

Enclosure 7

ICRANet collaboration with Belarus

ICRANet activities in Belarus

Cooperation Agreements with the Belarusian State University

On September 5, 2008 a Cooperation Agreement between ICRANet and the [Belarusian State University](#) (BSU) was signed by the director of ICRANet, prof. Remo Ruffini, and Rector of BSU, prof. Vasily Strazhev in Minsk, Belarus. This cooperation agreement has been renewed on August 26, 2013 by the director of ICRANet, prof. Remo Ruffini, and Rector of BSU, prof. Sergei Ablameyko.



Fig. 1 Opening of the Zeldovich meeting, organized by ICRANet and BSU. From left to right are the Rector of BSU, prof. Sergei Ablameyko, the director of ICRANet, prof. Remo Ruffini, and Dr. Gregory Vereshchagin. Minsk, 2009.

The goal of this agreement is to deepen the scientific and research cooperation, as well as to arrange bilateral seminars, make possible exchange of expertise, research and educational staff, publication of joint works. Within this agreement ICRANet has organized together with BSU the [Zeldovich meeting](#) in Minsk in 2009.

In addition, within this agreement two PhD students from BSU, Yuri Tsalkou and Aleksander Tarasenko, visited ICRANet. Two undergraduate students at the Department of Theoretical Physics and Astrophysics of BSU, Svetlana Vlasenko and Ivan Rybak, were supervised by Dr. Gregory Vereshchagin in their course works.



Belarusian State University

Agreement ICRANet - BSU

Rector

Sergey V. Ablameyko

Signatories

Prof. Sergey V. Ablameyko

Prof. Alexander Gorbatsevich

Contact person

Prof. Alexander Gorbatsevich

ONGOING AND PREVIOUS ACTIVITIES

Joint Activities



THE SUN, THE STAR, THE UNIVERSE AND GENERAL RELATIVITY The International Conference in Honor of Ya. B. Zeldovich 95th Anniversary

Belarusian State University, Minsk, Belarus, April 20-23, 2009

Visiting Professors to BSU

	<p>Dr. Alexei Aksenov Participation in the: · <i>Zeldovich meeting</i>, 20-23 April 2009</p>		<p>Prof. Hagen Kleinert Participation in the: · <i>Zeldovich meeting</i>, 20-23 April 2009</p>
	<p>Prof. Vladimir Belinski Participation in the: · <i>Zeldovich meeting</i>, 20-23 April 2009</p>		<p>Prof. Vladimir Popov Participation in the: · <i>Zeldovich-100 Meeting</i>, 10-14 March 2014</p>
	<p>Prof. Sandip Kumar Chakrabarti Participation in the: · <i>Zeldovich meeting</i>, 20-23 April 2009</p>	 <small>picture by Giliola Chisté</small>	<p>Prof. Remo Ruffini - ICRANet Director</p>
	<p>Prof. Jaan Einasto Participation in the: · <i>Zeldovich meeting</i>, 20-23 April 2009</p>		<p>Prof. Gregory Vereshchagin</p>
	<p>Prof. Roy Patrick Kerr Participation in the: · <i>Zeldovich meeting</i>, 20-23 April 2009</p>		<p>Prof. She-Sheng Xue Participation in the: · <i>Zeldovich meeting</i>, 20-23 April 2009</p>

**THE COOPERATION AGREEMENT
BETWEEN
INTERNATIONAL CENTER FOR RELATIVISTIC ASTROPHYSICS NETWORK
IN PESCARA, ITALY
AND THE BELARUSIAN STATE UNIVERSITY IN MINSK, BELARUS**

International Center for Relativistic Astrophysics Network - ICRANet in Pescara (Italy) and the Belarusian State University (the Republic of Belarus), hereinafter referred to as 'Parties', having an intention to further deepen the scientific and research cooperation, have decided to sign the present Agreement.

Article 1

The participants in the implementation of the Cooperation Agreement from the Italian side will be:

ICRANet Coordinating Center in Pescara, Italy

and from the Belarusian side:

Belarusian State University in Minsk, Belarus

Article 2

The scientific and research cooperation will include:

1. Conducting joint research on scientific issues of interest to both Parties,
2. Arranging bilateral seminars,
3. Exchange of expertise between research and educational staff,
4. Publication of joint scientific works in international journals,
5. Exchange of publications, manuals and course books.

Article 3

1. The Parties will conduct the exchange of academic staff and students by means of formal letters of invitation. The invitations will be sent by the Director of ICRANet and the Rector of Belarusian State University.
2. The aim of the academic staff and students exchange is: participation in scientific conferences, seminars, symposiums as well as exchange of expertise, methodological training and joint discussions on up-to-date scientific issues of interest to both Parties.
3. By norm the exchange program will be done on reciprocal basis. All the travel expenses will be paid by the home institutions, while the local expenses will be paid by the receiving institutions. Motivated exceptions can be allowed.
4. Detailed conditions of realization of cooperation agreement and especially with regards to methods of financing, plan of exchanges of the academic staff and students of both parties will be specified in an Attachment to this Agreement.

Article 4

The present Agreement shall remain in force for five years, and will be automatically renovated for an equal period barring communication by either of the Parties, at least three months before the expiry of the Agreement, of its intention to withdraw the Agreement. Once signed, Agreement does not exclude a possibility of undertaking other cooperative activities which may be subject to annex to the present Agreement. Any changes in the content of the Agreement, as well as in the particular stages of joint activities, may only be performed in the written form with the approval of both Parties.

Article 5

The present Agreement is signed in two copies in English, and two copies in Russian, both texts are legally

valid. The two Parties receive one copy in either language.

Article 6

All disputes which might arise from this Agreement shall be resolved by the Director of ICRANet and Rector of the Belarusian State University, or by the persons authorized by them on the basis of the powers of attorney granted in writing in the process of the conciliation procedure.

