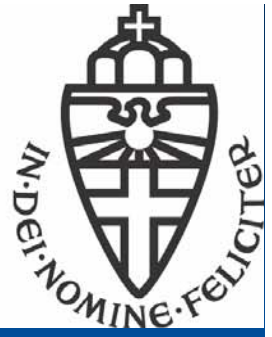
Radboud Universiteit Nijmegen



Scientist and Society: Problems at Interface

Mikhail Katsnelson

What is science and what is technology?

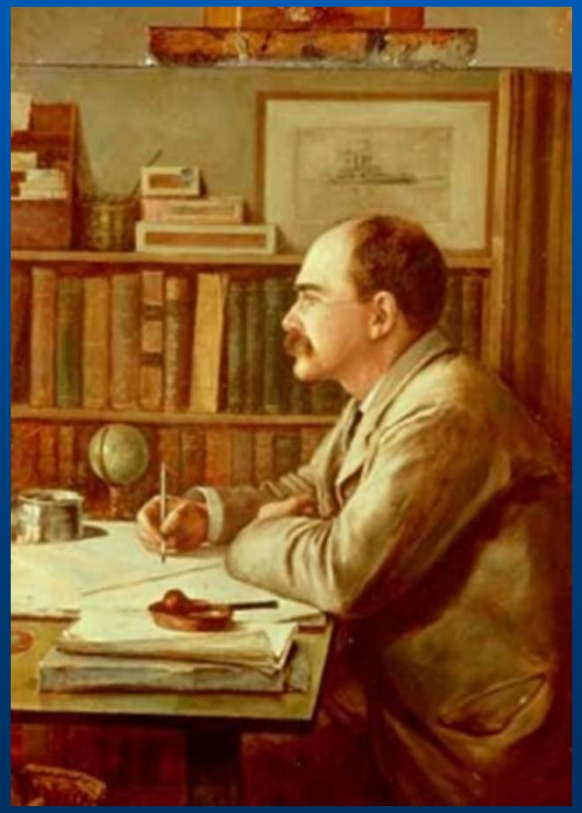
The aim of technology: to use

The aim of science: to understand

Can wrong idea be practically useful? – yes!

Why had the plague not broken out at the blacksmith's shop in Munday's Lane? Because, as I've shown you, forges and smithies belong naturally to Mars, and, for his honour's sake, Mars 'ud keep 'em clean from the creatures of the Moon… '"Eureka, good people!" I cried, and cast down a dead mill-rat which I'd found. "Here's your true enemy, revealed at last by the stars." "If you would stay the plague, take and kill your rats." None the less, the plague ceased and took off from the morning of the day that Mars enlightened me by the Lower Mill.'

(R. Kipling, A Doctor of Medicine)



Space travels

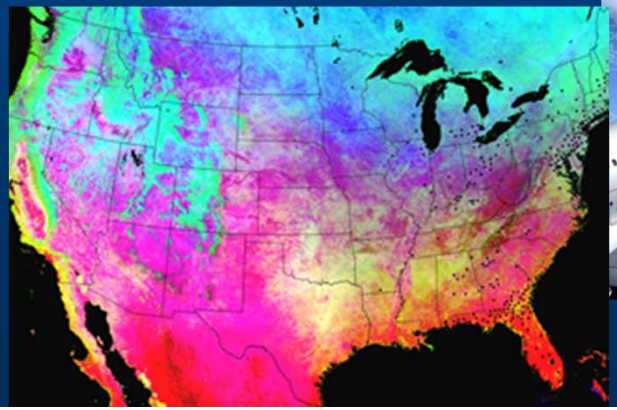
Konstantin Tsiolkovsky

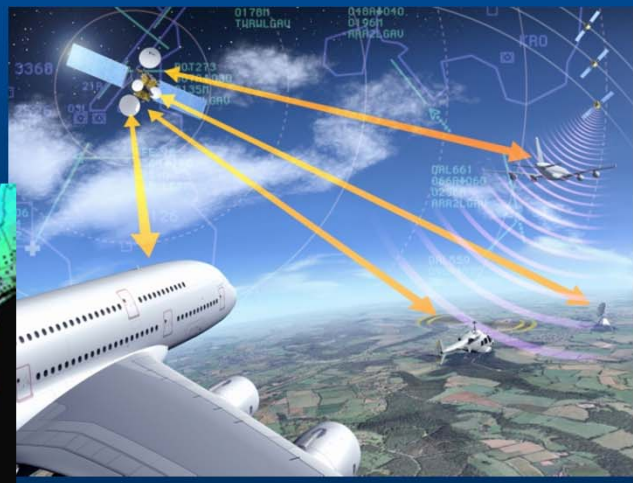
"Russian Cosmism"
Nikolai Fedorov
The aim: physical immortality and resurrection of the dead
Need a lot of space!
Motivation for space travels...

