

# **Programme Advisory Committee**

**for Condensed Matter Physics**

**(32th meeting, 24–25 June)**

## **Recommendations**

**V. Kantser**

**108th Session, of the JINR Scientific Council  
Dubna, 23–24 September 2010**

# JINR Directorate Information

- **JINR Scientific Secretary N. Russakovich informed the PAC June 2010 meeting about the Resolution of the 107th session of the JINR Scientific Council (February 2010) and the decisions of the Committee of Plenipotentiaries (March, May 2010).**
- **The PAC is pleased to note that the most part of the recommendations of the previous PAC meeting concerning JINR research in the areas of condensed matter physics have been accepted by JINR Scientific Council and Directorate.**

# Preparation of the IBR-2M reactor for physical start-up

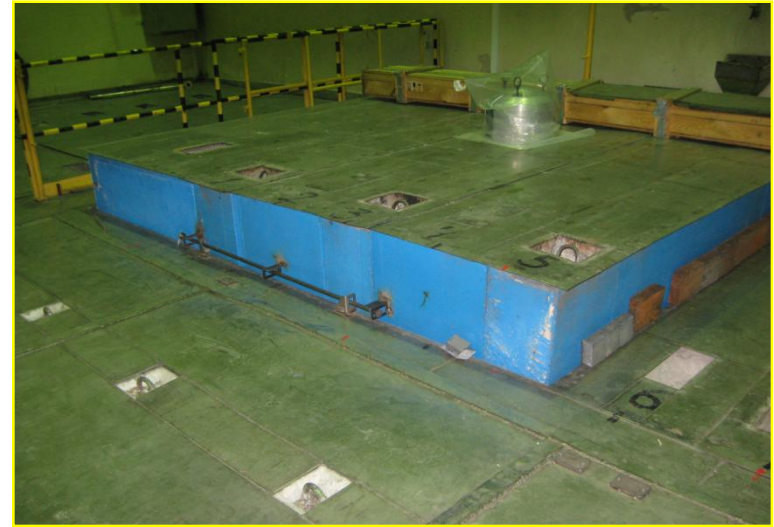
- The PAC was informed by A. Vinogradov about the latest work on the IBR-2 modernization and is pleased to Inform JINR Scientific Council that it comes to completion in accordance with schedule.
- Taking into account the forthcoming launching of the IBR-2M reactor, the PAC considers that timely and full financing of the planned activities has crucial importance for successful completion of the reactor modernization and expects that comprehensive support by the FLNP and JINR directorates will be continued.
- Physical start-up of the IBR-2M reactor at the end of this year will be one of great JINR things in the memory of acad.Alexei Sissakian.

**• Recommendation. The PAC recommends FLNP and JINR directorates continuation of efforts for the installation, adjustment and alignment of the new reactor equipment as well as for the project of cryogenic moderators.**

# Status of completion of the IBR-2 reactor for physical start-up



## Performance of performed works in 2010

- **Filling of the reactor cooling circuits with a liquid sodium**
- **Transportation of used fuel assemblies into additional storage facility** →
- **Mounting of the executive mechanisms and control rods of the reactor** →



# Status of completion of the IBR-2 reactor for physical start-up

## Performance of performed works in 2010

- Installation of spontaneous source ( $Cf\ 252$ ) into the active zone 
- Installation of equipment and switching lines of the automated system for technological parameters control (ASTPC)
- Assembled ASTPC' controllers in technological rooms 



# Status of completion of the IBR-2 reactor for physical start-up

## Performance of performed works in 2010

- Installation of electrical power equipment of the reliable power supply system, of the power supply system (PSS) of the reserve control console and the heaters of Na cooling circuits from the reserve PSS
- Installation of the operator console at the main control room of the reactor



New storage battery of new system of emergency power supply (SEPS)



Status of completion of the IBR-2 reactor for physical start-up

**Present view at the control room after renewal**



## Plan of main work for the physical start-up preparation up to the end of 2010

<b>Plan</b>	<b>Realization</b>
Performance of tests and adjustment of ASCS-12R' electronic equipment, of the control panel at the main control room as well as electronic equipment at the reserve control room.	Tests and adjustment of the electronics must be performed so that to start the reactor physical start-up in IV quarter, 2010.
Completion of installation of the equipment of the technological parameters control system	On the schedule
Full-scale tests of new installed technological, electronics and electrical equipment.	After completion of ASCS-12R' test
Preparation of organizational and technical documentation necessary for the reactor start-up: instructions, user manuals, guidebooks, etc.	Permanently
Commission of the modernized IBR-2 reactor: <ul style="list-style-type: none"><li>• working acceptance;</li><li>• nuclear safety acceptance.</li></ul>	IV quarter
Physical start-up of the modernized IBR-2 reactor	IV quarter



# IBR-2 reactor is just before its start up after the modernization

## but its modernization will continue

### Status of modernization of Cryogenic moderators of the IBR-2 reactor

- For testing of feeding of  $C_9H_{12}$  balls into chamber of the CM the research stand in real geometry is assembled in an experimental hall.



