementary Particle Physics”.

Since the conference of the year 1993 (the 6th Lomonosov Conference on Elementary Particle Physics) all of the subsequent conferences of this series were organized at the Moscow State University on a regular basis each odd year under the title the Lomonosov Conference on Elementary Particle Physics. A wide variety of interesting things, both in theory and experiment of particle physics, astrophysics, gravitation and cosmology, were included into the programmes. It was also decided to enlarge the number of institutions that would take part in preparation of the events.

The next 20th Lomonosov Conference will be held at the Moscow State University on August 19–24, 2021.

Mikhail Lomonosov (1711–1765), a brilliant Russian encyclopaedist of the era of the Russian Empress Catherine the 2nd, was world renowned for his distinguished contributions in the fields of science and art. He also helped to establish the high school educational system in Russia. The Moscow State University was founded in 1755 based on his plan and initiative, and the University now bears the name of Lomonosov.

There is a tradition to publish the conferences proceedings as a collection of review and research papers prepared by the conference speakers on the presented talks basis. It started in 1994 when publication of the volume “Particle Physics, Gauge Fields and Astrophysics” containing articles written by the speakers of the 5th and 6th Lomonosov Conferences was supported by the Accademia Nazionale dei Lincei (Rome, 1994). Proceedings of the 7th and 8th Lomonosov Conference (entitled “Problems of Fundamental Physics” and “Elementary Particle Physics”) were published by the Interregional Centre for Advanced Studies (Moscow, 1997 and 1999). Proceedings of the 9th, 10th, 11th, 12th, 13th, 14th, 15th, 16th, 17th, 18th and 19th Lomonosov Conferences (entitled “Particle Physics at the Start of the New Millennium”, “Frontiers of Particle Physics”, “Particle Physics in Laboratory, Space and Universe”, “Particle Physics at the Year of 250th Anniversary of Moscow University”, “Particle Physics on the Eve of LHC”, “Particle Physics at the Year of Astronomy”, “Particle Physics in the Year of Tercentenary of Mikhail Lomonosov”, “Particle Physics in the Year of Centenary of Bruno Pontecorvo”, “Particle Physics in the Year of Light”, “Particle Physics at the Silver Jubilee of Lomonosov

Conferences”) were published by World Scientific Publishing Co. (Singapore) in 2001, 2003, 2005, 2006, 2009, 2011, 2013, 2015, 2017 and 2019, respectively.

Following the tradition that has started in 1995, each of the Lomonosov Conferences on particle physics has been accompanied by a conference on problems of intellectuals. The 13th International Meeting on Problems of Intelligentsia held during the 19th Lomonosov Conference (August 28, 2019) was dedicated to discussions on the issue “The Heritage and Future of the Intelligentsia”.

The success of the 19th Lomonosov Conference was largely ensured by contributions of the International Advisory Committee and Organizing Committee. On behalf of these Committees I would like to warmly thank the session chairpersons, the speakers and all of the participants of the 19th Lomonosov Conference and the 13th International Meeting on Problems of Intelligentsia.

We are grateful to Victor Sadovnichy, the Rector of the Moscow State University, Victor Matveev, the Director of the Joint Institute for Nuclear Research, Leonid Kravchuk, the Director of the Institute for Nuclear Research of Russian Academy of Sciences, Andrey Fedyanin, the Vice Rector of the Moscow State University, Mikhail Itkis, the Vice Director of JINR for the support in organizing these two conferences.

We extremely appreciate continuous support of the Lomonosov Conferences from Nikolay Sysoev, the Dean of Faculty of Physics of the Moscow State University.

I would like to warmly thank our colleagues all over the world for their help in planning of the scientific programme of the meeting and inviting speakers for the topical sessions of the conference. Many thanks to Oscar Adriani, Yasuyuki Akiba, William Atwood, Ralf Aeverbeck, Alessandro Baldini, Rinaldo Baldini, Laura Baudis, Riccardo Brugner, Augusto Ceccucci, Patrizia Cenci, Mark Chen, Somnath Choudhury, Oliviero Cremonesi, Dmitry Denisov, Oleg Denisov, Antonio Di Domenico, Guido Drexlin, James Ferrando, Joseph Formaggio, Nicolao Fornengo, Brian Fujikawa, Cristian Galbiati, Marek Gazdzicki, Simone Giani, Carlo Giunti, Sergei Gninenko, Andrey Golutvin, Darren Grant, Claude Guyot, Douglas Hasell David Hertzog, Karl Jakobs, Takashi Kobayashi, Gennedy Kozlov, Yury Kudenko, Cristina Lazzeroni, Mikhail Libanov, Anna Lipniacka, Christine Marquet, Tsuyoshi Nakaya, Leonid Nemenov, Giovanni Passaleva, Haiping Peng, Ida Peruzzi, Federica Petricca, Sergey Petrushanko, James Pinfold, Gioacchino Ranucci, Grigory Rubtsov, Juerg Schacher, Kate Scholberg, Alan Schwartz, Bernhard Schwingenheuer, Maurizio Spurio, Guy Wilkinson, Masashi Yokoyama, Changzheng Yuan, and Qian Yue.

I would like to thank Konstantin Stankevich, Fedor Lazarev, Alexey Lichkov, and Andrey Egorov, the members of the conference Scientific Secretariat. Furthermore, I am very pleased to mention Albina Akhunova, Georgy Donchenko, Anna Petrova and Vadim Shakhov for their very efficient work in preparing and

running the meeting. I am also very thankful to Manya and Ivan Studenikin for their contribution.

I would also acknowledge Vladimir Arkhipov who made video records of the scientific sessions of the conference and interviews with the plenary speakers that are on view at the conference web site <http://lomcon.ru/>.

These Proceedings were prepared for publication at the Interregional Centre for Advanced Studies with support by the Russian Foundation for Basic Research. We are grateful to Professor Kok-Khoo Phua for supporting our long-term collaboration in publishing the proceedings of the Lomonosov conferences at World Scientific (Singapore).

Alexander Studenikin

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