Brisbane Planetarium

Practical use of satellites

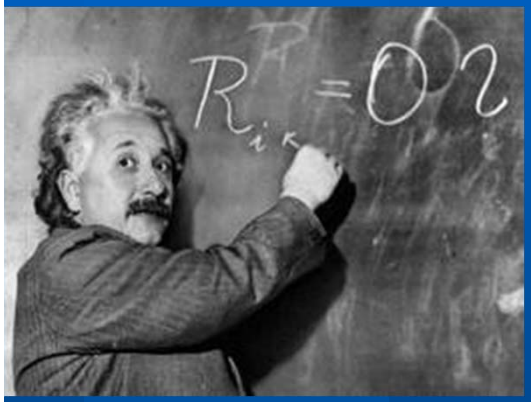
Navigation, weather forecast, communications, astronomy... Not talking on military applications



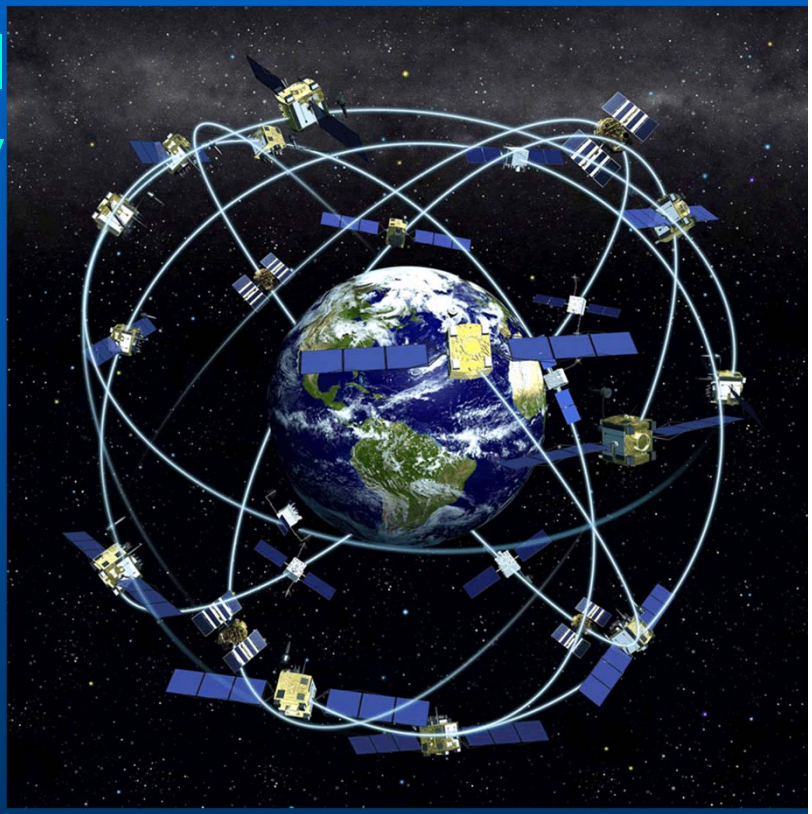


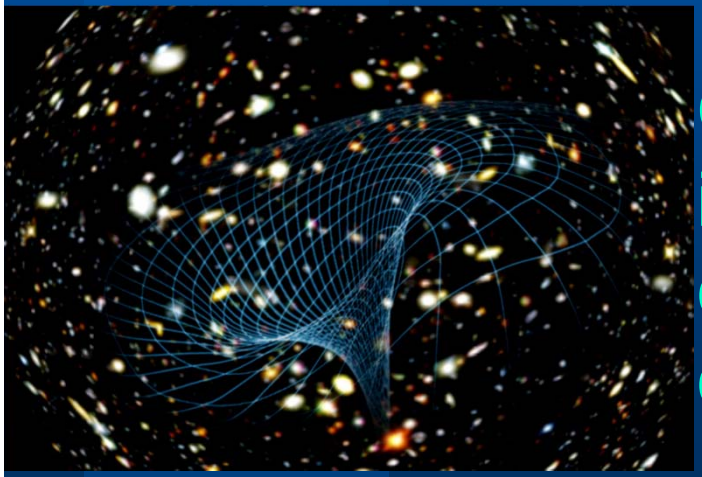
Can correct idea be practically useless?