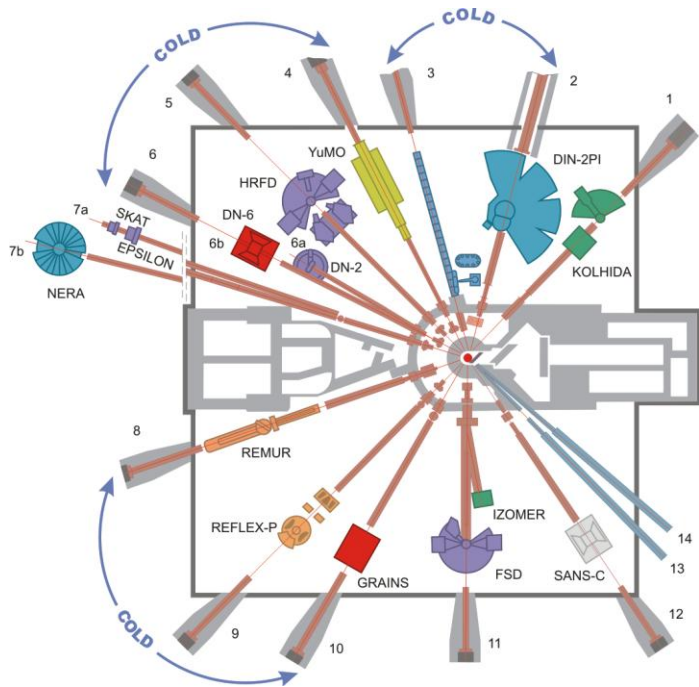
- Cryogenic facility KGU 700/15 and helium compressor “Keizer” are ready for routine work.



- Delivery and installation of the IBR-2M automated safety and control system (ASCS-12R)

# Status of the spectrometer complex of IBR-2M

- The PAC considers the preparation of the spectrometer complex to the IBR-2M start-up at the end of 2010 is one of the JINR important priority activity in the short-range period as well as in the long term stage.
- The PAC has the pleasure to inform SC that two stages for the upgrade of the spectrometer complex of IBR-2M are running. In the first, short term stage of three years the efforts will be concentrated on the realization of the first priority projects – DN-6, GRAINS and SKAT/EPSILON.
- In the long term prospective of seven years the modernization of the available spectrometers – REMUR, YuMO, REFLEX, DN-2, HRFD, NERA-PR, DIN-2PI, will be performed.



## Diffraction (6):

HRFD, DN-2, SKAT, EPSILON,  
FSD, DN-6

## SANS (2):

YuMO, SANS-C

## Reflectometry (3):

REMUR, REFLEX, GRAINS

## Inelastic scattering (2): NERA, DIN

13 spectrometers (3 new)

## Modernization of FLNP instruments: DN-6 diffractometer

The PAC was informed by D. Kozlenko about the status of the DN-6 diffractometer. It appreciates the progress in the realization of this first priority project that is underway according to planned schedule.

### Activities of the first half 2010:

- Fabrication of the head part of the neutron guide (both vacuum casing and mirrors) is completed and it is installed at the beamline 6 of IBR-2 reactor.
- Fabrication of the vacuum casing of the tail part of the neutron guide is completed.
- Fabrication of the mirrors for tail part of neutron guide is in progress.
- Preparation of the technical documentation for fabrication of mechanical units of the diffractometer is started.
- The technical documentation for fabrication of the  $^3\text{He}$  detector system was prepared and the model detector section has been tested (Spectrometers Complex Department).

### Plans for second half of 2010 - 2011

- Fabrication of the mirrors for tail part of neutron guide.
- Installation of the tail part of the neutron guide at the beamline 6B.
- Fabrication of mechanical units of the diffractometer.
- Fabrication of the detector system
- Development and fabrication of electronic blocks for DN-6.

The PAC recommends completion of the basic configuration of DN-6 by the end of 2011 and regards this work as a major task in the development of the IBR-2M spectrometer complex.

## Modernization of FLNP instruments: NERA-PR spectrometer

The PAC was informed by I. Natkaniec about the current status of the NERA-PR spectrometer. The PAC supports all the activities planned for modernization of the NERE-PR spectrometer and considers the financial support within the framework of grants of the Poland's Plenipotentiary to be very important for the full replacement of the NERA-PR neutron mirror guide in 2010–2011.

### Activities of the first half 2010:

-Splitter of neutron guides for the NERA, SCAT and EPSILON spectrometers

-Reconstruction of mirror neutron guides on channel #7 of the IBR-2

-Locations of  $\lambda$ -choppers for the NERA, SCAT and EPSILON spectrometers

-Be-filters @ crystal analysers and detectors of scattered neutrons of the NERA-PR



**Recommendation. Since the replacement of the NERA-PR neutron mirror guide after September 2010 will require stopping of the experiments, the PAC recommends to SC and JINR directorate high priority for this project.**