Article 7

This Agreement shall be in force from the date of signing by both Parties

Agreement approved by:

**International Center for
Relativistic Astrophysics Network**

Signature

Prof. Remo Ruffini

Belarusian State University



Signature

Prof. Sergey V. Ablameyko

Co-ordinators of the Co-operation

Signature

Dr. Gregory V. Vereshchagin

Signature

"26" August 2013

"26" August 2013

Contact details of the Parties

**International Center for
Relativistic Astrophysics Network**
P.le della Repubblica, 10, Pescara, Italy 65122
tel: +39-085-23054 / fax: +39-085-4219252
email: ruffini@icra.it

Belarusian State University
4, Nezavisimosti Ave., 220030,
Minsk, Belarus
tel./fax: +375-17-209-54-45
email: ablameyko@bsu.by

Cooperation Agreements with the National Academy of Sciences of Belarus

On September 6, 2013 a Cooperation Agreement between ICRANet and the [National Academy of Sciences of Belarus](#) (NASB) was signed by the director of ICRANet, prof. Remo Ruffini, and the Chief Scientific Secretary of NASB, prof. Sergei Kilin.

Within these agreement ICRANet has organized together with NASB the [Zeldovich-100 meeting](#) in Minsk in 2014.

In addition, a student from Belarus, Ivan Siutsou, was enrolled in the IRAP PhD program and successfully defended his thesis in 2013, receiving his PhD degree in relativistic astrophysics from all Universities participating in the program. He spend two years in Rio de Janeiro, Brazil, with a post-doc position within the ICRANet-CAPES program. Now he is researcher in ICRANet-Minsk.

ICRANet-Minsk center

On July 18, 2016 an Annex to the Cooperation Agreement between ICRANet and NASB was signed by the director of ICRANet, prof. Remo Ruffini, and the Chairman of NASB Presidium, prof. Vladimir Gusakov in Minsk, Belarus.



Fig. 2. Signature of the Annex to the Cooperation Agreement between ICRANet and NASB by the director of ICRANet, prof. Remo Ruffini, and Chairman of the Presidium of NASB, prof. Vladimir Gusakov. Minsk, 2016.

This document brought the collaboration between ICRANet and NASB to a new level and led to creation in Belarus of an ICRANet international academic center, [ICRANet-Minsk](#). The ICRANet-Minsk center aims fostering scientific research in relativistic astrophysics, gravitation and cosmology in Belarus. The center is funded within the Belarusian state scientific program “Convergence”, subprogram “Microworld and Universe” and it is located at the Stepanov Institute of Physics of NASB.



National Academy of Sciences of Belarus

ICRANet-NASB Agreement

Annex to Cooperation Agreement

The Chairman of NASB Presidium
Vladimir G. GUSAKOV

Signatories of Agreement

Prof. Sergei Ya. KILIN

Prof. Yuri A. Kurochkin

Signatories of Annex

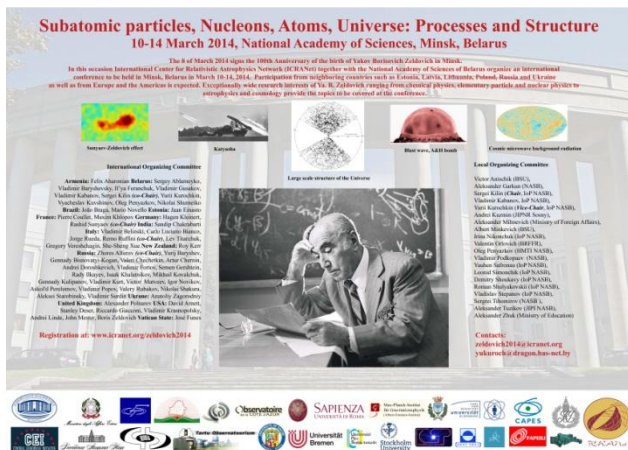
Prof. Vladimir G. GUSAKOV

Contact person

Prof. Sergei Ya. KILIN

Dr. Ivan Siutsou

ONGOING AND PREVIOUS ACTIVITIES



Zeldovich-100 Meeting

Minsk (Belarus)

March 11-14, 2014

ICRANet-Minsk center



Dr. Ivan Siutsou

Current position: Researcher at ICRA Net-Minsk

Previous positions: CAPES-ICRANet post-doc at CBPF 2014-2016

Publication list, meetings, schools

Visiting Professors to NASB

	<p>Prof. Vladimir Belinski Participation in the: · <i>Zeldovich-100 Meeting</i>, 10-14 March 2014</p>	 <small>picture by Giliola Chisté</small>	<p>Prof. Remo Ruffini - ICRANet Director</p>
	<p>Prof. Sandip Kumar Chakrabarti Participation in the: · <i>Zeldovich-100 Meeting</i>, 10-14 March 2014</p>		<p>Prof. Alexei Starobinsky Participation in the: · <i>Zeldovich-100 Meeting</i>, 10-14 March 2014</p>
	<p>Prof. Valeri Chechetkin Participation in the: · <i>Zeldovich-100 Meeting</i>, 10-14 March 2014</p>		<p>Prof. Lev Titarchuk Participation in the: · <i>Zeldovich-100 Meeting</i>, 10-14 March 2014</p>
	<p>Dr. Marco Muccino Participation in the: · <i>Zeldovich-100 Meeting</i>, 10-14 March 2014</p>		<p>Prof. Gregory Vereshchagin</p>

**THE COOPERATION AGREEMENT
BETWEEN
INTERNATIONAL CENTER FOR RELATIVISTIC ASTROPHYSICS NETWORK
IN PESCARA, ITALY
AND THE NATIONAL ACADEMY OF SCIENCES OF BELARUS
IN MINSK, BELARUS**

International Center for Relativistic Astrophysics Network - ICRANet in Pescara (Italy) and the National Academy of Sciences of Belarus – NASB in Minsk (the Republic of Belarus), hereinafter referred to as 'Parties', having an intention to further deepen the scientific and research cooperation, have decided to sign the present Agreement.

