



NANOTECHNOLOGY AS A BASIS FOR A NEW POSTINDUSTRIAL ECONOMY

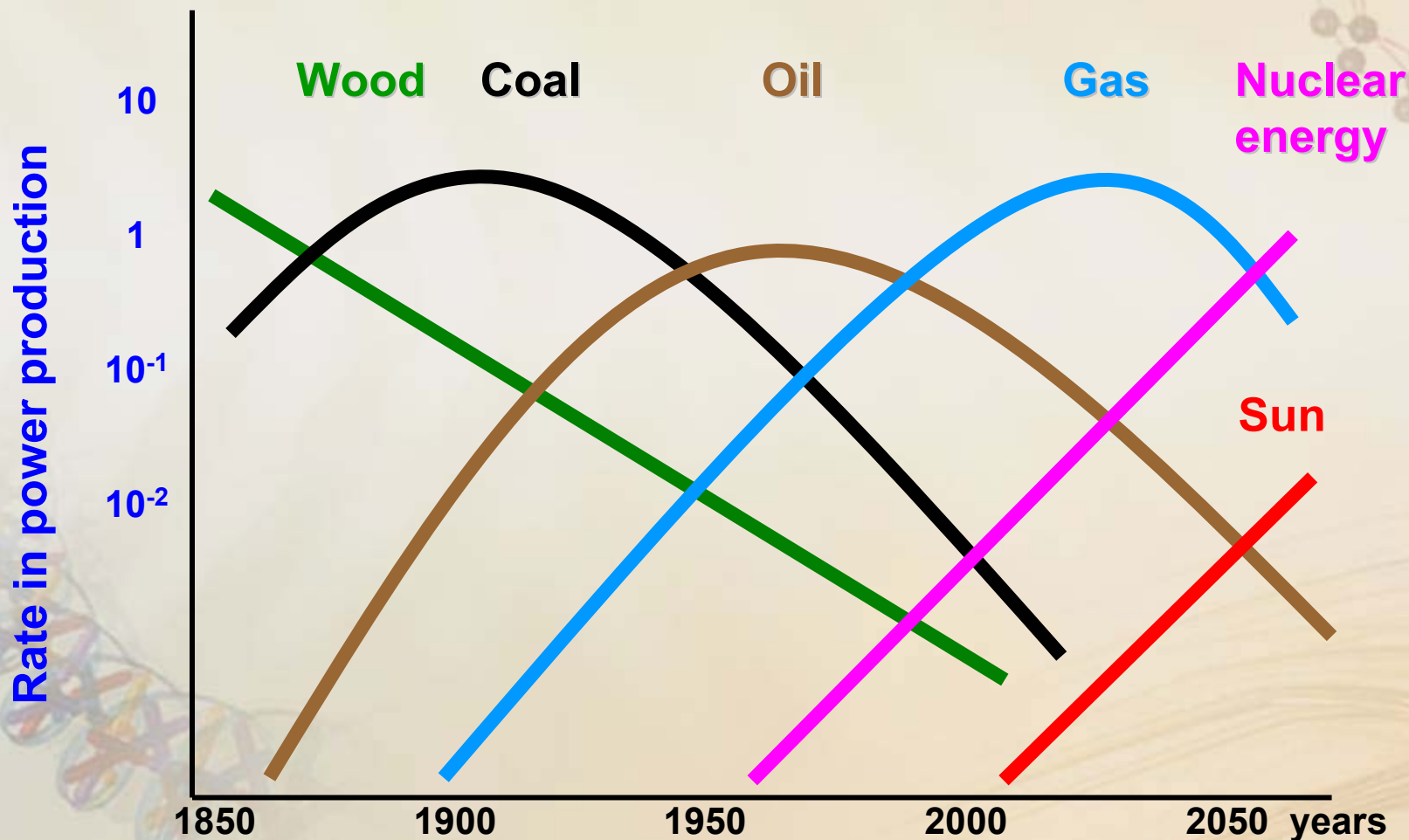
M. V. Kovalchuk

**Fourth European Conference on Research Infrastructures
Hamburg, June 5-6, 2007**



Russian Research Center
«Kurchatov Institute»