## Recommendations on the theme to be completed in 2010

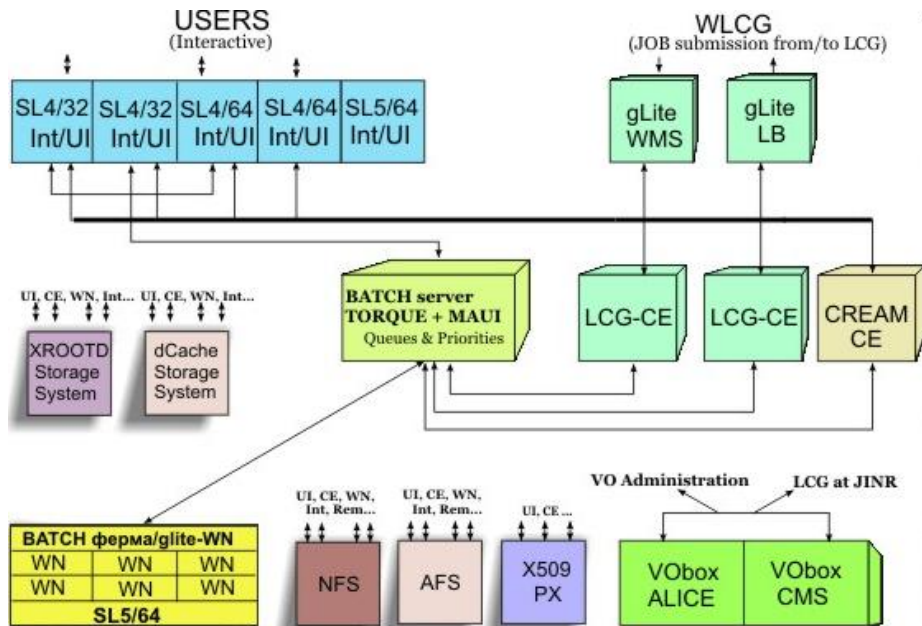
- The PAC took note of the new report presented by V. Korenkov on the closing theme “Information, computer and network support of JINR's activity” including information concerning the network and information support of the scientific activity inside JINR, as well as the development of the JINR integrated network and unified Grid telecommunication environment with research institutions in the JINR Member States and other countries.
- The PAC notes with satisfaction the significant improvement of the proposal, regard it as very promising and in high demand.
- **Recommendation . The PAC recommends continuation and extension of the research, with special emphasis on data protection, in the Grid environment, within the theme "Information, computer and network support of JINR's activity" in the period 2011–2013..**

