

Tribute to Samoil Bilenky

A Great Physicist, A Mentor, A Friend



23 May 1928, Zmerinka (Ukraine), USSR
5 November 2020, Vancouver, Canada

- ▶ I am presenting this tribute because I knew Samoil well: we spent long times together, with many interesting discussions, and we collaborated on many studies since 1992.
- ▶ For me he was a friend, a mentor and my main collaborator for many years.



Torino, September 2015



Munich, May 2002



Barcelona, November 2002



**Самойл БИЛЕНЬКИЙ —
ученый с мировым именем, педагог
и прекрасный человек**

Известный физик-теоретик Самойл Михайлович Биленький ушел из жизни 5 ноября 2020 г. в Ванкувере в возрасте 92 лет. Когда в 1999 г. его друзья, коллеги и ученики отметили его 70-летие на конференции, специально организованной по этому случаю в Турине. Пьер Бернабу в шутку предложил изменить отчество Биленького на «Нейтрино». Уже тогда причина была очевидна. Сегодня же вклад С. М. Биленького в физику нейтрино и всю его блестящую карьеру в этом, можно, даже больше оправдывает инициативу этого предложения.

[JINR News 2021, No.1]

**Samoil BILENKY —
a world-famous scientist, teacher and
personality**

Renowned theoretical physicist Samoil Mikhelovich Bilenky passed away in Vancouver on 5 November 2020 at the age of 92. When in 1999 his friends, colleagues and pupils celebrated his 70th birthday at a conference specially organized for the occasion in Torino, P. Bernabeu suggested as a joke to change Bilenky's patronymic name to "Neutrino". Already at that time the reason was obvious. The many important contributions of S. Bilenky to neutrino physics during his life-long and brilliant career, now perhaps more than ever, justify a sort of canonization of such a suggestion.

SAMOIL MIKHELEVICH BILENKY 1928–2020

A pioneer of neutrino physics

Eminent Russian theorist Samoil Mikhelovich Bilenky, one of the founders of modern neutrino physics, passed away on 5 November 2020. A teacher of a generation of particle physicists, not only in Russia but also in many Eastern European countries and later in Western Europe, Samoil Bilenky played a leading role in the evolution of neutrino physics to the present day.

Bilenky was born in Zmerinka, Ukraine, to an engineering family. He graduated in 1952 cum laude from the renowned Moscow Engineering Physics Institute. His thesis adviser was Isaak Pomeranchuk. The same year, Bilenky got a permanent position at the Institute for Nuclear Problems in Dubna, near Moscow, which in 1956 became the Joint Institute for Nuclear Research (JINR), and ever since was a staff member at JINR. He obtained his PhD in 1957 for applications of the dispersion-relation theory to weak-interaction processes. In a subsequent series of articles, Bilenky discovered a general connection between polarisation effects and internal parities of particles in scattering processes and proposed a method for determining the parities of strange particles, later used in experiments at Berkeley and CERN. These articles also initiated the development of the polarisation-target technique.

Bilenky's most prominent contributions are in the field of neutrino physics. In a fruitful collaboration and co-authorship with the Italian/Soviet physicist Bruno Pontecorvo, which started in the early 1950s, he developed the theory of neutrino oscillations in vacuum and laid the foundations



Bilenky helped lay the foundations of the phenomenological theory of neutrino mixing.

of the phenomenological theory of neutrino mixing, on which every theoretical model of neutrino mass generation (including grand unified theories) is based. After Pontecorvo's passing in 1993, Bilenky continued to make original and insightful contributions to the development of neutrino physics. For his devotion to the studies of neutrinos, which he called "the most interesting among the elementary particles", and – in view of the fact that neutrino properties suggest the existence of physics beyond the Standard Model – "a gift of nature", his long-term friend and renowned particle physicist Jose Bernabeu

proposed once, jokingly, that Bilenky should be called "Mister Neutrino".

Bilenky was an excellent teacher, mentor and inspiration for many young researchers in the field of elementary particle and neutrino physics. His lectures on different topics in theoretical particle physics at Moscow University, where he taught for 30 years, and on neutrino physics at various international schools, were characterized by remarkable clarity. This made him a sought-after speaker and he was invited and gave lectures at universities across Europe. Bilenky initiated and was a tireless organizer of the well-known Pontecorvo Neutrino Physics School.