THE ROLE OF THE MAIN ENERGY SOURCES



ENERGY PRODUCTION

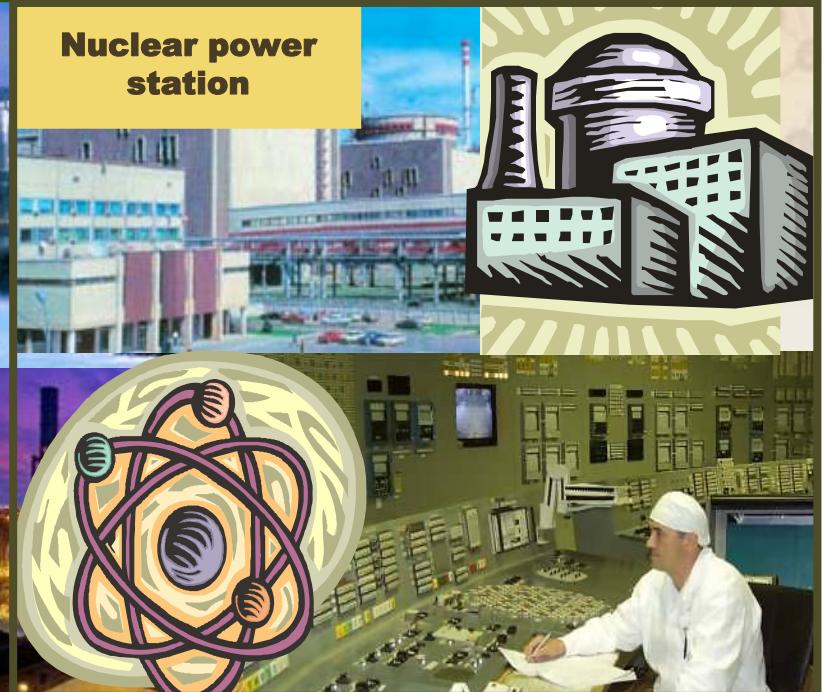
Coal & hydrocarburants power stations



Hydropower stations



Nuclear power station

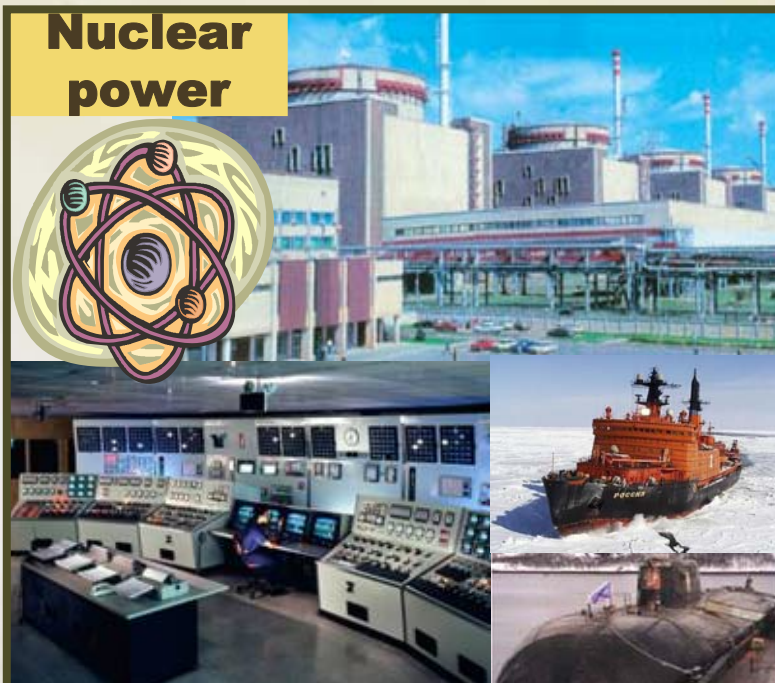


**Non-traditional sources:
wind, sunlight**



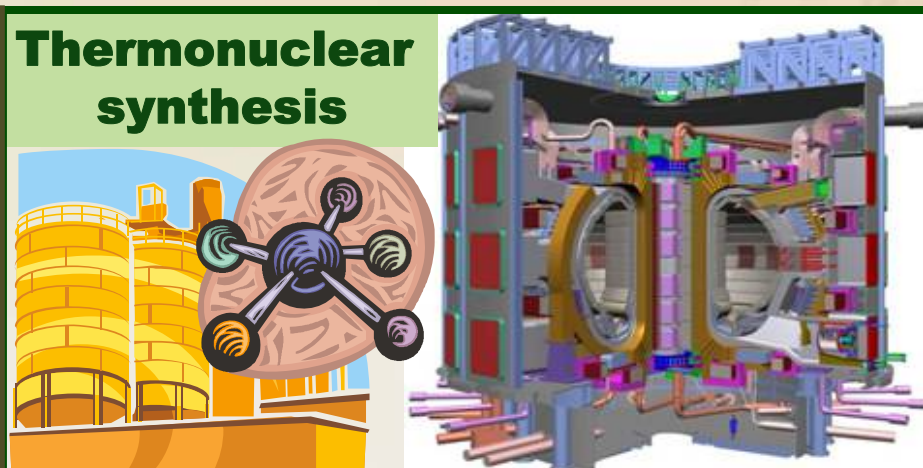
FUTURE DEVELOPMENT

Nuclear power



A collage illustrating nuclear power. It features a stylized atomic symbol with a central nucleus and orbiting electrons. Below this, there is a photograph of a large industrial nuclear power plant with multiple cooling towers. To the left, a control room is shown with several operators at consoles. To the right, a large orange and black icebreaker ship is sailing on the water.

Thermonuclear synthesis



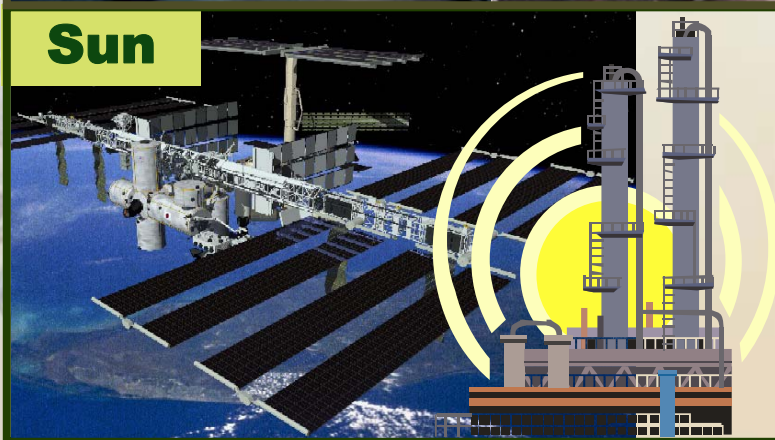
A collage illustrating thermonuclear synthesis. It includes a stylized atomic symbol with a central nucleus and orbiting electrons. To the left, there are yellow cylindrical structures representing fusion reactors. On the right, a detailed 3D cutaway diagram of a tokamak fusion reactor is shown, highlighting its complex internal structure with various components and piping.

Wind, ocean



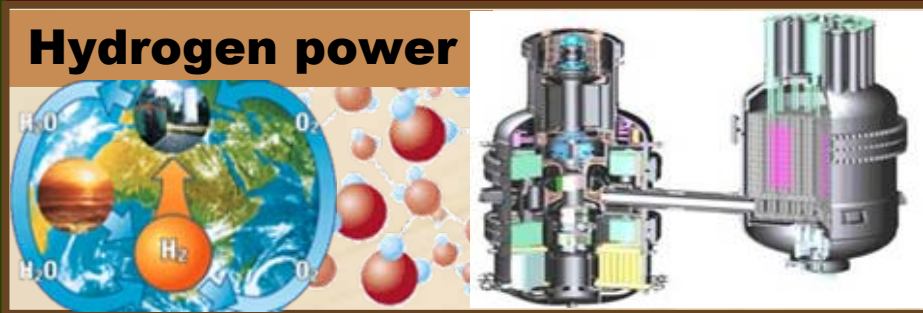
A collage illustrating wind and ocean energy. It features a photograph of a control room for a power plant. Below this, there are images of wind turbines: a close-up of a turbine's blades, a field of turbines in a hilly landscape, and a large transmission tower. In the bottom right, a large offshore oil or gas platform is visible in the ocean.

Sun



A collage illustrating solar energy. It features a large image of a space station or solar power satellite in orbit above Earth, with long solar panel arrays extending from its structure. To the right, a stylized graphic shows a sun with rays and a power plant structure, symbolizing the conversion of solar energy into electricity.

Hydrogen power



A collage illustrating hydrogen power. It features a globe with arrows indicating the hydrogen cycle, showing the conversion of water (H₂O) into hydrogen (H₂) and back. To the right, there are two detailed 3D cutaway diagrams of hydrogen fuel cells, showing their internal components and how they generate energy.



Energy

Production

Saving

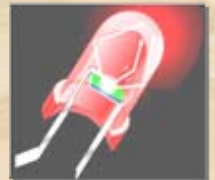
Nanotechnology



- *Dematerialization of manufacturing*
- *Decrease of resource and energy consumption*