Well... for sure (how can we use Higgs bosons or gravitational waves discovered very recently)? But...



Einstein's general theory of relativity (one of the most abstract physical concepts)





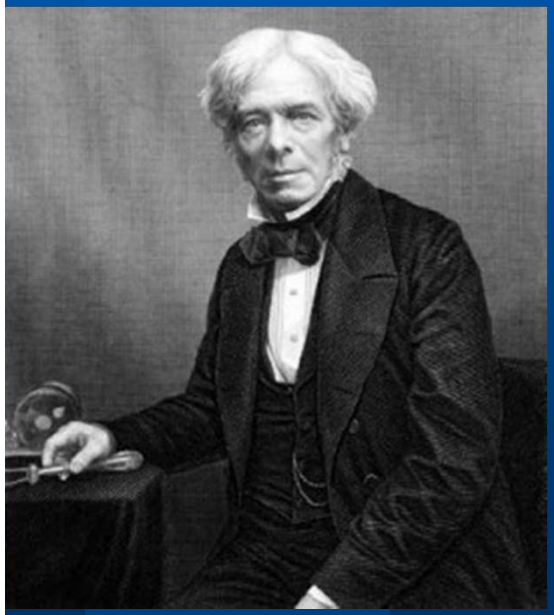
Gravitation is the curvature of space-time

Time is slowing down by gravity

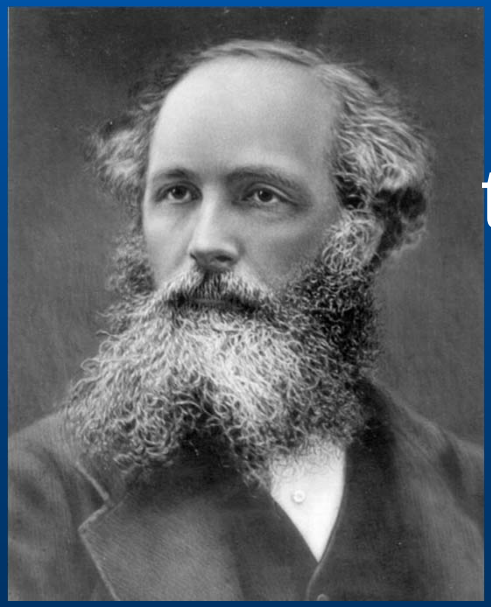
Should be taken into account in GPS!

Example: classical electrodynamics

From a long view of the history of mankind - seen from, say, ten thousand years from now - there can be little doubt that the most significant event of the 19th century will be judged as Maxwell's discovery of the laws of electrodynamics. The American Civil War will pale into provincial insignificance in comparison with this important scientific event of the same decade (R. P. Feynman)



Faraday



Maxwell

Faraday and Maxwell together have probably justified all expenses for fundamental science for thousands years in advance

Science and technology II

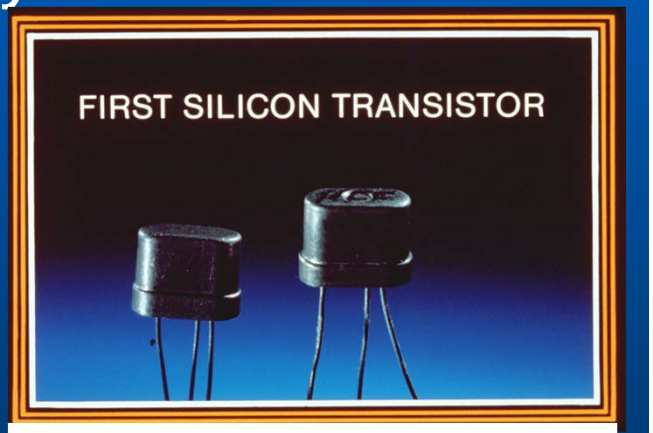
If we do not know whether the problem is solvable or not, it is science; if we are sure that we can do it but do not know whether it is worth to do or not – it is technology

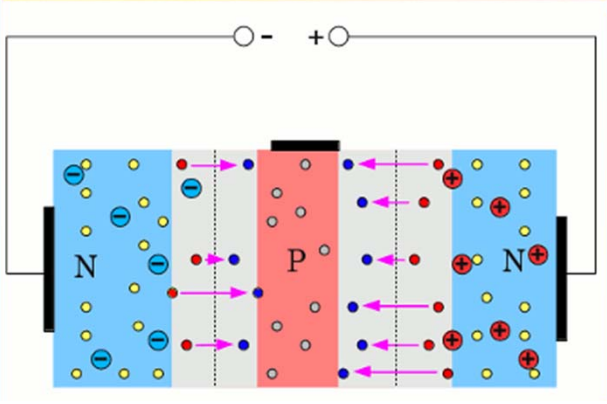
Science opens ways for dramatically new solutions