Article 1

The participants in the implementation of the Cooperation Agreement from the Italian side will be:
ICRANet Coordinating Center in Pescara, Italy
and from the Belarusian side:
the National Academy of Sciences of Belarus.

Article 2

In order to consent the best coordination of the activities, the two Parties will form a joint permanent Scientific Committee, composed of four members appointed, two on each side, within thirty days of the signing of this Agreement.

Article 3

The scientific and research cooperation will include:

1. Conducting joint research on scientific issues of interest to both Parties;
2. Arranging bilateral seminars;
3. Exchange of expertise between research and educational staff;
4. Publication of joint scientific works in international journals;
5. Exchange of publications, manuals and course books.

Article 4

1. The Parties will organize the exchange of academic staff and PhD students.
2. The aim of the academic staff and students exchange is: participation in scientific conferences, seminars, symposiums as well as exchange of expertise, methodological training and joint discussions on up-to-date scientific issues of interest to both Parties.

Article 5

The present Agreement shall remain in force for five years, and will be automatically renovated for an equal period barring communication by either of the Parties, at least three months before the expiry of the Agreement, of its intention to withdraw the Agreement. Once signed, Agreement does not exclude a possibility of undertaking other cooperative activities which may be subject to annex to the present Agreement. Any changes in the content of the Agreement, as well as in the particular stages of joint activities, may only be performed in the written form with the approval of both Parties.

Article 6

The present Agreement is signed in two copies, both in English and in Russian, the copies are equally valid.

Article 7

All disputes which might arise from this Agreement shall be resolved by the Parties.

Article 8

This Agreement shall be in force from the date of signing.

Agreement approved by:

ICRANet
International Center for
Relativistic Astrophysics Network

Signature 

Director of ICRANet
Prof. Remo Ruffini

NASB
The National Academy of Sciences of Belarus

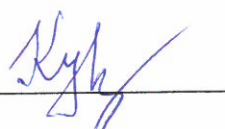
Signature 

Chief Scientific Secretary of NASB
Prof. Sergei Ya. Kilin

Co-ordinators of the Co-operation

Signature 

Dr. Gregory V. Vereshchagin

Signature 

Prof. Yuri A. Kurochkin

"6" September 2013

"20" 08 2013

Contact details of the Parties

International Center for
Relativistic Astrophysics Network
P.le della Repubblica, 10, Pescara, Italy 65122
tel: +39-085-23054200 / fax: +39-085-4219252
email: ruffini@icra.it

The National Academy of Sciences of Belarus
66 Independence Avenue, 220072
Minsk, Belarus
tel: +375-17-2841801 / fax: +375-17-2842816
email: nasb@presidium.bas-net.by

Annex to the Cooperation Agreement
between
International Center for Relativistic Astrophysics Network (Pescara, Italy)
and
National Academy of Science of Belarus (Minsk, Belarus)

Following the Cooperation Agreement between International Center for Relativistic Astrophysics Network (hereafter referred to as ICRANet) and National Academy of Science of Belarus (hereafter referred to as the NASB) signed on September 6, 2013 ICRANet, located in Pescara (Italy), Piazza della Repubblica n.10 (C. F. 91080720682), directed by Professor Remo Ruffini, and NASB, located in Minsk (Belarus), Independence Avenue 66, chaired by Academician Vladimir G. Gusakov, hereafter referred to as 'Parties', agree to create in Minsk an ICRANet international academic center (hereafter referred to as ICRANet-Minsk), to foster scientific research in relativistic astrophysics, gravitation and cosmology in Belarus and their integration into international activities in this field. Initially ICRANet-Minsk will be based in the B.S. Stepanov Institute of Physics of NASB (hereafter referred to as Institute of Physics).

Article 1

ICRANet-Minsk will operate in areas of relativistic astrophysics, gravitation and cosmology, in the theoretical and observational fields, in close collaboration with ICRANet. The activities of the ICRANet-Minsk will include organization of schools, courses, workshops, and conferences, training and research at post-graduate and post-doctoral levels in areas of competence of the ICRANet-Minsk, combined with an active visiting program.

Article 2

1. ICRANet will provide an international support for the operations of the ICRANet-Minsk.
2. ICRANet will extend the IRAP-PhD program to the interested research institutions of Belarus.
3. ICRANet will allow for the Belarusian Party to use the facilities and structures of the ICRANet Seats, in Rome (Italy), Pescara (Italy), Nice (France), Rio de Janeiro (Brazil), and Yerevan (Armenia), and from there to collaborate with scientific institutions of these and other countries.
4. ICRANet will help to build scientific data center in ICRANet-Minsk, providing computer facilities and data transfer from ground and space based observatories.

Article 3

1. NASB will provide financial support to ICRANet-Minsk, based on the State scientific programs and joint international projects, subject to the legislation of the Republic of Belarus.
2. Initially the rooms for ICRANet-Minsk will be provided by the Institute of Physics and the former will be considered as a department of the Institute, in accordance with the legislation of the Republic of Belarus.
3. The NASB will coordinate the scientific activities carried by ICRANet-Minsk and will foster cooperation between ICRANet-Minsk and Belarusian research institutions.
4. The annual programs of activity of ICRANet-Minsk will be approved by the governing bodies of NASB and ICRANet.

Article 4


Initially ICRANet-Minsk will recruit the Director, 2 scientists, as well as a system administrator and a secretary, following the national rules. The Director of ICRANet-Minsk will be approved by the corresponding Vice Chairman of NASB Presidium and the Director of ICRANet.

Article 5

The present Annex to the Cooperation Agreement shall be in force from the date of signing of both Parties.