*From bulb to LED
- economy 10 %*

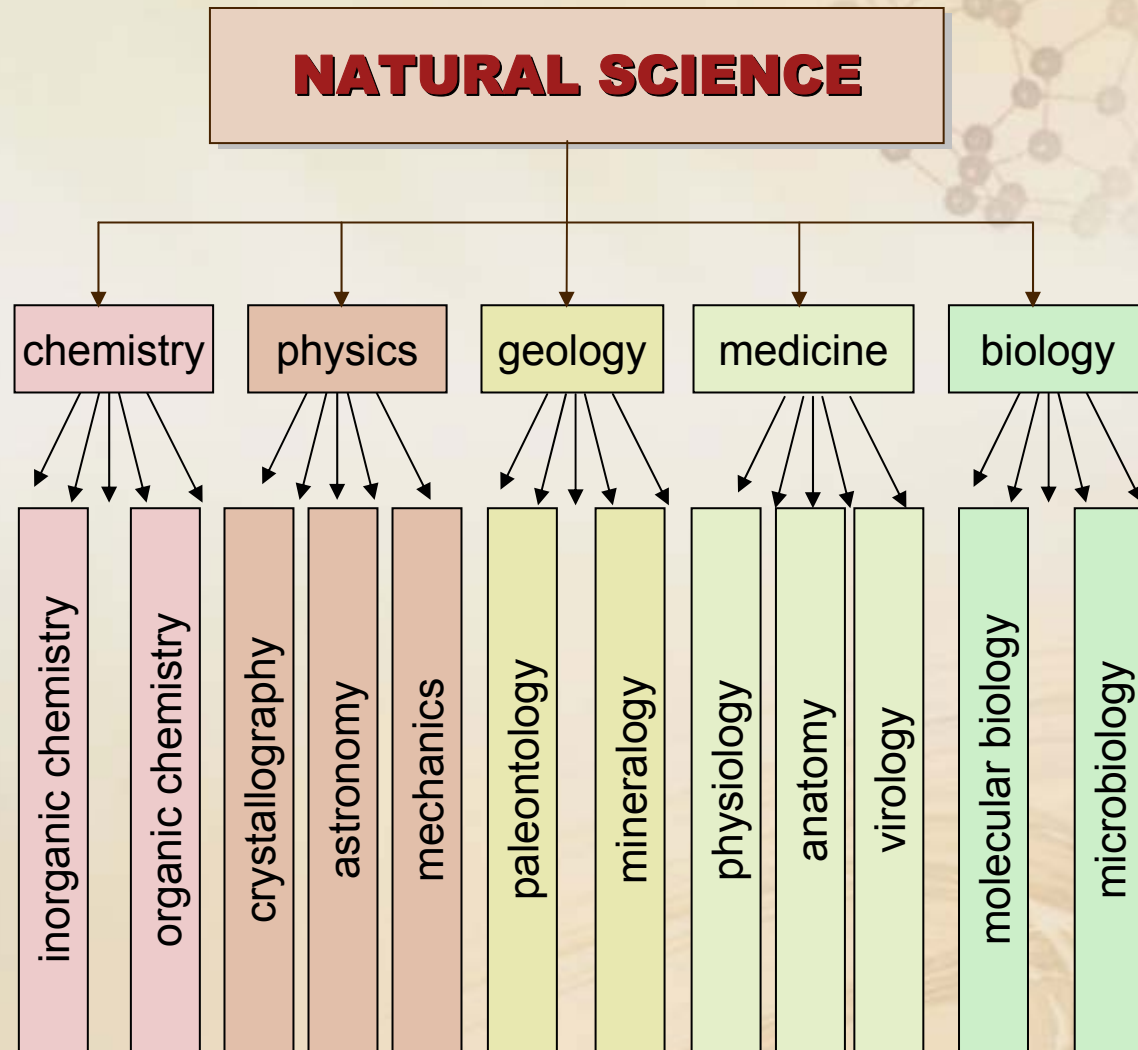
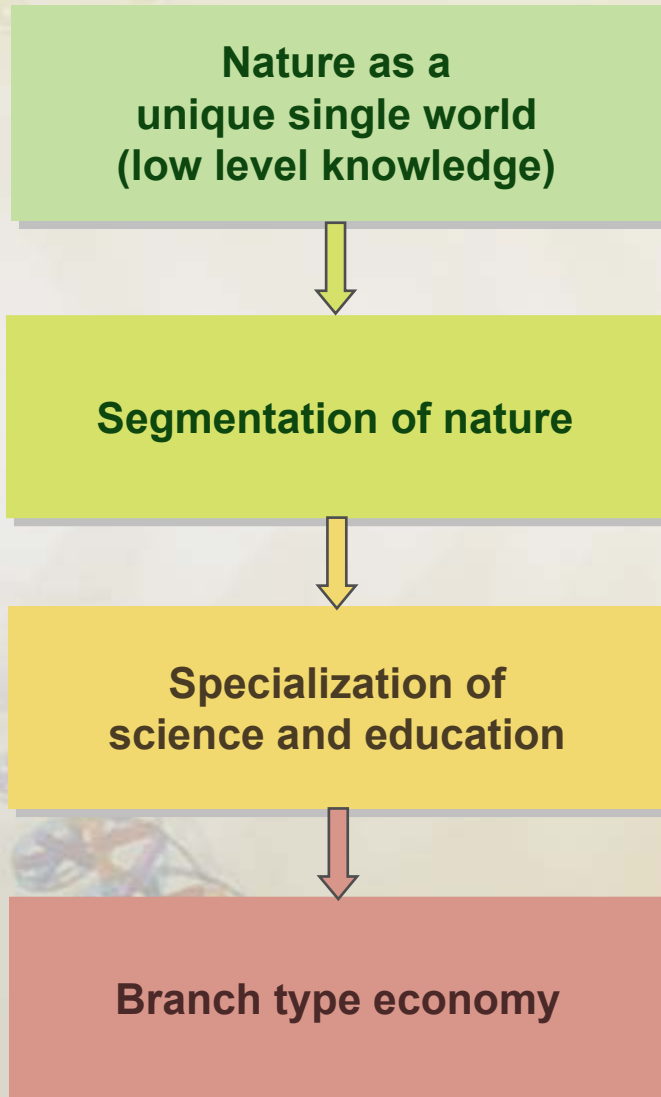


SCIENTIFIC REVOLUTION OF THE XX CENTURY

- ♦ **Discovery of the structure of atom and nucleus**
- ♦ **Transition from the classic to quantum model of the world**
- ♦ **Scientific revolution - «Atomic project»**
 - from accelerator
 - to atomic bomb
 - to nuclear power plant
- ♦ **New world model**
 - science, technology, weapons,
 - power engineering, geopolitics ...



UNDERSTANDING OF THE WORLD



INDUSTRIAL DEVELOPMENT

Branch technologies:

metallurgy, chemical industry, building materials, mining operations etc

Integrated inter-branches technologies:

microelectronics, engineering industry, power engineering etc

Over-branches technologies:

Information technology



Information Technology (IT)



inorganic chemistry

organic chemistry

crystallography

astronomy

mechanics

paleontology

mineralogy

physiology

anatomy

virology

molecular biology

microbiology



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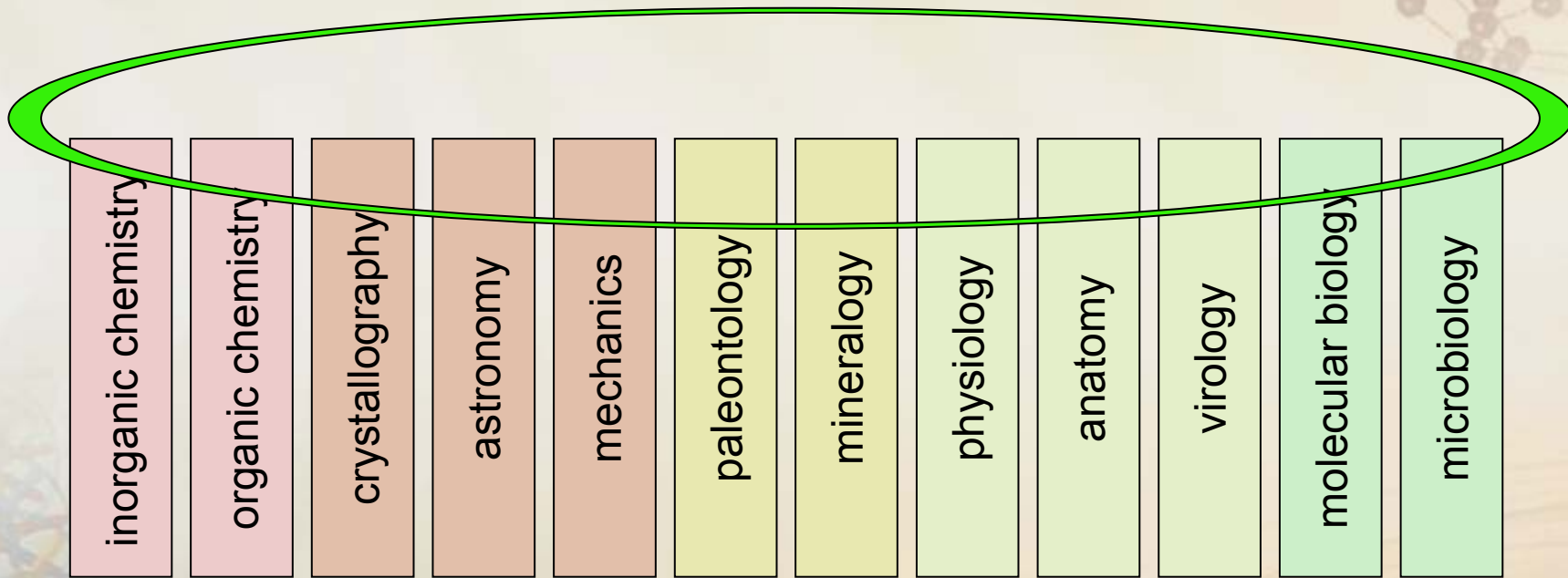
virology

molecular biology

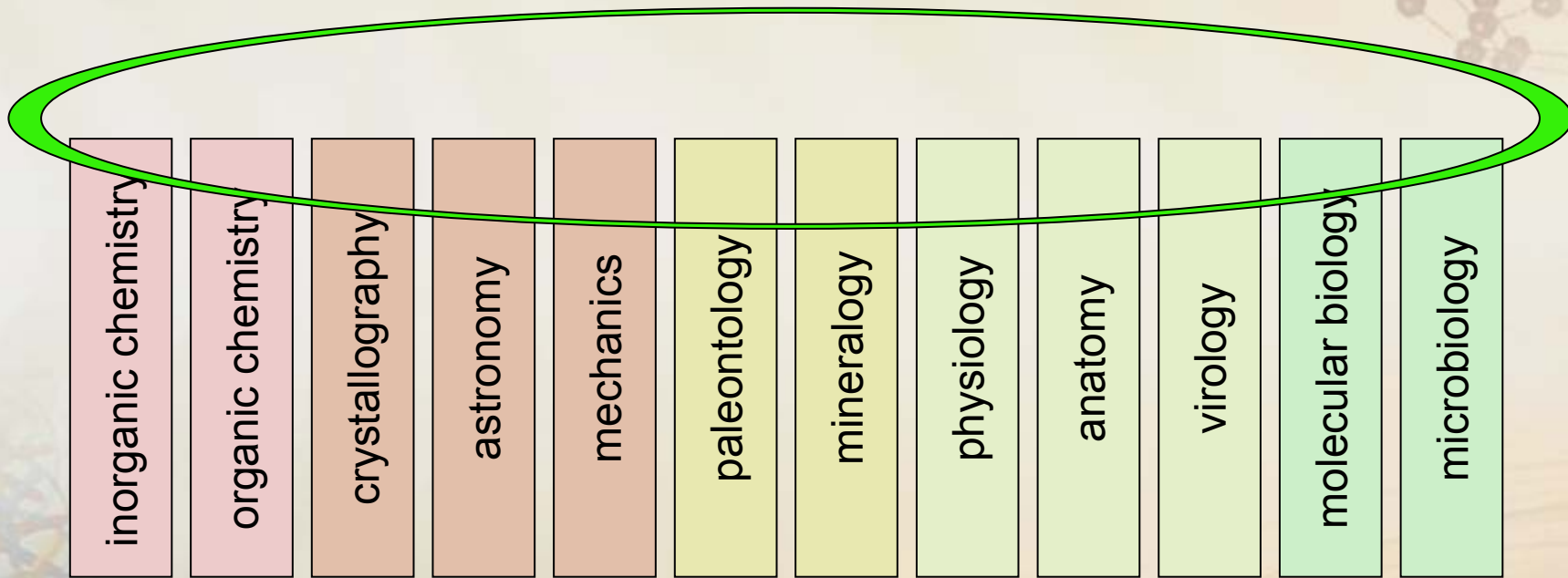
microbiology



Information Technology



Information Technology



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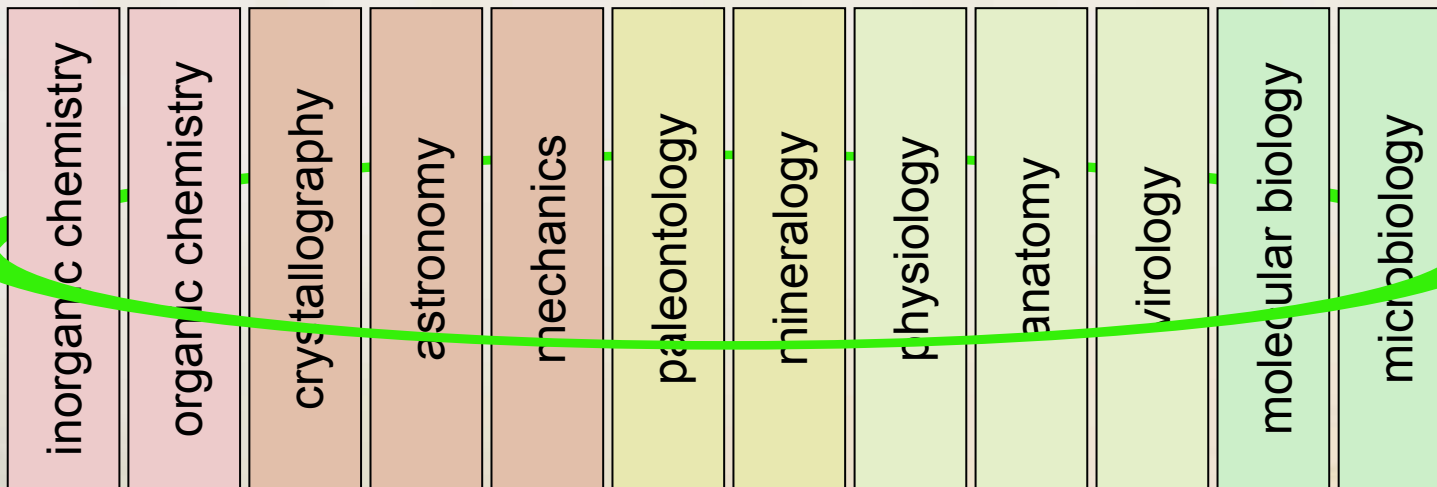
molecular biology