Triode (electronic vacuum tube)

Based on classical physics

Transistor is based on quantum physics – totally new concept of nature

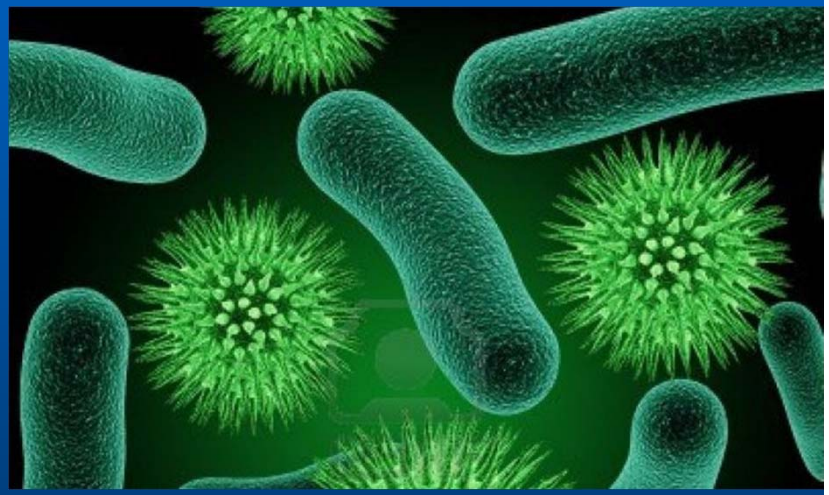




Science is necessary for survival of humankind

Agriculture (“green revolution”)
Medicine (new antibiotics: arms race with bacteria)

We cannot just stop: too many will die



Our society is crucially dependent on communications, transport, computers... well... weapons...

Very important to know how science works

The aim of science: Understanding

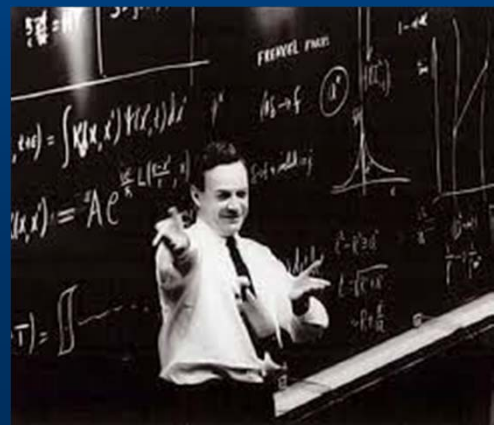
Duality of understanding and knowledge

Newton laws... Rotation...
Air resistance... I know this stuff
but the result will be... well...

He does not know (?!) Newton Mechanics – but it works! He feels (=understands) what to do

I think I can safely say that nobody understands quantum mechanics

(R. P. Feynman)



A normal way of doing theoretical physics

Combining elements: a (known) method A, apply to calculate a property B (was caclulated earlier but in another way), consider a system C (was calculated earlier for other systems)...

You can be taught to do it

Dramatically new ideas (e.g., gravity as a curvature of space-time): very rare, very important and we do not know how it happens)

It may be useful to know how people did it before (most of physicists are quite ignorant in history of physics) but you are not guaranteed...

Working with a space of ideas

Mathematics is the *art* of giving the same name to different things (H. Poincare)

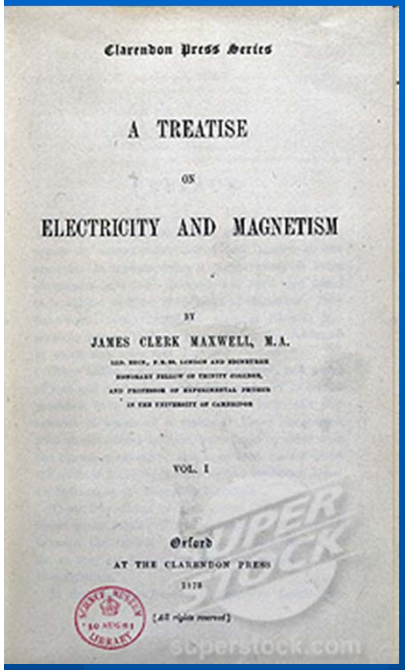
Like in a good book or a good movie: a lot of intrinsic relations, cultural references...