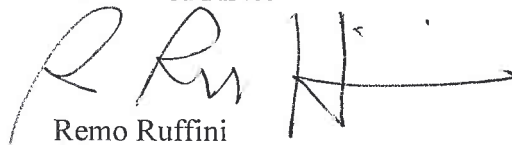
Done in Minsk on 18 July 2016, in two original copies, each in Russian and English, all texts being equally authentic. In case of divergence of interpretation the English version shall prevail.

For the NASB



Vladimir G. Gusakov
Chairman of Presidium

For the ICRANet



Remo Ruffini
Director



**МІНІСТЭРСТВА
ЗАМЕЖНЫХ СПРАЎ
РЭСПУБЛІКІ БЕЛАРУСЬ**

Вул. Леніна, 19, 220030, г. Мінск
Тэл. (+375 17) 327 29 22
Факс (+375 17) 327 45 21
E-mail: mail@mfa.gov.by
Р/р 3604900003255 у філіяле № 510
ААТ «ААБ Беларусбанк», код 603

25.04.2016 № 07-79/1578

На № _____ ад _____

**МИНИСТЕРСТВО
ИНОСТРАННЫХ ДЕЛ
РЕСПУБЛИКИ БЕЛАРУСЬ**

Ул. Леніна, 19, 220030, г. Мінск
Тэл. (+375 17) 327 29 22
Факс (+375 17) 327 45 21
E-mail: mail@mfa.gov.by
Р/с 3604900003255 в филиале № 510
ОАО «АСБ Беларусбанк», код 603

Prof. Remo Ruffini
Director of ICRANet

Dear Mr. Ruffini,

With great interest I became familiar with your initiative to establish membership of Belarus in ICRANet and its seat in Minsk.

The Ministry of Foreign Affairs welcomes scientific cooperation of the National Academy of Science and State Committee for Science and Technology with ICRANet and supports further development of effective cooperation and mutually beneficial relations.

At the same time, given the complicated situation in the national economy and the center in Armenia having close partnership relations with Belarus in the framework of the Commonwealth of Independent States and Eurasian Economic Union including scientific cooperation issues, we believe it makes sense to preserve "the status quo" and to continue the fruitful collaboration between the Republic of Belarus and ICRANet directly or through the seat of ICRANet in Erevan.

I wish you every success in your future activities,

Sincerely Yours,

Aleksandr Mikhnevich

International Center for Relativistic
Astrophysics Network
P.zza della Repubblica
10-65122 Pescara, Ytaly

Zeldovich Meetings

Two international meetings have been organized in Belarus by ICRANet and co-sponsored by ICRANet, NASB, BSU, and Central European Initiative (CEI).

In 2009, within the celebration of the International Year of Astronomy, ICRANet organized the international conference “[Zeldovich meeting](#)” in Minsk on April 20-23, 2009. Yakov Barosovich Zeldovich, the outstanding soviet scientist, was born in Minsk, Belarus, and the conference celebrated his 95th anniversary. The conference has created a stimulating environment for scientific exchange and contacts between scientists in the West, those coming from the great Russian school of Zeldovich, and local scientist from Belarus. Such internationally renowned scientists as Roy Kerr, Hagen Kleinert, Nikolay Shakura attended the conference and presented talks there. In addition, a memorable public lectures were given by Remo Ruffini, Gregory Vereshchagin and Vladimir Kurt, as well as a round table with participation of Zeldovich collaborators such as Vladimir Belinski, Valeri Chechetkin, Jaan Einasto, Vladimir Kurt, Vladimir Popov, and Nikolai Shakura, was organized. The proceeding of the meeting were published by the American Institute of Physics, in [volume 1205](#) of AIP conference proceedings.



Fig. 3. Participants to the Zeldovich meeting in Minsk, 2009.

In 2014, the 100th anniversary of Yakov Barosovich Zeldovich was celebrated with many international conferences. The first international meeting in this series was the [Zeldovich-100 meeting](#) in Minsk. Many of the lecturers at the conference were the closest former collaborators of Ya. B. Zeldovich. Many young researchers took part in the meeting. In particular, the students from International Relativistic Astrophysics PhD program, including both CAPES-ICRANet and Erasmus Mundus program, participated in the conference and presented results of their scientific

work. The conference was jointly organized by ICRANet and the National Academy of Sciences of Belarus. The opening address was given by Nobel Laureate prof. Zhores Ivanovich Alferov and by Prof. Remo Ruffini. There were more than 80 participants, nationals of Argentina, Armenia, Belarus, Brazil, China, Germany, India, Italy, Kazakhstan, Poland, Russia, and other countries. The conference covered many topics including cosmology, relativistic astrophysics, general relativity, elementary particle and nuclear physics, detonations and explosions.

Plenary papers are published in the leading Russian journal on astronomy and astrophysics, [Astronomy Reports](#), vol. Volume 59, Issues 6 and 7. Regular contributions are published in special open access issue of [Nonlinear Phenomena in Complex Systems](#), Vol. 17 No 4 (2014).



Fig. 4. Participants to the Zeldovich-100 meeting in Minsk, 2014.

Discussion on possible entrance of Belarus in ICRANet

In March 2014 Prof. Remo Ruffini had a meeting with the First Deputy Minister of Foreign Affairs, Mr Aleksandr Mikhnevich. They discussed successful joint activities, including two international conferences organized by ICRANet in Belarus, as well as organization of ICRANet center in Belarus, and possible entrance of Belarus to ICRANet.

In August 2015 Dr. Gregory Vereshchagin had a meeting with the chairman of the State Committee on Science and Technology of the Republic of Belarus, Dr. Alexander Shumilin and discussed with him, on behalf of Director of ICRANet, organization of ICRANet center in Belarus and possible entrance of Belarus to ICRANet.