microbiology

Information Technology



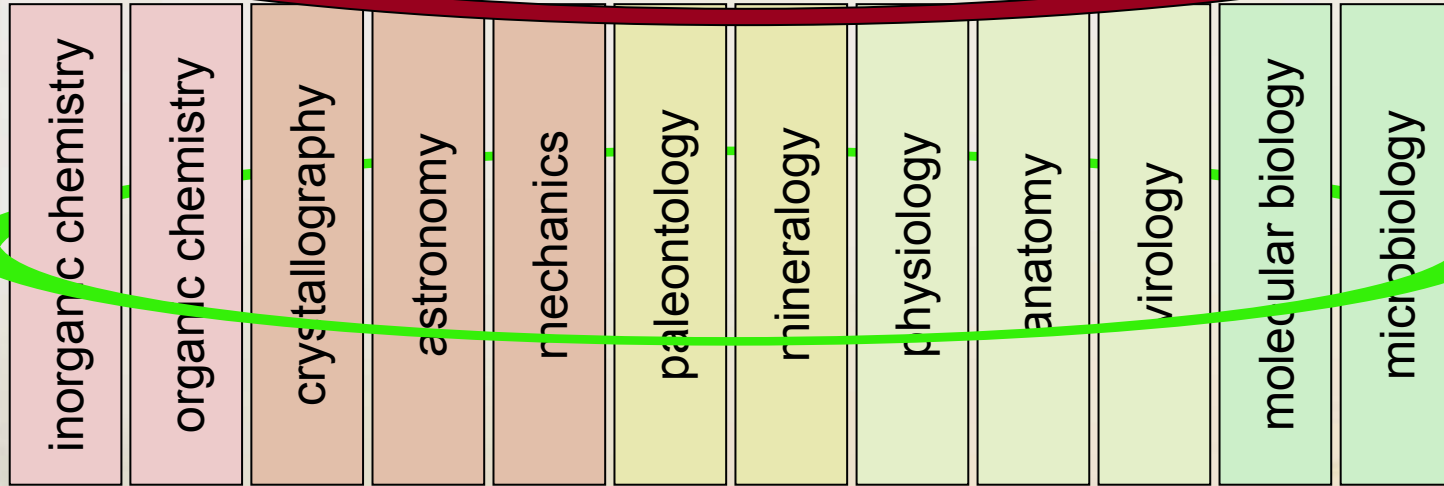
Nanotechnology



Information Technology



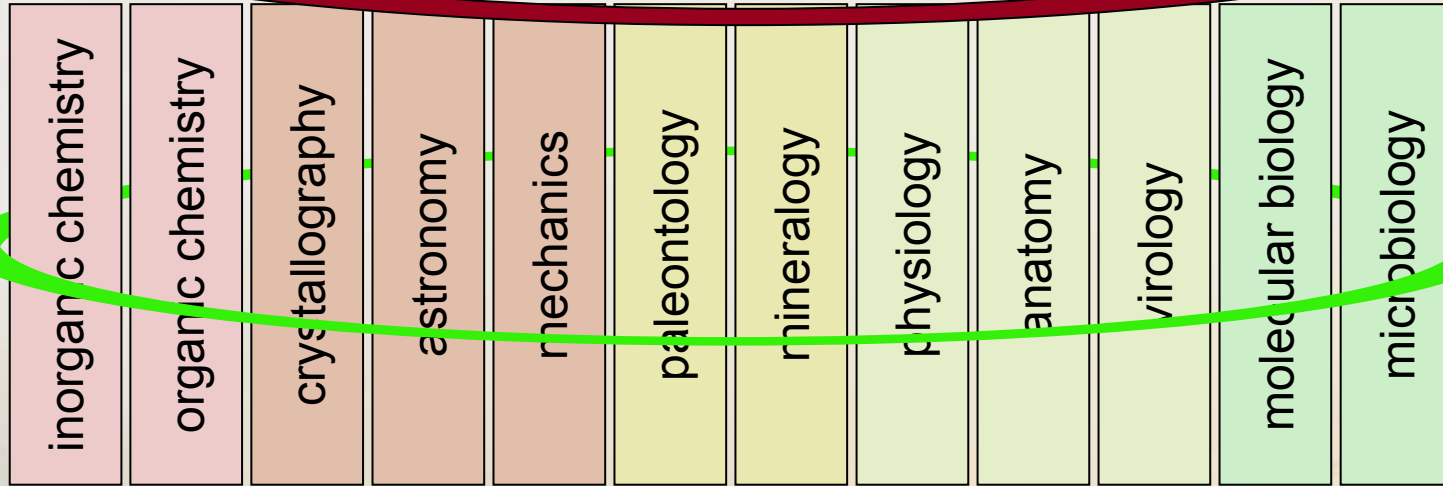
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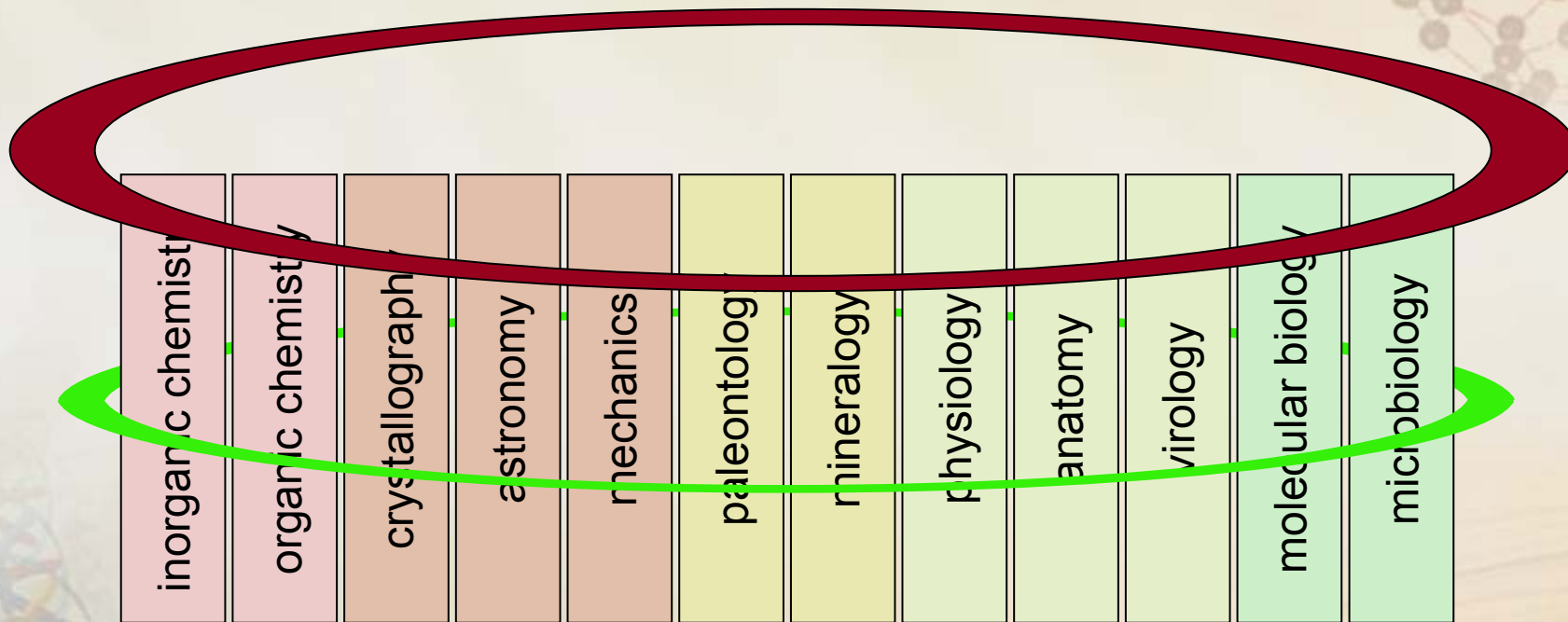
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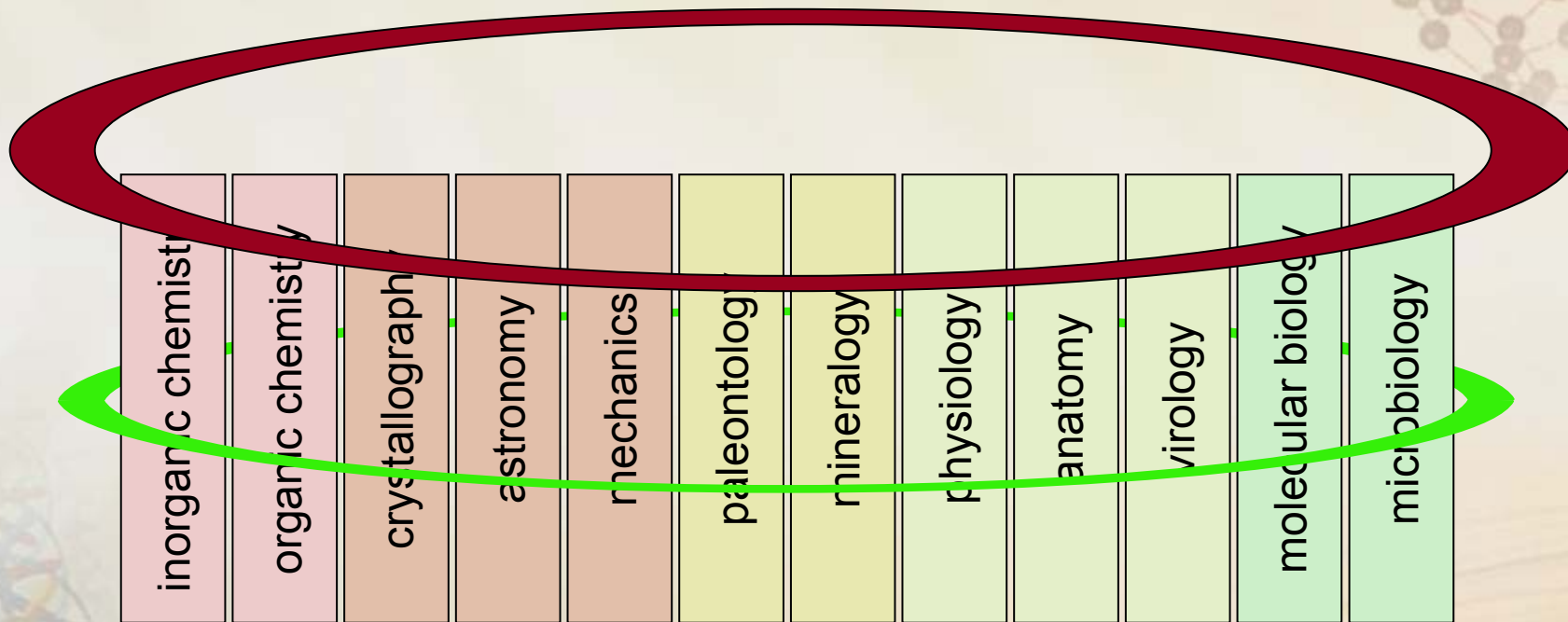
Nanotechnology



Information Technology



Nanotechnology