Analogy: a quantum computer vs classical

Working with N elements or with the whole “Hilbert space” (2^N combinations)

Graphene: coupling together solid state physics, soft matter, relativistic quantum mechanics and even gravity

Correct theories from wrong assumptions


Clarendon Press Series

A TREATISE

ON

ELECTRICITY AND MAGNETISM

BY

JAMES CLERK MAXWELL, M.A.

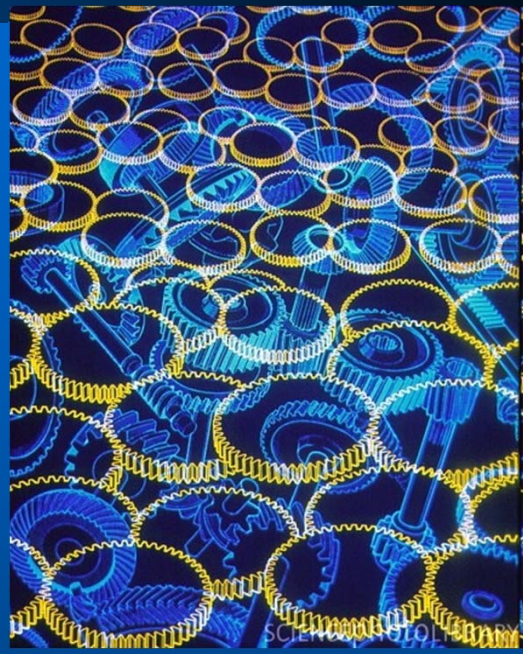
VOL. I

Oxford

AT THE CLARENDON PRESS

Electromagnetic fields as deformations in ether; gears and wheels

We do not believe now in mechanical models for electromagnetic field but Maxwell equations are correct



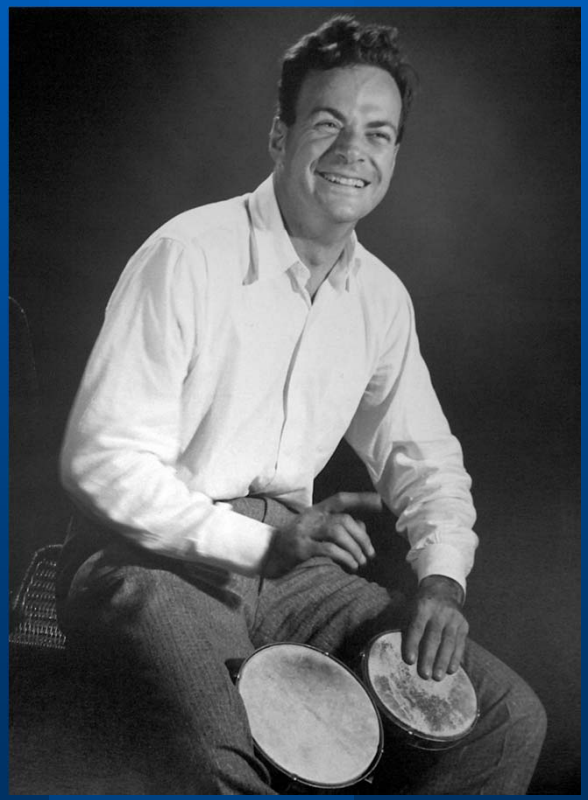
Also: Dirac equation (relativistic wave equation is not necessarily the first-order equaiton as Dirac postulated)

Landau theory of superfluidity of helium (he did not take into account Bose statistics of helium atoms which is crucially important)

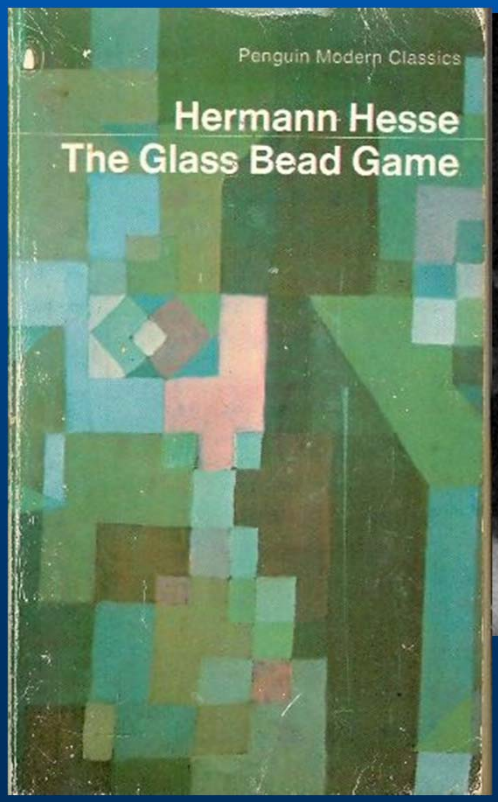
Curiosity-driven research

Physics is like sex: sure, it may give some practical results, but that's not why we do it

R. P. Feynman



Motivations are very different...