For his research and teaching activities Bilenky received many recognitions: the Russian state medal "For distinguished service to the State", the International Bruno Pontecorvo Prize, the Humboldt Prize, and the Medal of First Degree of the Faculty of Physics and Mathematics of Charles University in Prague, among others. He also wrote five books on particle-physics theory, which have helped and continue to help many young scientists enter into the fascinating fields of modern particle and neutrino physics.

Bilenky attracted people with his kind and obliging character, and had collaborators and friends in many countries. His warmth and benevolent personality embodied the best humanistic and cultural traditions of the Russian intelligentsia to which Samoil Mikhelovich Bilenky belonged. We shall miss him.

His colleagues and friends

[CERN Courier, May/June 2021]

▶ See also: [Serguey Petcov, Commemoration of Samoil Bilenky, XIX International Workshop on Neutrino Telescopes, February 2021](#)

- ▶ Samoil was born in Ukraine in 1928.
- ▶ He and his family left Ukraine when it was invaded by German troops during the Second World War.
- ▶ They went to some place in Siberia, far from the front.
- ▶ After the War, he studied in Moscow and graduated “cum laude” in 1952 under the supervision of I. Pomeranchuk.
- ▶ A short time later he started to work at the Laboratory for Nuclear Problems in Dubna, which was classified until 1954 and became JINR (Joint Institute for Nuclear Research) in 1956.
- ▶ Since 1956 Samoil was a staff member of JINR. He also gave lectures in Moscow.
- ▶ Although born in Ukraine, Samoil considered himself Russian.



S.M. Bilenky in 1966

- ▶ The early scientific career of Samoil was mainly devoted to the study of scattering of polarized particles (hadrons and leptons).
- ▶ He remained interested in this topic.
- ▶ Our second paper, in 1993, was on polarized $p\bar{p}$ scattering!
- ▶ He was very interested in nucleon properties, especially form factors.
- ▶ Samoil was the driving force of several papers on this topic with different collaborators (mainly Wanda Alberico, Torino) from about 1995 to 2009.

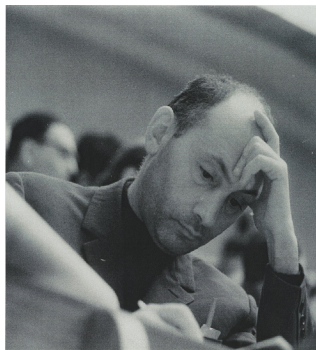


Wanda Alberico and Sofia Bilenkaya



Torino, 2018

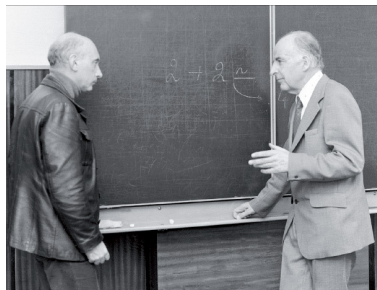
- ▶ Samoil and Bruno Pontecorvo were friends since the 50's, together with their families.
- ▶ He liked to tell stories of Bruno Pontecorvo and their adventures (hiking, camping, etc. together with their families).
- ▶ Around 1970 Samoil started to work on neutrino physics:
 - ▶ Bardin, Bilenky, Pontecorvo, On the $\nu - \nu$ interaction (1970); On the $\bar{\nu}_e + e \rightarrow \bar{\nu}_e + e$ process (1970)
 - ▶ Andryushin, Bilenky, Gershtein, Possible method of measuring the electromagnetic form factor of the neutrino (1971)



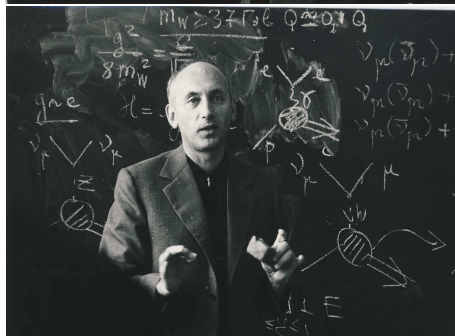
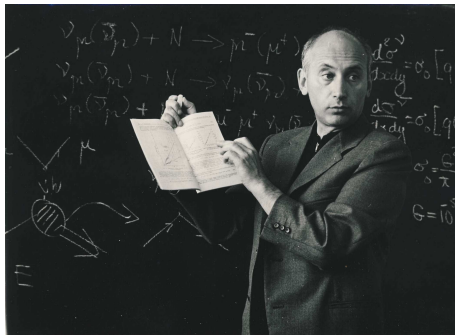
С.М. Биленький
1972 г.