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Information Technology



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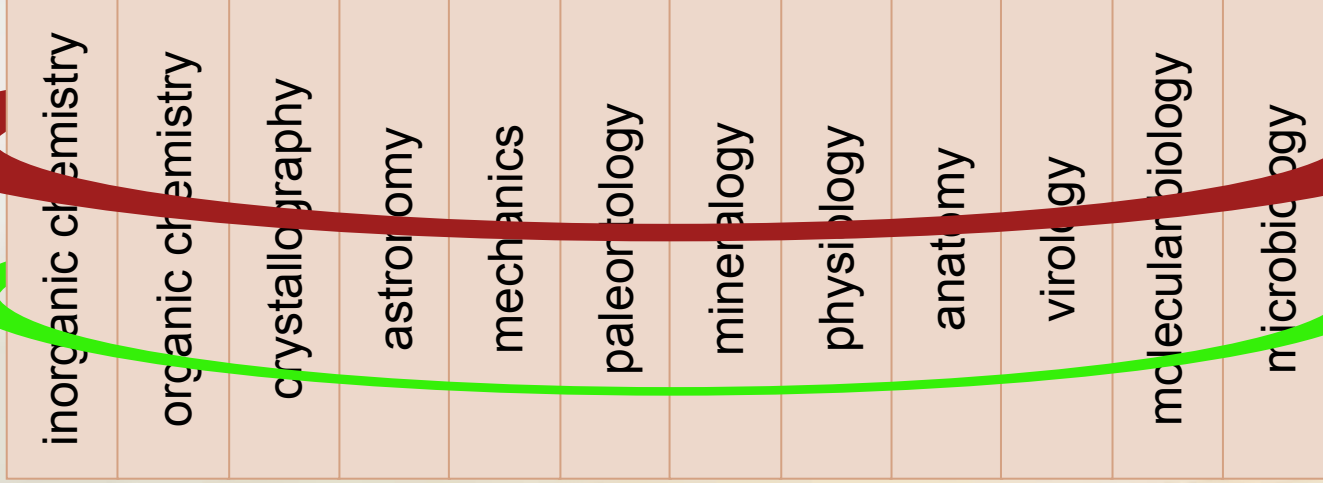
Nanotechnology

inorganic chemistry	organic chemistry	crystallography	astronomy	mechanics	paleontology	mineralogy	physiology	anatomy	virology	molecular biology	microbiology
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Information Technology