# JINR Central Information and Computing Complex

**In 2008**, total CICC performance was 1400 kSI2K, the disk storage capacity 100 TB

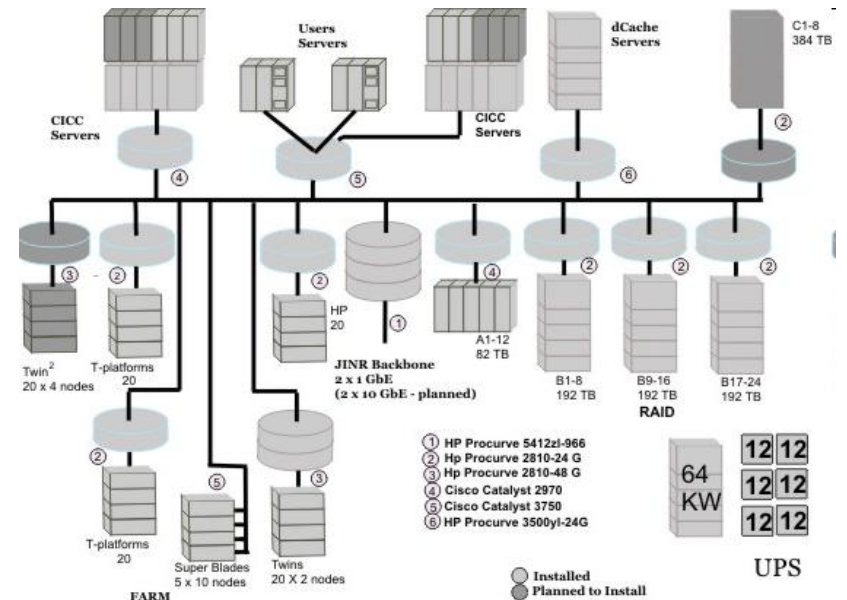


**At present (2010)**, the CICC performance equals 2400 kSI2K and the disk storage capacity 500 TB

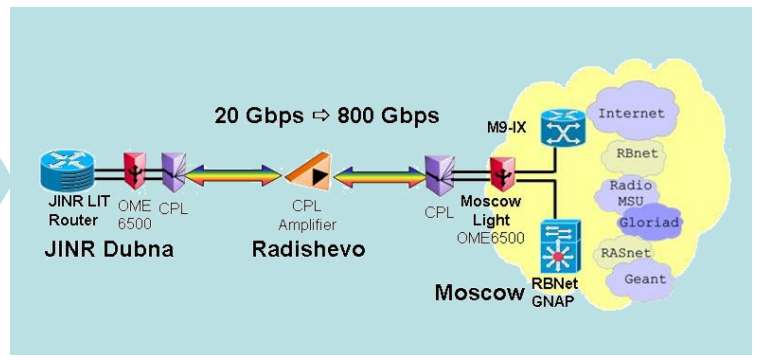
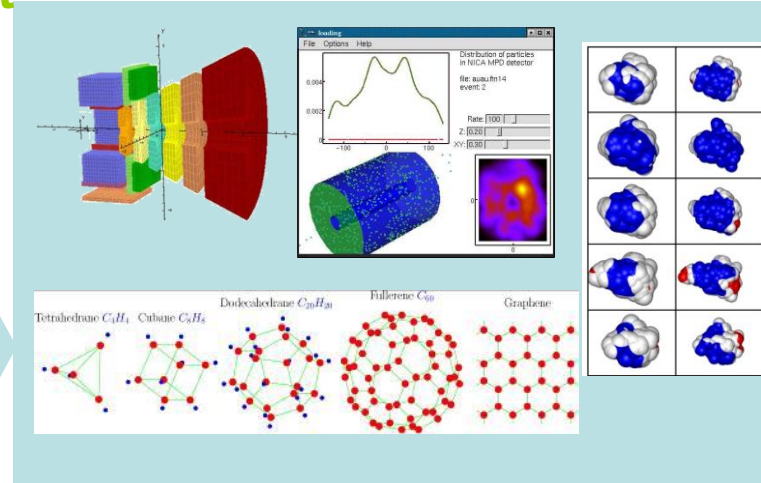
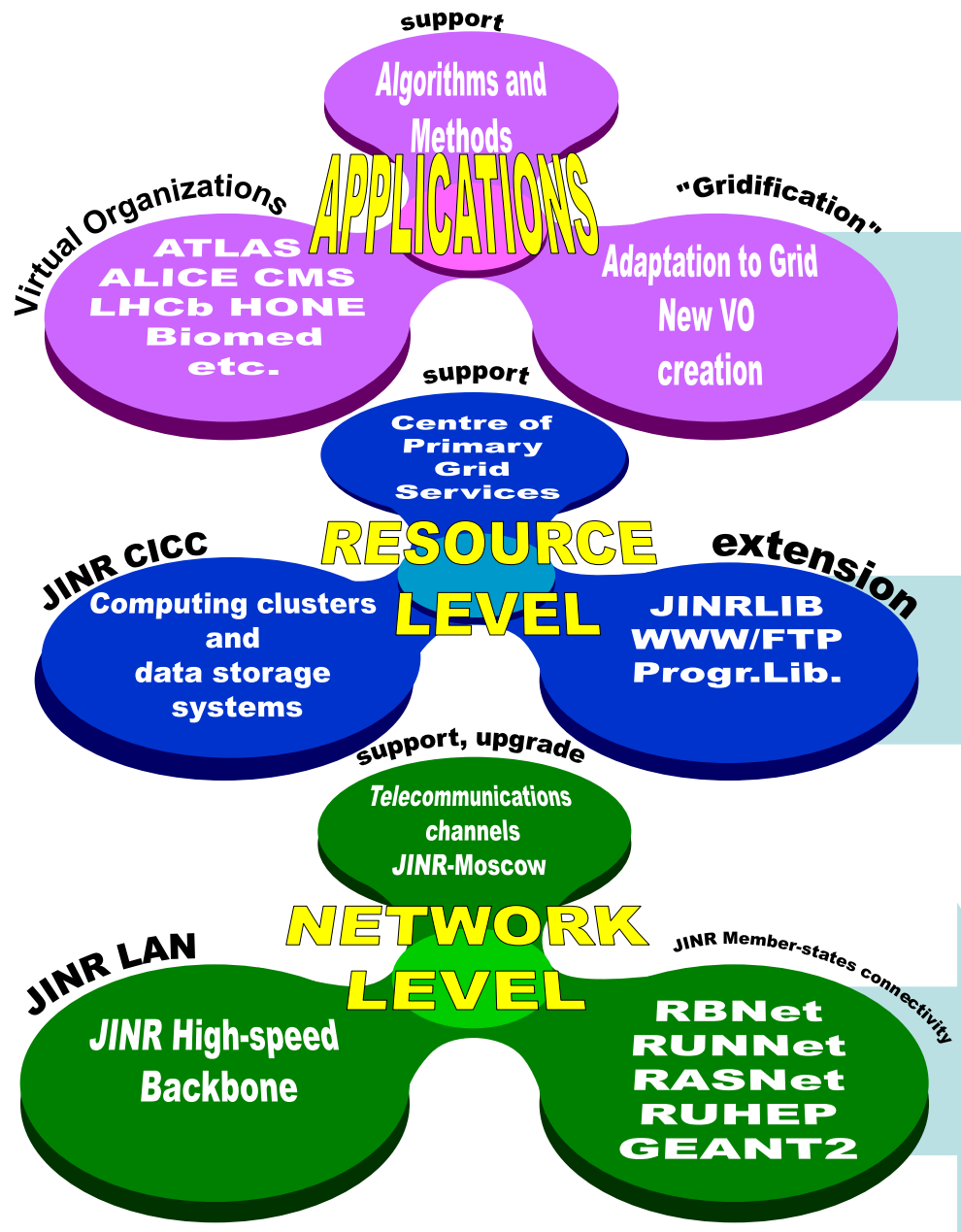


CICC. Resources, Access & Support

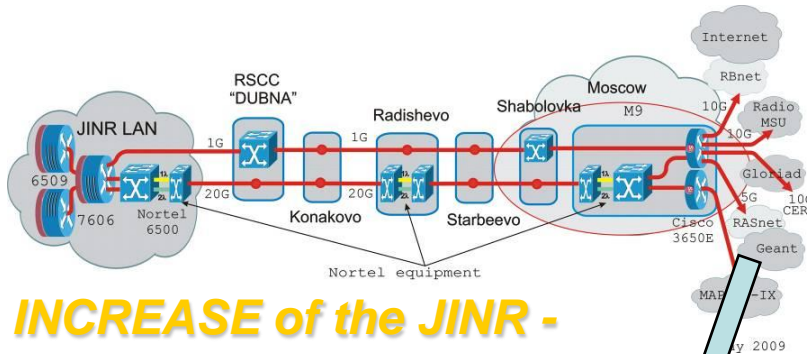
## Scheme of the CICC network connections