THE SUN, THE STARS, THE UNIVERSE AND GENERAL RELATIVITY

INTERNATIONAL CONFERENCE IN HONOR OF
YA. B. ZELDOVICH'S 95th ANNIVERSARY

Minsk, Belarus 20-23 April 2009

EDITORS

Remo Ruffini
ICRANet
Pescara, Italy

Gregory Vereshchagin
ICRANet
Pescara, Italy

SPONSORING ORGANIZATIONS

BSU – Belarusian State University

CEI – Central European Initiative

ICRANet – International Center of Relativistic Astrophysics

ICTP – International Center for Theoretical Physics

AIP
American Institute
of Physics

Melville, New York, 2010

AIP CONFERENCE PROCEEDINGS ■ 1205

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Moments with Yakov Borisovich Zeldovich

Remo Ruffini

*ICRANet, p.le della Repubblica, 10 - 65122 Pescara, Italy and
ICRA and University of Rome "Sapienza", p. Aldo Moro 5, I-00185, Rome, Italy and
ICRANet, University of Nice-Sophia Antipolis, 28 avenue de Valrose, 06103 Nice Cedex 2, France*

Abstract. A recollection of special moments spent with Yakov Borisovich Zeldovich and with the scientists of Soviet Union and abroad.

The first impression upon meeting a person is the one which characterizes all subsequent interactions.

I met Yakov Borisovich Zeldovich for the first time in 1968 at the GR5 meeting in Tbilisi. I had known his name from his two classic papers on relativistic astrophysics in *Physics Uspekhi* coauthored with Igor Novikov [1, 2]. There had been a strong impulse to boycott the GR5 meeting due to the tense relations over human rights between the Soviet Union and the USA at that time. Finally a small group around Johnny Wheeler decided to participate. Among them were Arthur Komar, Bruce Partridge, Abe Taub and myself.

It was also my first visit to the Soviet Union. The entrance to Leningrad was already very special showing the difference in organization from our Western world. I will recall elsewhere some of the anecdotes. It was in the airplane to Tbilisi that a very particular experience occurred. The year 1968 was a time in which dissent was growing in the Soviet Union and the New York Times had just written an article on Andrei Sakharov and his reflections on peaceful coexistence and intellectual freedom. I boarded the plane for Tbilisi with Arthur Komar. We sat in the last row of a quite modern jet plane with open seats and shining windows, and we were commenting and laughing on all those stories we had heard in the West about windowless seats reserved for westerners on Soviet planes. When the plane was almost full the stewardess called the names of Arthur Komar and Remo Ruffini asked us to move to seats reserved for us in the front of the plane. We were delighted and we considered this an honor. Our two seats were in a line of three seats ... the only ones in the plane without a window. We were quite upset. In between us there was a third person who did not seem to speak English. So we started complaining about these methods and commenting appropriately also about Sakharov's recent opinions as presented in the New York Times and asking ourselves about the fate of Sakharov after his open statements. The plane was supposed to be a direct flight to Tbilisi of approximately seven hours. After approximately three hours of flight,

without any announcement, the plane abruptly started to descend quite rapidly and landed in a town called Mineralnye Vody. After landing there was a lot of confusion, there were additional planes and finally it was disclosed that, as a common practice in the Soviet Union in the presence of bad weather, the plane had stopped and we would continue the flight the morning after. It was also announced that for foreigners there would be a room to sleep. Soon after I realized that there was only one room for all the foreigners! Since it was impossible to sleep I went back to the airport hall and I noticed this person who had been sitting between me and Komar on the plane to be alone in the hall and had found a chair. He was seating quietly waiting for the morning. I was attracted by his silence and his self-control. I approached him introducing myself: "Ruffini, Italy." To this his answer: "Sakharov, Soviet Union!" I still remember his serene smile. He was the first Soviet scientist I met on the way to our meeting in Tbilisi. The arrival in Tbilisi with Kumar and Sakharov was marked by the fortunate encounter with other monumental scientific figures.

We had the marvelous opportunity to meet some historical figures like Vladimir Fock, Iosif Shklovsky and Alexei Petrov and also Dmitry Ivanenko. It was amusing to see the ceremonial relations between Fock and Ivanenko. Fock, who as expected was always in the first row, had a conspicuous auditorial "apparat." Every time Ivanenko was taking the floor to speak, Fock was disconnecting his "apparat" with a very explicit gesture. In addition of course there was Yakov Borisovich surrounded by a large number of then young collaborators including Gennady Bisnovatyi-Kogan, Valery Chechetkin, Viktor Shvartsman, Nikolay Shakura, Alexei Starobinsky, Rashid Sunyaev, Sergei Shandarin and others. Zeldovich was encouraging all his students to attack in their scientific presentations almost like a boxer ring trainer.

The first day of the meeting Zeldovich invited me to lunch and asked me just at the beginning to speak about my research. I started to explain my work on self-gravitating bosons I had started in Rome and just recon-

cluded “Yes: although Gamow made many mistakes he is one of the greatest Soviet scientists!” And then recalling the fundamental contributions Gamow made to the understanding of the DNA structure he asked: “How many Nobel prizes did Gamow receive? Two?” I answered: “None.” And I was surprised how distant he was from our world.

Paradoxically the work of neutrinos in cosmology was later repropounded by Viktor Shvartsman [6] by considering the role of the many neutrino species and in general to the number of “difficult to observe particles with zero rest mass”. In that paper Viktor, see figure 2 established his classical result of an upper limit to the number of neutrino species $N_\nu \leq 3$ assuming that the chemical potential of the electron neutrino be zero. This result signed a new



Figure 2. Picture of Viktor Shvartsman taken by myself in Moscow in 1975. Among the students of Zeldovich I was most impressed by Viktor. We reproduced one of his fundamental works in one of our book [22]. It was clear to all of us that his isolation in the Caucasian mountains, so far from the world of Moscow and the world of theoretical research he was so strongly aiming for, was a key factor in the tragic epilogue of his life.

beginning in the dark matter problem in the Universe. I myself worked later on the role of massive neutrinos in cosmology. I considered their fundamental role both in cosmological nucleosynthesis [7] and in formation of the structure in the Universe due to dark matter, leading to a fractal structure of the Universe [8].