Nanotechnology



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Information Technology

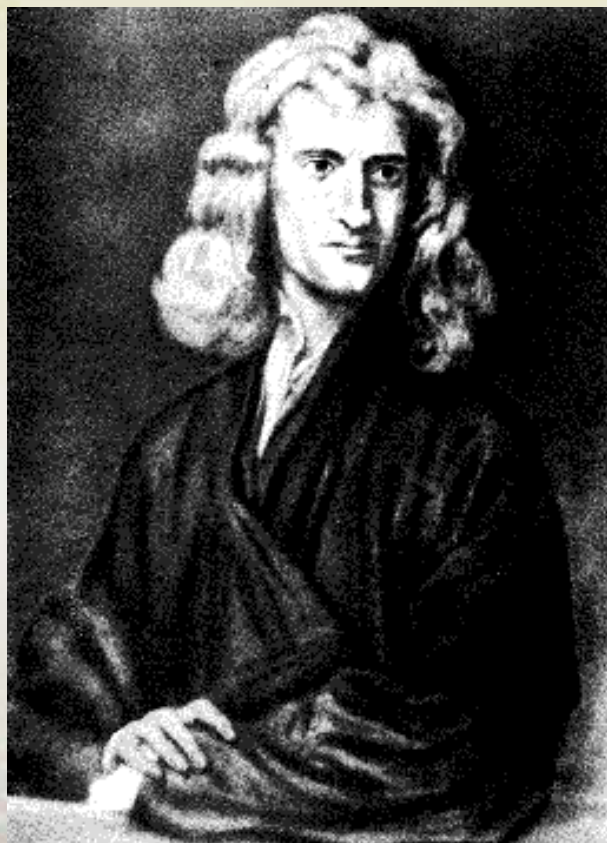


Nanotechnology

NATURAL SCIENCE

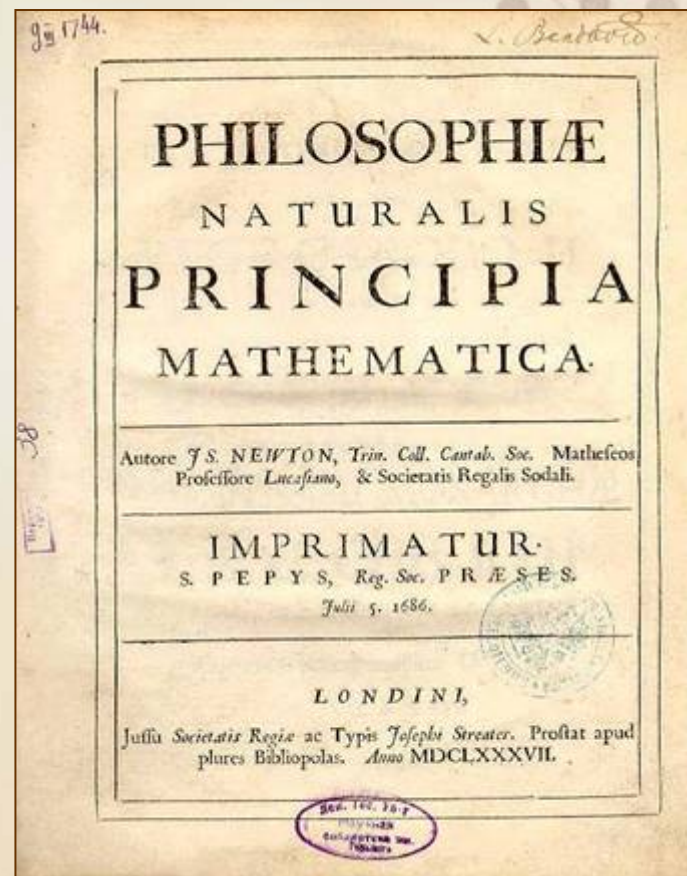
Nanotechnology – universal technological basis
of postindustrial society





Isaac Newton
(1642...1727)

«*Philosophiæ Naturalis Principia Mathematica*» (1687)



MODERN TRENDS IN SCIENCE

Return to the integral vision of the world

- Technologies of atomic-molecular engineering (transition to nanodimension)
- Convergence and interpenetration of views on inorganic and organic substances
- Interdisciplinary approach instead of narrow specialization

Design of principally new materials, tools and devices, copying nature on the base of integral technologies (bionics)

- Anthropomorphism (similarity to human) of technical systems
- Dematerialization of industry – decrease of resources consumption
- Creation of hybrid systems



ARTIFICIAL EYE – THE UNIQUE DETECTOR OF ELECTROMAGNETIC RADIATION



protein of rhodopsin

Investigation of vision
(**physiologist**,
neurophthalmologist)

Investigation of functions of
rhodopsin molecules (**biologist**)

Separation of proteins
(**biochemist**)

Crystallization of the protein,
X-ray structural analysis
(**crystallographer**)

Design of a chip
(**engineer - system analyst**)

Creation of two-dimensional
protein films (**physicist, chemist**)



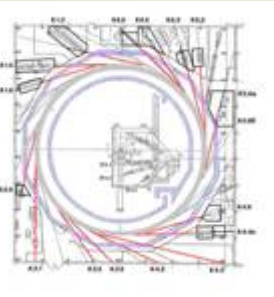
Existing world system of science-education organization and their financing is strongly against interdisciplinary approach

Interdisciplinary national labs are the best places to implement new type of science and educations

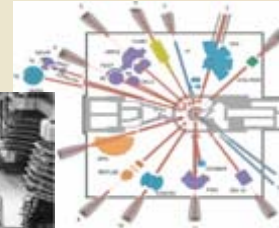
National labs in globalizing world are the base of global nanotechnology network



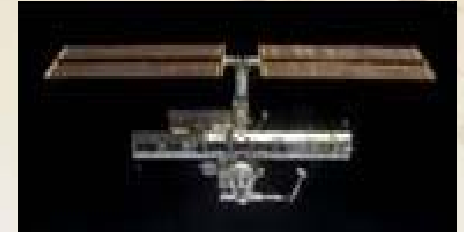
LARGE-SCALE FACILITIES



**Synchrotron
Radiation Sources**



Neutron Sources



**International
Space Station**

Way of Analysis:

Big and expensive facilities for small number of scientists

Way of Synthesis:

Big facilities are converted for multidisciplinary application of a wide scientific community



DEVELOPMENT, PRODUCTION and UTILIZATION of TECHNOLOGICAL, METROLOGICAL and DIAGNOSTIC EQUIPMENT for NANOINDUSTRY



MBE unit



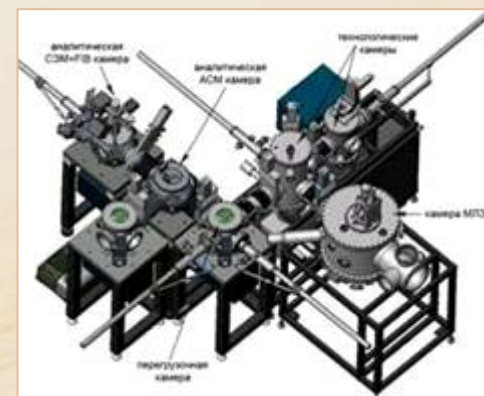
Synchrotron



“Clean room” manufacturing



Neutron reactor



NANOFAB



Relative Number of Nuclear Research Facilities (NRF) of MAGATE-member and Other Countries