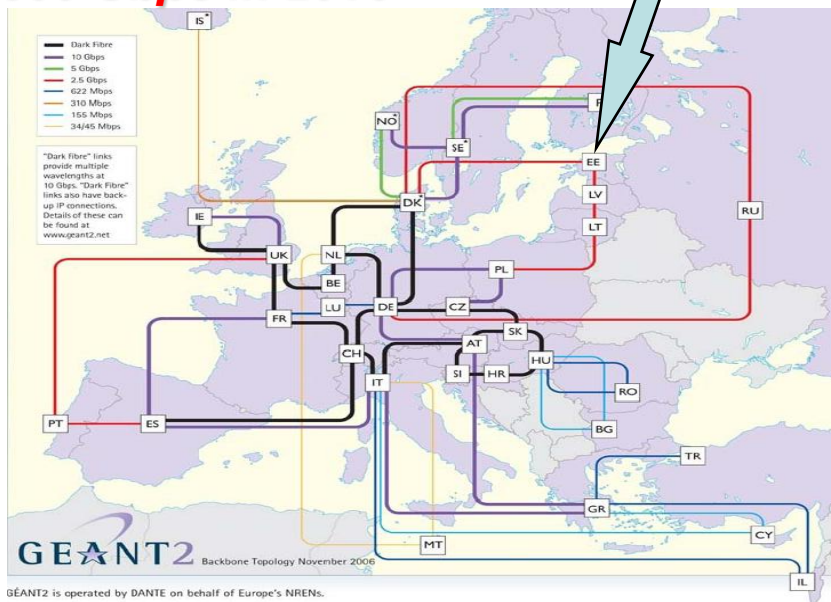
# Development of the JINR Grid - environment



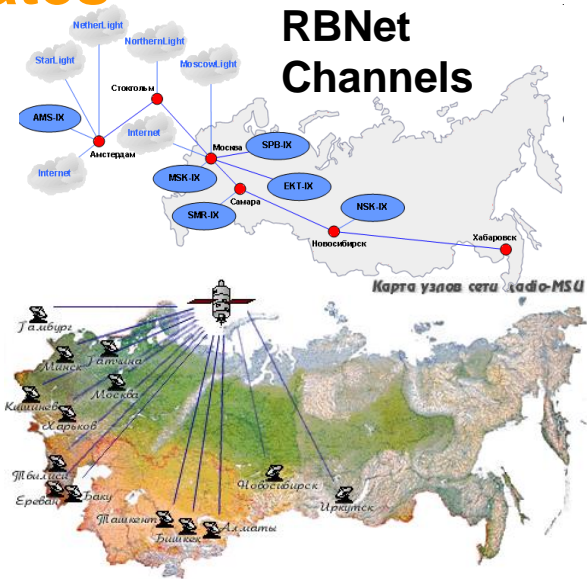
# Connectivity of JINR Member States



**INCREASE of the JINR - Moscow data link:**  
**20 Gbps in 2009**  
**800 Gbps in 2016**



**GEANT2 Pan-European Backbone Consortium of 34 NRENs**



**Radio-MSU Links to NIS**



**APAN: Asia Pacific Academic Network**



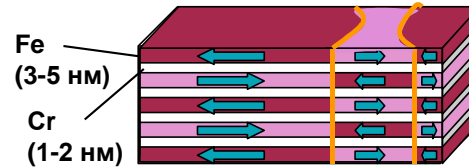
# Overview of the joint investigations of JINR Laboratories and Research Institutes of the JINR Member States in the area of nanoscale physics and nanomaterials

- The PAC was informed by D. Kozlenko about the joint research in the area of nanoscale physics and nanomaterials performed by FLNP in collaboration with research institutes of the JINR Member States by neutron scattering methods.
- The PAC appreciates the wide range of activities, the importance of scientific results and effective collaboration in this research area.
- **Recommendation 1** . The PAC expects that the re-start of the IBR-2 reactor and realization of the user policy at the spectrometer complex should promote further development and extension of the collaborative research in nanoscale physics, nanomaterials and other condensed matter physics fields with universities and research centres in the Member States and other countries.
- **Recommendation 1** . The PAC recommends that FLNP present at its next meeting an analytical review of the future directions of the development of the neutron scattering technique for the next 10 years at the IBR-2M reactor taking into account the competitiveness and complementarity with synchrotron radiation sources.

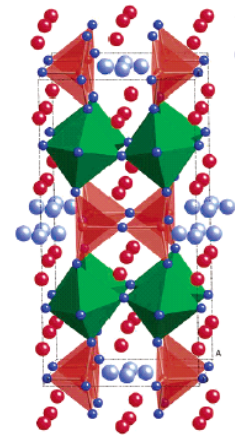
# Investigations of Nanosystems and Novel Materials by Neutron Scattering Methods

Theme 04-4-1069-2009/2011

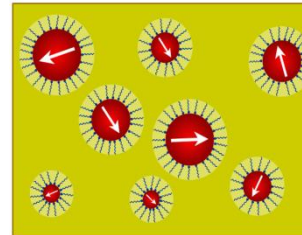
- Physics of Nanosystems



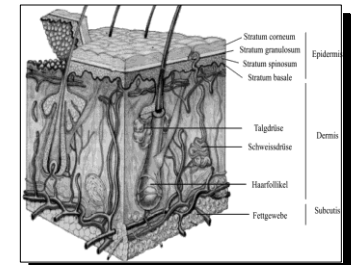
- Structure and Dynamics of Functional Materials



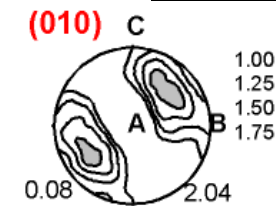
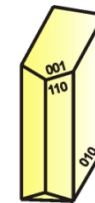
- Complex Liquids and Polymers