S.M. Bilenky
1972

- ▶ In the middle 70's Samoil started to work with Pontecorvo on the **theory of massive neutrinos** and **neutrino oscillations**.
- ▶ The **deep physical intuition of Pontecorvo** and the **profound theoretical knowledge and wisdom of Samoil** led to fundamental contributions to the development of the **theory and phenomenology of massive neutrinos**:
 - ▶ The theory and phenomenology of **neutrino oscillations in vacuum**
 - ▶ The theory and phenomenology of massive Majorana neutrinos obtained from the diagonalization of the **Dirac + Majorana mass Lagrangian**



- ▶ **Bilenky, Pontecorvo,** Quark-Lepton Analogy and Neutrino Oscillations (1975)
- ▶ **Bilenky, Pontecorvo,** Again on Neutrino Oscillations (1976)
- ▶ **Bilenky, Petcov, Pontecorvo,** Lepton Mixing, $\mu \rightarrow e + \gamma$ Decay and Neutrino Oscillations (1977)
- ▶ **Bilenky, Pontecorvo,** Majorana and Dirac Masses, Neutrino Oscillations and the Number of Charged Leptons (1980)



First complete review on massive neutrinos and oscillations

PHYSICS REPORTS (Section C of Physics Letters) 41, No. 4 (1978) 225–261. NORTH-HOLLAND PUBLISHING COMPANY

LEPTON MIXING AND NEUTRINO OSCILLATIONS

S.M. BILENKY and B. PONTECORVO

Joint Institute for Nuclear Research, Dubna, USSR

Monumental review

Massive neutrinos and neutrino oscillations

S. M. Bilenky

Joint Institute of Nuclear Research, Dubna, Union of Soviet Socialist Republics

S. T. Petcov

*Institute of Nuclear Research and Nuclear Energy, Bulgarian Academy of Sciences, 1784 Sofia,
People's Republic of Bulgaria*

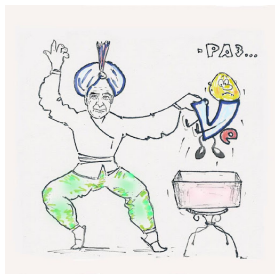
- ▶ In the early 80's Samoil published fundamental papers on the physics of Majorana neutrinos:
 - ▶ **Bilenky, Hosek, Petcov**, On Oscillations of Neutrinos with Dirac and Majorana Masses (1980)
 - ▶ **Bilenky, Niedermayer**, A Possible Test of CP Invariance in Neutrino Oscillations (1981)
 - ▶ **Bilenky, Nedelcheva, Petcov**, Some Implications of the CP Invariance for Mixing of Majorana Neutrinos (1984)
- ▶ A very good review on weak neutral current interactions:
 - ▶ **Bilenky, Hosek**, Glashow-Weinberg-Salam theory of electroweak interactions and the neutral currents (1982)



S.M. Bilenky at the Neutrino Telescopes Workshop in the 1990s

From: **Serguey Petcov**, Commemoration of Samoil Bilenky, XIX International Workshop on Neutrino Telescopes, February 2021

- ▶ After the fall of Soviet Union, in 1992 Samoil lived mostly out of Russia, always accompanied by his very kind wife Sofia (a physicist until 1992).
- ▶ They spent considerable time in many places: **Barcelona** (J.A. Grifols, E. Masso), **Munich** (W. Potzel, F. von Feilitzsch), **Padova** (A. Masiero), **Seoul** (C.W. Kim), **Trieste** (S.T. Petcov), **Torino** (W. Alberico, CG), **Tübingen** (A. Faessler, F. Simkovic), **Valencia** (J. Bernabeu), **Vienna** (W. Grimus).
- ▶ They finally settled in **Vancouver (Canada)** where their son Mikhail (Misha) was already living (he was a physicist until about 1999 and now he is a brilliant biologist working on the human genome).