But let us go back to Zeldovich: we became very good friends in the following years, and I regularly met him in Moscow. We had also the great pleasure to share so many common friends. In particular, I remember many interactions with Bruno Pontecorvo, see figure 3. In particular,



Figure 3. Picture taken by myself in an unplanned visit to an hospital in Moscow. On the left side Zeldovich, on the right side Pontecorvo.

with the participation of Bruno and Italian television we produced a documentary “Il caso neutrino” recovering the fundamental moments of the discovery of the neutrino all the way to the determination of their mass and their role in cosmology [9].

Since 1973 I had the great fortune to become a very close friend of Evgeny Lifshitz. He had just granted to me and John Wheeler the honor of being quoted in a named exercise in the volume “Theory of Fields” of his classic series with Landau. As we became more familiar with Evgeny, I developed a profound admiration of his intellectual abilities, of his understanding of physics and of his moral stature. Evgeny often recalled a series of anecdotes. One of the best aphorisms of Landau: “Astrophysicists often in error, never in doubt,” and a different one related not only to astrophysicists but to physicists at large: “Due to the shortness of our lives we cannot afford the luxury to spend time on topics which are not promising successful new results”. It was Evgeny who made me aware of some additional peculiarities in Zeldovich’s character.

Lifshitz described that famous argument on the equation of state of neutron stars. Zeldovich first challenged the concept of the critical mass of the neutron star using an ad hoc model of supranuclear density interaction [10]. He had then purported the possibility of having an equation of state with the speed of sound equal to the speed of light, see [11]. Lifshitz then recalled that Landau did not want “to offend” the intelligence of colleague physicists. If an issue was very difficult and important he would explain this issue. In other cases he was not going to explain and would ask the person to answer himself. In the specific case of the extreme equation of state



Figure 4. The picture of Li-Zhi Fang with his wife, myself, Leopold Halpern, Volodia Belinski and his wife at the Rimini Meeting of CL of 1991.



Figure 5. Dinner at Lifshitz home in Moscow (circa 1985). At the center Evgeny Lifshitz and, on his left, Zeldovich and Vitaly Ginzburg with their wives. Picture taken by my wife Anna Imponente.



Figure 6. Picture taken by myself.

$p = \rho$ of Zeldovich he simply told him “wrong!”, and to Zeldovich’s request “why?” he simply answered “you



Figure 7. Ya. B. Zeldovich monument in Minsk in front of National Academy of Sciences of Belarus.



Figure 8. The picture of George Coyne and myself greeting John Paul II.

find out.” This was before the tragic Landau car accident. After the accident Landau was no longer in any condition to give a proof of the statement, and Zeldovich was unable to give a proof either. One day at the restaurant of the Academy in Leninsky Prospect, Yakov Borisovich asked Evgeny in my presence “Why you did not insert my equation of state in the Landau and Lifshitz book?”

To this Lifshitz replied “Did you solve the problem assigned by Landau?”, and to that Zeldovich said “No.”, and to that Lifshitz’s answer was “Then I do not quote the result in the Landau and Lifshitz book.”



Figure 9. I look with terror Zeldovich approaching the Pope John Paul II clearly with an unidentified object disguised under his jacket.



Figure 10. Zeldovich presenting his books to Pope John Paul II.



Figure 11. Zeldovich after the presentation of his books. To the offering of the books the Pope said “Thanks” and Zeldovich very loudly shouted “Not just ‘thanks’ ! These are fifty years of my work!” The Pope kept Zeldovich’s collected papers under his arm during the entire rest of the audience.

My visit to Moscow was specially joyful due to the interactions with so many extraordinary scientists like Aleksandr Prokhorov, Isaac Khalatnikov, Pavel Cherenkov, Vitaly Ginzburg and others kindly invited to lunch with me in the Italian Embassy by the then Italian ambassador Sergio Romano and his predecessors. Encounter with Khalatnikov was especially productive. Khalat was the founder of the Landau Institute. However, among the others faculty members was Vladimir Belinski. The friendship with Lifshitz and Khalat soon extended to Volodia. So much so, that it transferred to Italy with his wife Elena, see figure 4, and became Italian citizen and one of the first faculty members of the newly founded ICRANet since 2005. Also extremely pleasant were the meetings at Yevgeny’s home with friends and their wives, see figures 5 and 6. One very special oc-



Figure 12. Picture of Wheeler, Christodoulou and myself in Fine Hall in Princeton in the former office of Albert Einstein. The picture is taken in front of the fireplace where Einstein wrote with charcle, and now is engraved in gothic scripture in the marble, the famous sentence “Raffiniert ist der HerrGott, aber boshaft ist er nicht”.

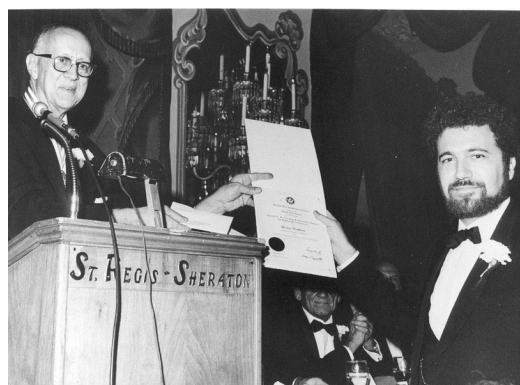


Figure 13. Receiving the Cressy Morrison Award of the New York Academy of Sciences in 1972.

casion took place in Moscow. One day I was visiting Yakov Borisovich in his Institute. He said “Come and see a present I received from my friends in Minsk, where I was born.” And he showed me a bronze statue of him-



Figure 14. Solvay meeting of 1973.

self. I told him “Congratulations, I can finally say that I have a friend with the bronze face!” using the Italian meaning “faccia di bronzo” which are not very complementary words addressed to someone who is insensitive to problems. Full of these memories I was delighted to see in the city of Minsk, now reconstructed and rebuilt, in the serenity of the spring his statue in form of a monument in front of the Academy of Sciences, see figure 7.