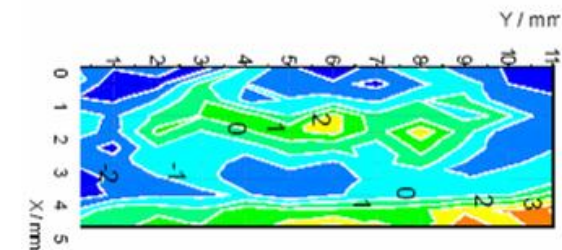
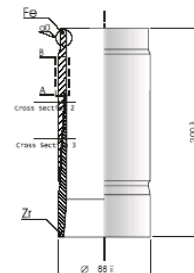
- Molecular Biology and Pharmacology



- Structure of rocks and minerals



- Neutron Nanodiagnostics



- Engineering Diagnostics

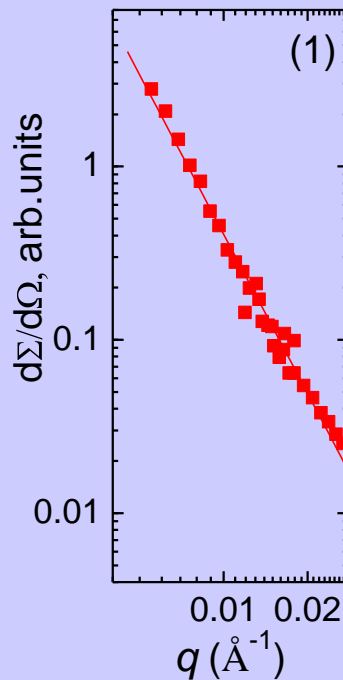
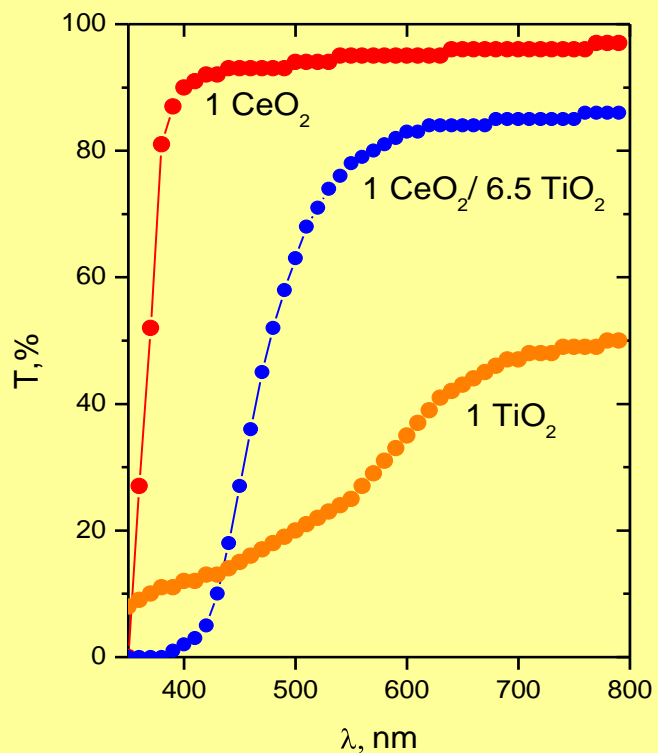
# Nanomaterials with controlled optical properties

## Silicon glass doped by $\text{CeO}_2/\text{TiO}_2$ :

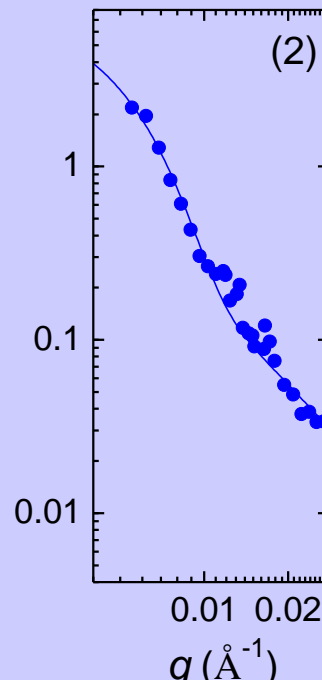
$\text{CeO}_2/\text{TiO}_2$  doping effect



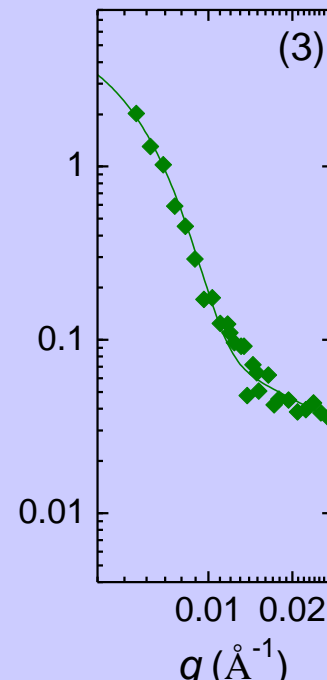
Change of optical absorption coefficient