Model of science

Resume

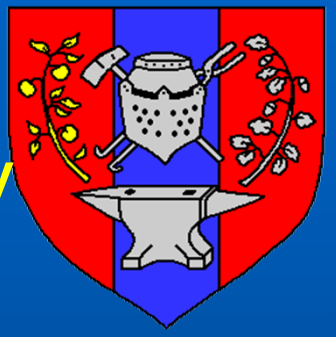
1. We do not know what is the origin of new ideas
2. Sometimes the best results originate from wrong background
3. We can plan less important works but breakthroughs are always unexpected
4. Our work is crucially important for humankind but it is impossible to tell what we are doing since we do not know ourselves

AND

5. We need money (science is expensive)!

What to do?

1. Trust us, we are smart guys and we know what to do – medieval guilds principle



It will not work in modern society

2. Convince people that we are useful

Well... We are useful but in a complicated way

Strong temptations: lie and intimidate

Polite version: tell on success only, overestimate practical importance, promise something too early..

Responsibility of scientists

Practical questions:
risk of natural disaster?

Scientists as oracle

May be real...
Too big responsibility?!

NEWS IN FOCUS

FILIPPO MONTEFORTE/AFP/GETTY

More than 300 people perished in the earthquake that struck the medieval centre of L'Aquila.

RISK ASSESSMENT

Scientists cleared of quake deaths

Italian appeals court says six seismologists were not guilty of manslaughter following the 2009 L'Aquila disaster.

BY ALISON ABBOTT & NICOLA NOSENGO

Six seismologists accused of misleading the public about the risk of an earthquake in Italy were cleared of manslaughter on 10 November. An appeals court overturned their six-year prison sentences and reduced to two years the sentence for a government official who had been convicted with them.

The magnitude-6.3 earthquake struck the historic town of L'Aquila in the early hours of 6 April 2009, killing more than 300 people.

The finding by a three-judge appeals court prompted many L'Aquila citizens to react with rage, shouting "shame" and saying that the Italian state had just acquitted itself, local media reported. But it comes as a relief to scientists around the world who had been following the unprecedented case with alarm.

"We don't want to have to be worried about the possibility of being prosecuted if we give advice on earthquakes," says seismologist Ian Main of the University of Edinburgh, UK. "That would discourage giving honest opinion."

The defendants themselves have mixed feelings. Giulio Selvaggi, former director of the National Earthquake Centre in Rome, says that although he is happy to be acquitted, "there is nothing to celebrate — because the pain of the people of L'Aquila remains".

In the months before the major earthquake struck, the region around L'Aquila had been subject to frequent, mostly low-magnitude tremors known as seismic swarms. Residents were alarmed by a local amateur earthquake predictor's claims that he had evidence of an impending quake, although geologists dismissed his methods as unsound.

A commission of experts met on 31 March 2009 to advise the government. According to the prosecution, a press conference after that meeting — attended by the acting president of the commission, volcanologist Franco Barberi of the University of Rome 'Roma Tre', and by Bernardo De Bernardinis, then deputy director of the Italian Civil Protection Department — conveyed a reassuring message that a major earthquake was not on the cards. Moreover, in a television interview recorded shortly before the meeting but aired after it, De Bernardinis said that "the scientific community tells me there is no danger because there is an ongoing discharge of energy" during the seismic swarms.

As a consequence, according to the prosecution, when the earthquake struck on 6 April, 29 people chose to stay indoors and died as their homes collapsed. All members of the expert commission were found guilty of manslaughter in October 2012, after a 13-month trial that transfixed the international scientific community.