In 1985 I decided to create an international consortium dedicated to the field of relativistic astrophysics, the International Center for Relativistic Astrophysics (ICRA). This consortium relates the University of Rome “La Sapienza” to the University of Stanford, and the Space Telescope Institute at the USA, the University of Science and Technology in Hefei, China, the Specola Vaticana and the ICTP. It was coherently founded by George Coyne, Li-Zhi Fang, Francis Everitt, Riccardo Giacconi, Abdus Salam, and myself, see figure 8.

The most unique occasion with Zeldovich came in

1986 in Rome during the visit of the four delegations of the space research program of Europe, Japan, Soviet Union and the USA in occasion of the Halley comet mission. ICRA organized the meeting at “La Sapienza” and the Vatican. It was the first time Zeldovich could come to the West as a member of a very exceptional delegation created by Roald Sagdeev for this epochal meeting. There are many anecdotes with Zeldovich being shocked by a number of cars in the Italian streets and proposing to help himself with one since in his opinion it would be impossible to trace back the real owner. I did successfully convince him not to proceed in such an idea. Entering in the “Sala Regia” in the Vatican he attempted to seat in the first row and to my request to take his assigned seat in the 21st row seeing all the remaining ones still empty he said “Nobody will notice me in the first row.” I insisted that he should come back to the seat assigned to him by the Vatican ceremonial office. After few minutes he realized that the first rows were occupied on one side by the cardinals, the bishops and personnel

of the Vatican, and on the other side by the ambassadors to the Vatican all in their sumptuous vests. Certainly the presence of Zeldovich in the first row would have been quite obvious and unjustifiable! But the surprises were not yet over. I was supposed to introduce him to the Pope during the audience with the members of the delegations. And I saw Zeldovich approaching with a clearly large object under his jacket. I was terrified, see figure 9.

Suddenly Zeldovich opened the jacket in front of John Paul II, extracted two books and put them into the hands of the Pope John Paul II, see figure 10. His holiness said “Thank you very much, professor Zeldovich”, and to this with a very loud voice which penetrated the entire “Sala Regia” Zeldovich forcefully replied “Not just ‘thanks’! These are fifty years of my work!” There was a great laugh from everybody as they relaxed. Later on John Paul II recalled that this was one of joyful audiences he had ever had. And he kept the two large red volumes over his white robe during the entire audience, see figure 11.

Finally I would like to remark that a great scientist can even make a great discovery when he participates in some irrational actions. In the late fifties when the race to the Moon between the US and the Soviet Union was on someone proposed to show the great technical ability in the space vehicles and in the nuclear technology proposing to the Soviet superiority to explode at a fixed time an atomic bomb on the Moon². This awful project fortunately was never implemented. Nevertheless it was one of the motivations to develop a highly secret mission from the United States in order to test the no proliferation agreement: the Vela satellites. These satellites were conceived to patrol all the region around the Earth and the Moon for possible nuclear explosions! Everybody knows today that this led to the discovery of gamma-ray bursts and we were very honored and pleased to announce their discovery at the 1972 AAAS meeting in San Francisco which was chaired by Herb Gursky and myself [14].

In 1987 I visited Zeldovich in Moscow for the last time. There was a meeting at the Academy of Sciences on cosmology. While he went to deliver his talk he asked me to keep his jacket with the three gold stars and red stripes of the Hero of Socialist Labor. He was among the few people to have three such decorations. They told me that even Stalin had only one such “star”. I was not surprised. By that time I had become aware of his many contributions in ignition, combustion, explosions as well as of his work with Yulii Khariton and Igor Kurchatov on the atomic bomb. Slowly but inevitable I became also aware of the role of John Wheeler in the American H-bomb project. Of course it was clear they had done an



Figure 15. Jonhy enjoying the pictures of Jacopo in 1999.



Figure 16. Picture of Ginette and Johny Wheeler with Anna in High Island with Ginette holding one of her preferred Gucci scarf.



Figure 17. Picture taken in my office at “La Sapienza” of Vladimir Popov surrounded by Gregory Vereshchagin, She-Sheng Xue and myself in 2006.

² Different versions exist of this story. Some presented direct involvement of Zeldovich [12], some show Zeldovich as an opponent of this idea on technical grounds [13].



Figure 18. The picture of the participants of the Varenna summer school. In the second row Anthony Hewish (Nobel Prize, 1974), Joe Taylor (Nobel Prize, 1993), Subrahmanyan Chandrasekhar (Nobel Prize, 1983) and Riccardo Giacconi (Nobel Prize, 2002).

enormous work in the physics of the bomb and also it was evident that they had learned one of the greatest amount of physics reachable at the time.

When it came to the work on Relativistic Astrophysics I was surprised to see that this vast quantity of knowledge in physics they had acquired in making the bombs did not help as much as one would have expected. They were somewhat overshooting and did not catch the beauty, the different and possibly more profound physical scientific complexity, and also the conceptual simplicity of the new phenomena. In the case of Wheeler the interactions with him during the first years in Princeton had been tremendously intense. At times we were working 13 hours a day. We wrote that celebrated article for *Physics Today* [17], recently reprinted [18], in which we were presenting for the first time a Black Hole as a physical object and not just as a mathematical solution. Such an object was indeed interacting actively with the rest of the Universe by a vast amount of energy, in principle extractable: the rotational and the electromagnetic energy. These works were received an exponential growth with the coming to Princeton of Demetrios Christodoulou from Greece at the age of 16. When he started his thesis of PhD at the age of 18 Demetrios approached the problem suggested by Wheeler of the collapse of a scalar field forming a black hole which he finally solved in 2009 [19]. A second part of his thesis was developed under my guid-

ance [5] which has led to the general mass formula of the black hole [24], see figure 12. Interestingly precisely these concepts have made later the Black Holes through their “Blackholic energy” the explanation of Gamma Ray Bursts [25]: the largest instantaneous energy sources in the Universe second only to the Big Bang [5, 20, 21]. In collaboration with Rees we also wrote a book giving guidelines for the study of Black Holes, Gravitational Waves and Cosmology [22]. The field of Relativistic Astrophysics started to grow exponentially after the introduction of X Ray Astronomy by Riccardo Giacconi and his group [23]. Paradoxically Wheeler interest started to depart from these topics and drifted toward a (possibly too) vast field of exploring the world of mathematics in the quest for better expressing the laws of physics, see also my recollections in [5]. It was that time in which I proposed the paradigm for the first identification of a Black Hole in our Galaxy [26], see figure 13.