(data for 2000)

Today Russia has more NRF and high-flux nuclear reactors than any other country in the world

Mega science:

- **Big machines (mega clusters)**
– research and technological basis for nanotechnology and for new future development
- **Ready to go model for new science of XXI centre**

Country, or group of countries	Number of NRF, %
Russia	22
USA	19
Japan	7
Germany	5
France	5
China	5
Canada	3
Great Britian	1
Other developed countries	9
Other developing countries	24



MAIN SR and Neutron Facilities in Russia



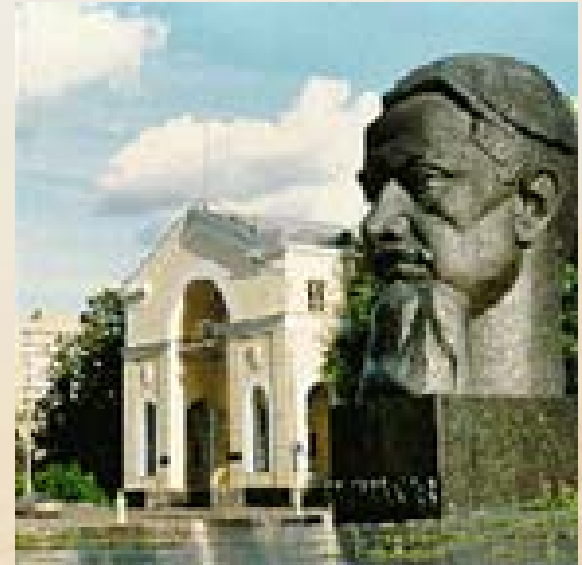
NANOTECH PROJECT FRAMEWORK

Global character of the Project presumes **network structure**
(National Nanotechnology Network – **NNN RF**)

The core of network – the leading scientific national institute, with an unique interdisciplinary scientific and technological capabilities - Russian Research Center «Kurchanov institute».

Structure of NNN RF

- Leading institutes
 - a) by fields
 - б) by regions (Federal districts)
- Science and education centers
- On the base of NNN – technological platforms in all directions of activity
- Global computing network (GRID-GLORIAD)



TECHNOLOGICAL PLATFORMS of NNN RF

RESEARCH - TECHNOLOGICAL

Support of R&D, metrology, the base for standardization and certification

RESEARCH - EDUCATION and HUMAN RESOURCES

Support of interdisciplinary education, high mobility, quick response to labor-market trends, social infrastructure

IT and COMMUNICATIONS

IT integration of national nanoindustry, data bases, monitoring, foresight, GRID, GLORIAD, remotely controlled experiments

ORGANIZATION and ECONOMY

Commercialization of NANO products, private-public partnership (SBIR)

ORGANIZATION and LEGISLATION

Legal base of innovations in NANO area, intellectual property, standards, risk insurance

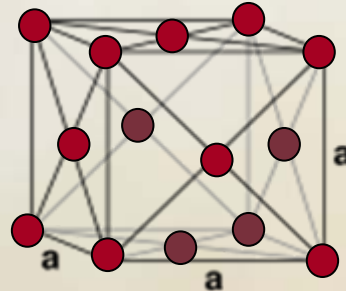
INTERNATIONAL COOPERATION

International scientific exchange, cooperation projects



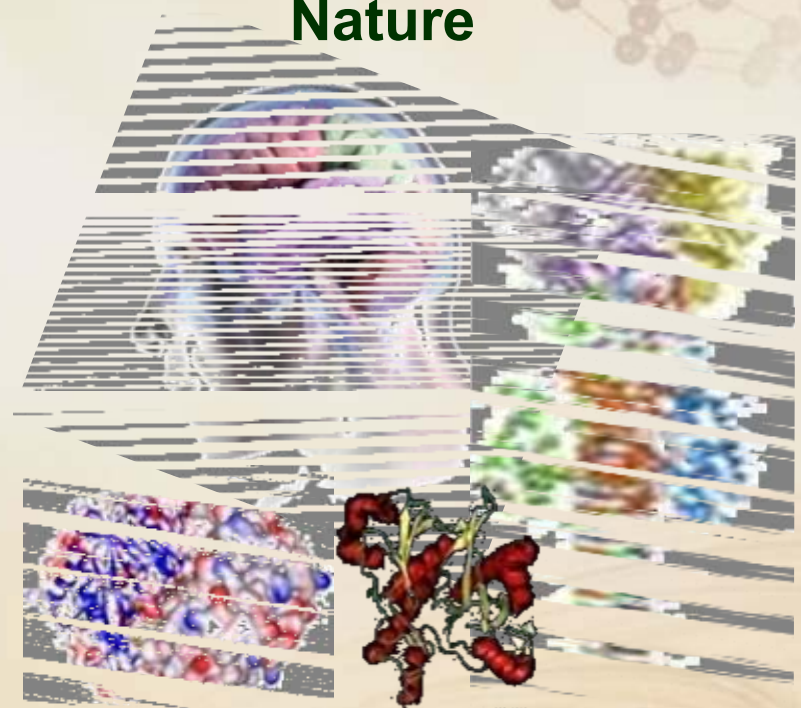
THE MAIN AIM OF SCIENCE AND TECHNOLOGY DEVELOPMENT IN INDUSTRIAL SOCIETY – IS THE INVESTIGATION OF **HUMAN«STRUCTURE» AND CAPABILITIES** AND COPYING IN MODEL TECHNICAL SYSTEMS

Model approach of XX century



The main result – solid-state microelectronics technology, reproducible everywhere in the world

Nature



Bio-robotics systems



THE MAIN AIM OF SCIENCE AND TECHNOLOGY DEVELOPMENT IN POST-INDUSTRIAL SOCIETY – REPRODUCTION OF LIVING SYSTEMS

1-st STEP of NANOREVOLUTION:

combination of capabilities of modern microelectronics with progress in understanding of nature (nano-biotechnology)



AIM:

design of hybrid anthropomorphous technical systems of bionic type



RESULT:

platforms for creation of nanobiosensors – new hybrid systems of bionic type



THE MAIN AIM OF SCIENCE AND TECHNOLOGY DEVELOPMENT IN POST-INDUSTRIAL SOCIETY – REPRODUCTION OF LIVING SYSTEMS

2-nd STEP of NANOREVOLUTION:
integration and unification of nano-biosensor platforms, created on the 1-st step

AIM:
Atomic-molecular engineering and technologies, based on self-organization of atoms and bioorganic molecules

RESULTS:
bio-robotics systems





Federal State Agency Russian Research Center «Kurchatov institute»