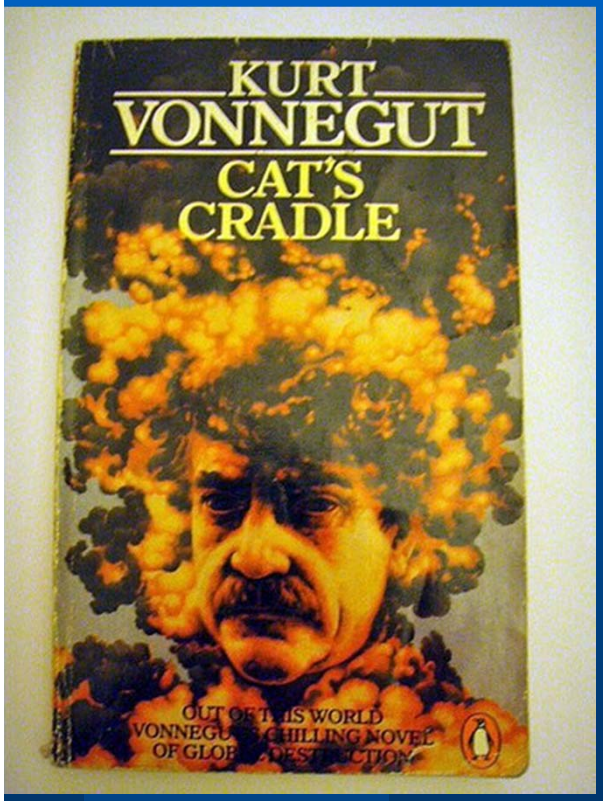
In addition to De Bernardinis, Selvaggi and Barberi, the other defendants were Enzo Boschi, former president of the National Institute of Geophysics and Volcanology in Rome; Claudio Eva, an Earth physicist at the University of Genoa; Mauro Dolce, head of the seismic-risk office of the Civil Protection Department in Rome; and Gian Michele Calvi, director of the European Centre for Training and Research in Earthquake Engineering in Pavia.

Over the course of six hearings before the appellate court in L'Aquila, the defence argued that there was no proof of a causal link between the meeting and the behaviour of the people of L'Aquila citizens. The lawyers also argued that the scientists could not be held accountable for De Bernardinis's reassuring statements, and that their scientific opinions were ultimately correct.

De Bernardinis was acquitted of the manslaughter charges in 16 cases, but not for the other 13. The judges can take up to three months to publish the reasoning behind their verdict. Lawyers for the families of the deceased have announced that they will challenge the ruling in the Supreme Court of Cassation in Rome, which could call for a retrial. ■

Misuse of science

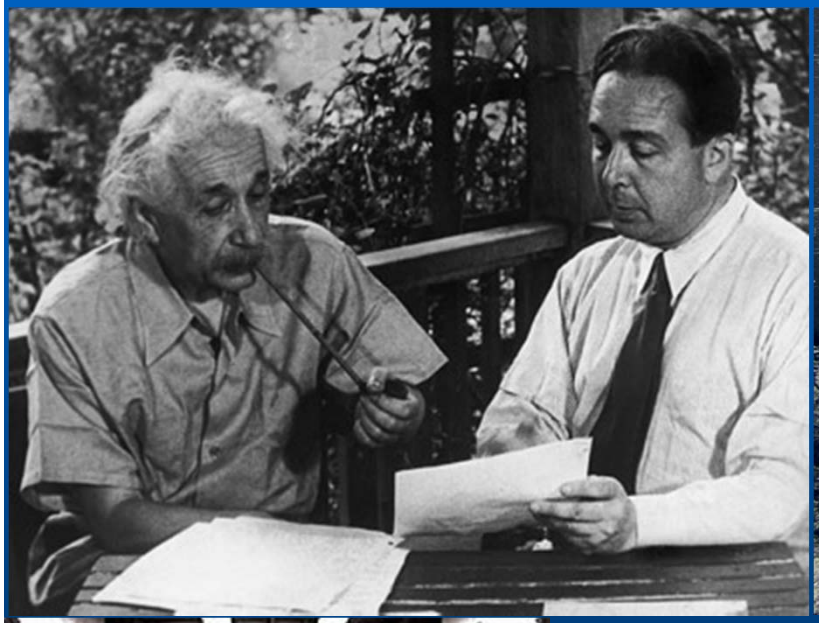
Everything a scientist did was destined to become a weapon (K. Vonnegut, Cat's Cradle)



Was/is arms race useful for science? Well...