Mikhail Bilenky cartoons in B. Pontecorvo office, JINR, Dubna

International Pontecorvo Neutrino Physics School

Initiated by Samoil Bilenky in 1998 (with A. Sissakian and S. Ivanova of JINR)

VI International Pontecorvo Neutrino Physics School
 Alushta, Crimea, Ukraine
 6-16 June 2017

Organizing Committee: Bilenky S., Ivanova S., Sissakian A., ...

School Program: Theoretical lectures, Experimental lectures, ...

Organized by JINR, Dubna

http://www.jinr.ru/~nu



VII International Pontecorvo Neutrino Physics School
 Horný Smokovec, Slovakia
 August 27 – September 4, 2015

Organizing Committee: Bilenky S., Ivanova S., Sissakian A., ...

School Program: Theoretical lectures, Experimental lectures, ...

http://www.jinr.ru/~nu

VIII International Pontecorvo Neutrino Physics School 2017
 Prague, Czech Republic
 August 20 – September 1, 2017

Organized by: ...

Members: ...

http://www.jinr.ru/~nu

IX International Pontecorvo Neutrino Physics School
 Sinaia, Romania
 September 1 – September 10, 2019

Organizing Committee: ...

Members: ...

http://www.jinr.ru/~nu

X International Pontecorvo Neutrino Physics School
 Sinaia, Romania
 September 1 – September 10, 2019

Organizing Committee: ...

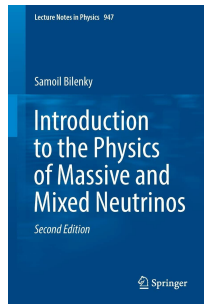
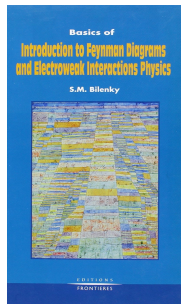
Members: ...

http://www.jinr.ru/~nu



5 Books!

- ▶ Introduction to Feynman diagrams (1970 in Russian; 1971 in English)
- ▶ Introduction to the physics of electroweak interactions (1980 in Russian; 1981 in English)
- ▶ Introduction to scattering theory (1985 in Russian)
- ▶ Basics of introduction to Feynman diagrams and electroweak interactions physics (1994)
- ▶ Introduction to the Physics of Massive and Mixed Neutrinos (2010 1st Edition; 2018 2nd Edition)



Several Awards

- ▶ 1999 Humboldt Research Award
- ▶ 2002 Pontecorvo Prize
- ▶ Russian state medal “For Distinguished Service to the State”
- ▶ Medal of First Degree of the Faculty of Physics and Mathematics of Charles University in Prague
- ▶ Honorable diploma of the Lomonosov Moscow State University



[2002 Pontecorvo Prize]

Well-Known PhD Students

Dimitri Bardin, Serguey Petcov, Victor Semikoz, Fedor Simkovic

Samoil's Conjectures on Sterile Neutrinos

Eur. Phys. J. C 1, 247–253 (1998)

hep-ph/9607372

THE EUROPEAN
PHYSICAL JOURNAL C

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Neutrino mass spectrum from the results of neutrino oscillation experiments

S.M. Bilenky^{1,2} C. Giunti² W. Grimus³

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³ Institute for Theoretical Physics, University of Vienna, Boltzmannngasse 5, A-1090 Vienna, Austria

$$P_{\nu_{\alpha} \rightarrow \nu_{\beta}} = \frac{1}{2} A_{\nu_{\alpha}; \nu_{\beta}}^2 \left(1 - \cos \frac{\Delta m^2 L}{2p}\right) \quad (\alpha \neq \beta)$$

$$P_{\nu_{\alpha} \rightarrow \nu_{\alpha}} = 1 - \frac{1}{2} B_{\nu_{\alpha}; \nu_{\alpha}}^2 \left(1 - \cos \frac{\Delta m^2 L}{2p}\right)$$

$$|U_{e4}|^2 \leq a_e^0 \quad \text{and} \quad |U_{\mu 4}|^2 \leq a_{\mu}^0$$

$$A_{e;\mu} = 4|U_{e4}|^2 |U_{\mu 4}|^2 \leq 4a_e^0 a_{\mu}^0$$

Thus in the case of neutrino mass hierarchy $\nu_{\mu} \rightleftharpoons \nu_e$ oscillations are strongly suppressed.