A profound separation of scientific interests had already occurred in those days at the Les Houches summer school: the first one solely dedicated to black holes [27]. After that event I dedicated myself to the study of Black Holes larger than 3.2 solar masses. While S. Hawking and his group directed all the attention to mini black holes (see e.g. [28]). The field of matter accretion on a Black Hole was not developed in the West and became dominated by the Russian (see Titarchuk contribution to

this volume) and Indian schools (see Chakrabarti contribution to this volume). In the case of Wheeler a different point of view on the role of European scientists in the United States of America emerged, and a separation of our scientific interest became manifest in the 1973 Solvay meeting (see figure 14), which was followed by my return to Europe. These differences did not affect in any way the deep friendship between us extended to our families, see figures 15 and 16.

In the case of Zeldovich some similar event happened. I was trying to make him appreciate the beauty of the work I was developing with an American hero of Relativistic Astrophysics, Jim Wilson, himself a distinguished participant of the American Bomb projects. The work on the relativistic magnetohydrodynamics effect around Black Holes have today reached the greatest interest for microquasars and active galactic nuclei explanations [29]. To that he was answering with his interests toward the possible radiation of a rotating sphere due to quantum effects. To me that work did not appear so promising in view of the intrinsic stability imposed by quantum effects on a rotating system.

Thinking over my scientific discussions with Zeldovich I was especially admiring his work with Vladimir Popov on heavy nuclei, as expressed in our recent report [21]. On this topic see also Popov's contribution in this book. This topic has become central to our current research, see figure 17.

In all my discussions with Zeldovich through the seventies I was particularly eager to illustrate to him my work on the black hole identification and to observe his feedback. Much of these works, following the Solvay meeting, were summarized in our celebrated Varenna summer school, see figure 18. This basic work then appeared in the book [15] which is currently being reprinted [16]. That epochal meeting in the scientific content was followed until today by three Nobel Prize winners among the lecturers as S. Chandrasekhar (1983), J. Taylor (1993), and R. Giacconi (2002), see figure 19.

But let us return after this digression to my last meeting with Zeldovich. While he was speaking Sakharov entered the room and sat in the first row near me. He had just been permitted to return to Moscow after the Gorky exile. I had just been helping at the University of Rome to attribute to him a *laurea honoris causa - in absentia*. I looked at him closely: the face had changed from the Tbilisi days, his smile was gone and his gentle aspect had been modified. Even the structure of the face was somewhat more tense with a more prominent jaw. I gave my hand to him: "Ruffini, Italy" and his immediate answer recalling a serene expression resembling the old days "Sakharov, Soviet Union!"

In June 1988 on the hundredth anniversary of the birth of Alexander Alexandrovich Friedman we went to Leningrad with Werner Israel and a few other rel-



Figure 19. Picture of Riccardo Giacconi receiving the Nobel Prize.



Figure 20. Television broadcast made by Igor Novikov, Andrei Sakharov and myself in the celebration of Alexander Alexandrovich Friedman's 100th Anniversary, Leningrad, 1988.

ativists. It was a very emotional occasion to find the tomb of Friedman and put some flowers on it. Yakov Borisovich Zeldovich had died on December 2, 1987. This was the occasion of a trip by night sleeping train between Moscow and Leningrad with my wife Anna.

The next compartment on that train was occupied by Andrei Sakharov and Elena Bonner. The day after a memorable broadcast from the television was made by Igor Novikov, Andrei Sakharov and myself in the celebration of Alexander Alexandrovich Friedman, see figure 20.

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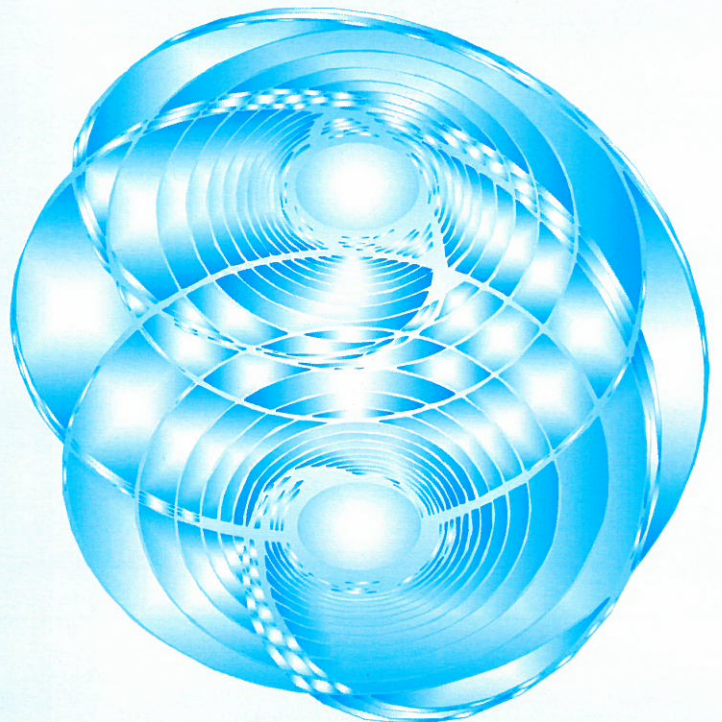
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