Pure glass



Glass doped with molar concentration 2.0/6.5  $\text{CeO}_2/\text{TiO}_2$

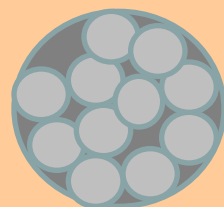


Glass doped with molar concentration 2.0/10  $\text{CeO}_2/\text{TiO}_2$

**Measured SANS curves**

$R_g = 34 \text{ nm}$

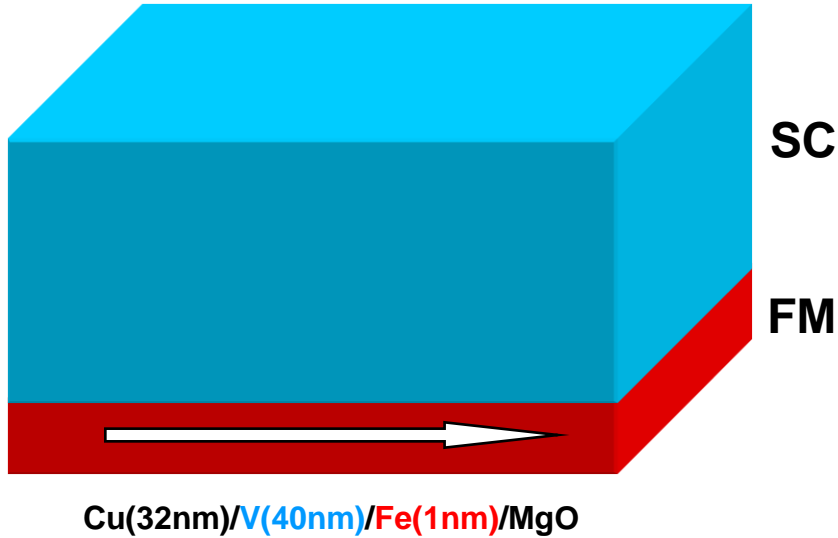
$35 \text{ nm}$



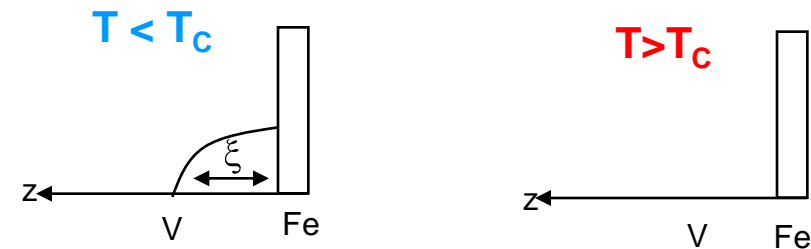
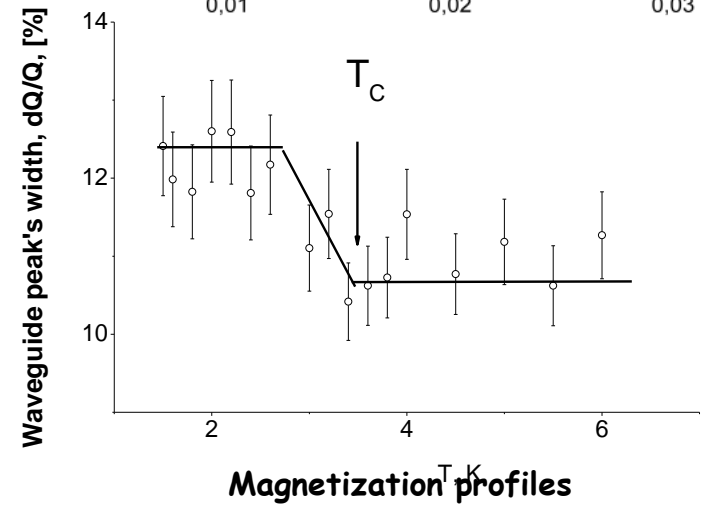
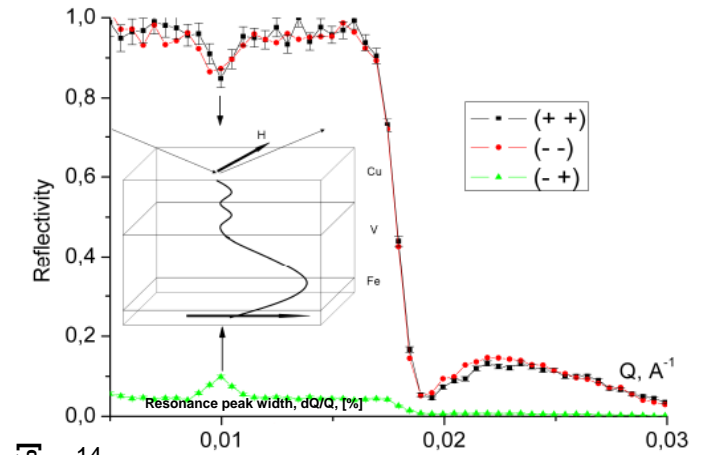
Formation of Ce-Ti-O aggregates, correlating with change of optical absorption

# Proximity effects in “superconductor/ferromagnet” layered nanostructures

FLNP JINR – RUB (Germany), KFKI RIPNP (Hungary), ILL (France)



- ✓ **N**ew types of superconducting pairing (triplet condensate)
- ✓ **M**odification of the superconducting and ferromagnetic order parameters
- ✓ **A**pplications for the spintronics