S.M. Bilenky handwriting

- ▶ In the last years Samoil was very skeptical about the existence of **light sterile neutrinos** for reasons of economy and simplicity, as indicated by the **seesaw mechanism**:

If light sterile neutrinos will be discovered in future short baseline and other neutrino experiments in this case our ideas about the origin of small neutrino masses will be completely changed. [arXiv:1907.01472]

- ▶ However, he emphasised that the question of the existence of light sterile neutrinos **must be answered experimentally**. See:
 - ▶ **Neutrino Masses from the Point of View of Economy and Simplicity**, arXiv:1907.01472
 - ▶ **Neutrinos: Majorana or Dirac?**, arXiv:2008.02110
- ▶ His last contribution to physics is the nice pedagogical review **Basics of General Theory of Relativity for Beginners**, arXiv:2010.11823

"Simplicity is a guide to the theory."

In the 70-80's the main question was: *Are neutrino masses different from zero? Now, when it was established that neutrino masses are different from zero, the main question is: How are neutrino masses generated?*
It is very important that we have the Standard Model as a reference theory

After the Higgs discovery (the most untrivial prediction of SM) the SM became the Theory of Elementary Particles in a electroweak region (up to ~ 300 GeV)

The SM is based on the following general principles

- ▶ Local gauge symmetry
- ▶ Unification of the weak and electromagnetic interactions
- ▶ Brout-Englert-Higgs mechanism of the spontaneous symmetry breaking

In the framework of these principles Nature chooses the simplest possibilities



Prague, 23 May 2018

Celebrating Neutrinos: Colloquium in honor of prof. S. Bilenky
at occasion of his 90th birthday

NEUTRINO MIXING

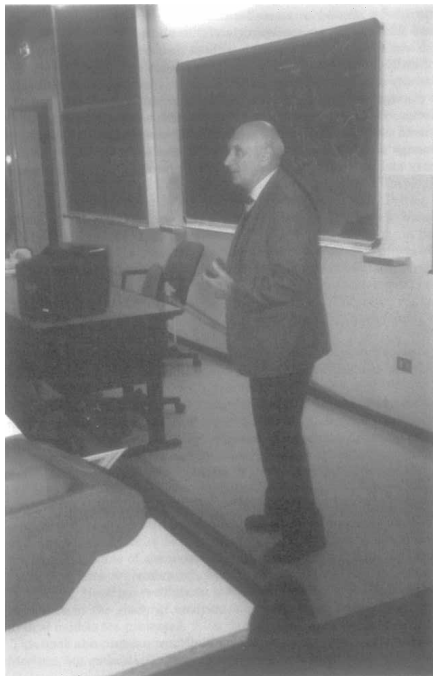
Meeting in Honour of Samoil Bilenky's 70-th Birthday

TORINO, March 25-27, 1999

W. Alberico (Univ. of Torino)
V. de Alfaro (Univ. of Torino)
M. Baldo Ceolin (Univ. of Padova)
R. Bernabei (Univ. of Roma II)
J. Bernabeu (Univ. of Valencia)
S. Bilenky (JINR, Dubna)
A. Bottino (Univ. of Torino)
F. Buccella (Univ. of Napoli)
M. Chaichian (Univ. of Helsinki)
F. von Feilitzsch (Tech. Un. of Muenchen)
B. Fiorini (Univ. of Milano)
G. Fogli (Univ. of Bari)
C. Giunti (INFN, Torino)

W. Grimus (Univ. of Wien)
J. Höseke (Univ. of Prague)
A. Masiero (Univ. of Padova)
G. Navarra (Univ. of Torino)
F. Niedermayer (Univ. of Bern)
S. Petcov (SISSA, Trieste)
A. Santamaria (Univ. of Valencia)
P. Strolin (Univ. of Napoli)

Aula Magna, Istituto di Fisica, Via P. Giuria 1, Torino





Dubna, 20 June 2018
Jubilee of Samoil Mihelevich Bilenyk

Good bye, we miss you!