Science as mass occupation

Starts with A-bomb making



Completely changes relations between scientists and society

From History of Soviet Science

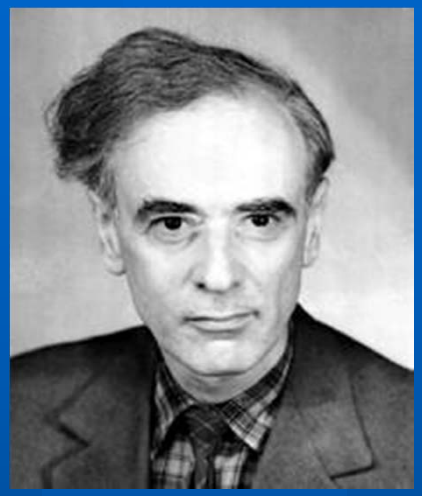
After the revolution 1917: Bolsheviks and Science

Humanities – just destroyed ("Marxism-Leninism" in its most primitive forms as obligatory "method")

Science in 1920th: a lot of people sent abroad
A huge amount of very talented people appeared

A very serious contribution to the new physics

From History of Soviet Science II



Landau
(Nobel laureate,
pupil of Bohr)

Kapitsa
(Nobel laureate,
pupil of Rutherford)

Fock

Arrested 1937, released 1938

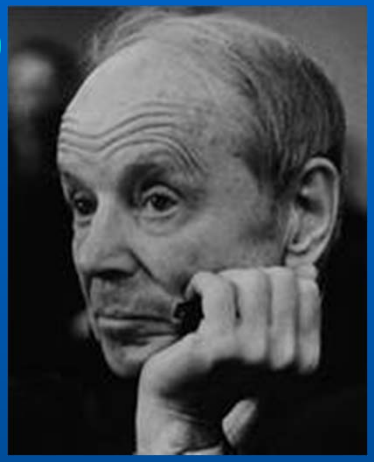
Frenkel

Gamow

My background: Theoretical physics in Sverdlovsk

S. P. Shubin (1908-1938)

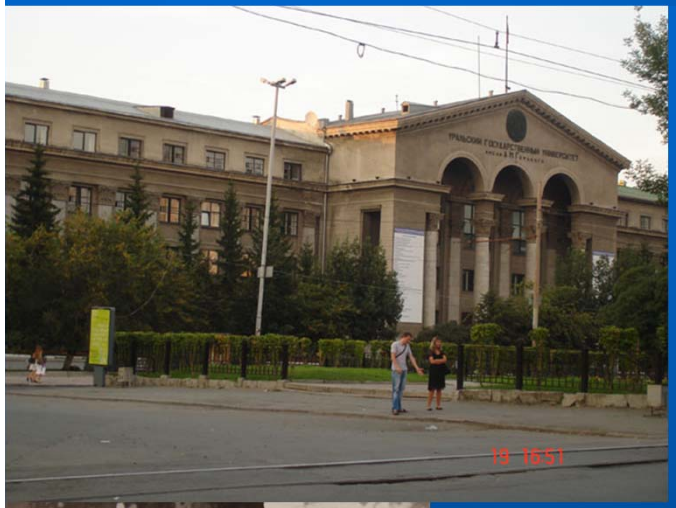
S. V. Vonsovsky (1910-1998)



Arrested 1929, Professor, head of the department 1933, arrested 1937, died 1938. Published 18 papers

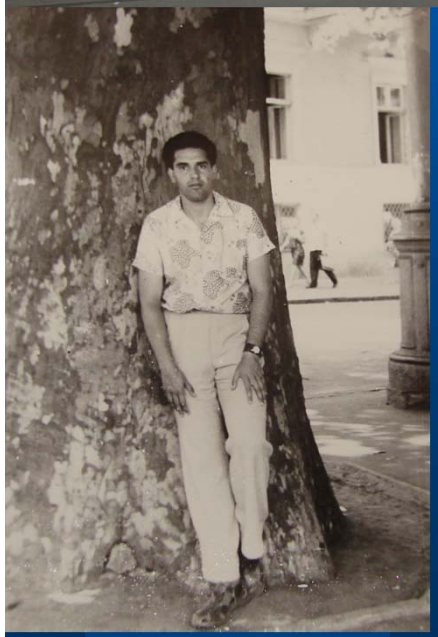
"Polar model" ("Mott insulators"), liquid metals, photoeffect, s-d exchange (Vonsovsky-Zener) model...

Studying and Working in Ural



Ural State Univ.

Inst. Metal Physics



Me (1979)

Advanced Physics and Mathematics Schools
Olympiads

Mathematics, Physics, Chemistry vs History,
Philosophy, Literature...

No choise: only physics/mathematics/chemistry

Well... Good for science?!

Peculiarities

No grants, no proposals. “You always did whatever you like”

A very broad education

“Physics is an oral science”. Role of journals and seminars

“Scientific schools”. The War of the Roses

No need to be convincing for public (but a huge need to be convincing for authorities)

What happens with Russian physics?

Disaster? or Great success?

Like chemical evolution in stars: a very peculiar medium which does not exist anymore

Reunification with the world science and enrichment of the world science