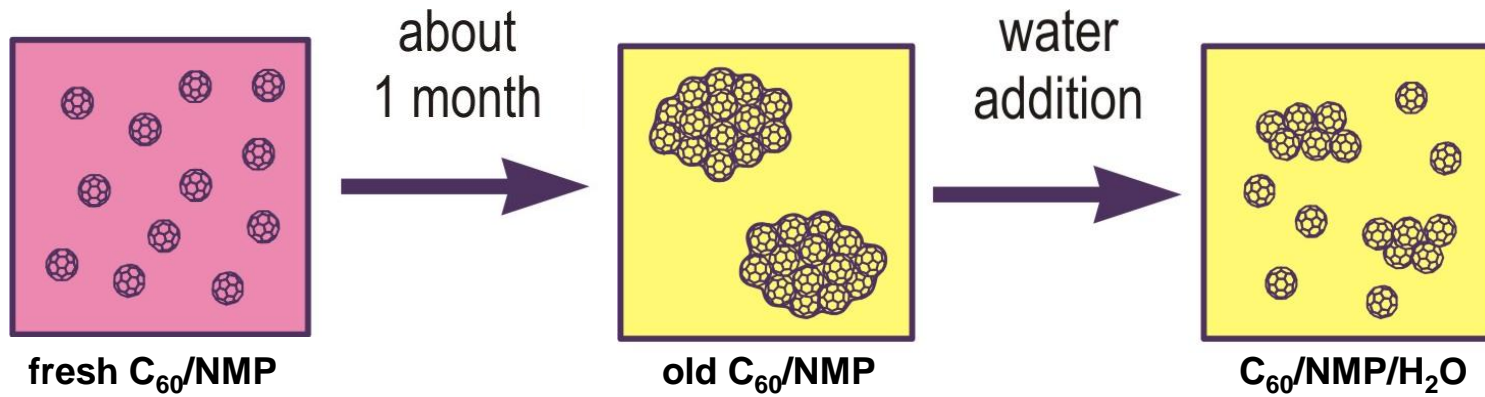
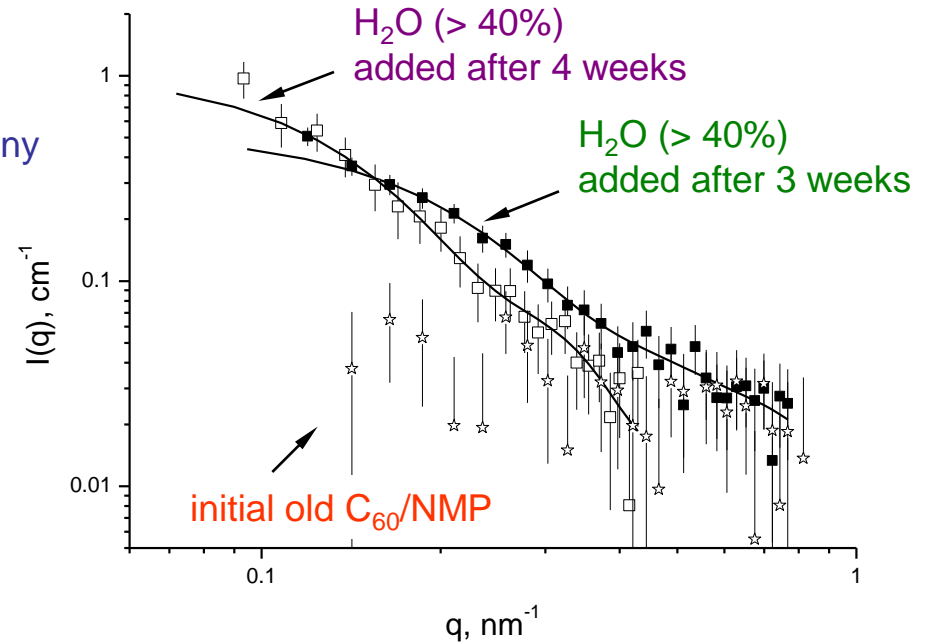
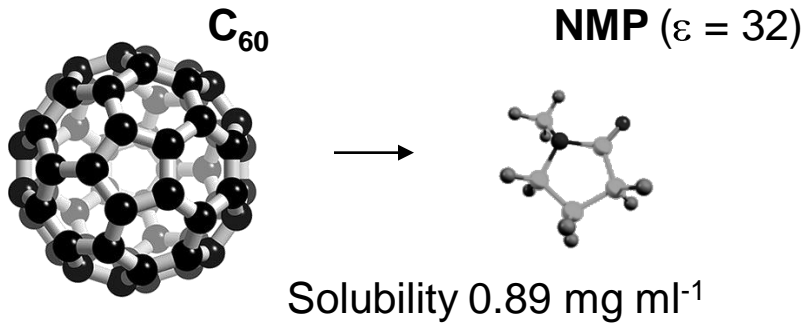
Possible Cooper pairs polarization on the interface superconductor/ferromagnet

# Cluster reorganization in polar fullerene solutions after water addition

SANS

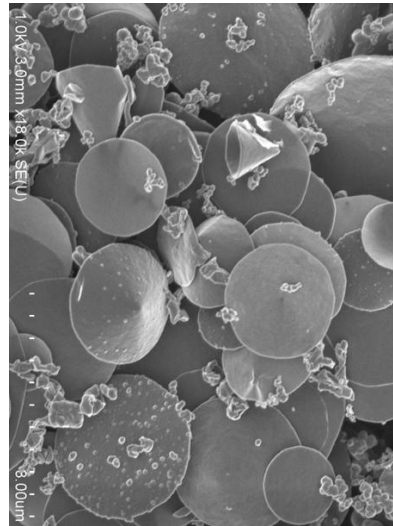
Collaboration: FLNP JINR Dubna –  
KNU, ISC NASU, Kyiv, Ukraine –  
RISSP Budapest, Hungary - GKSS Geesthacht, Germany

## Solutions of C<sub>60</sub> in N-methyl-pirrolidone (NMP)

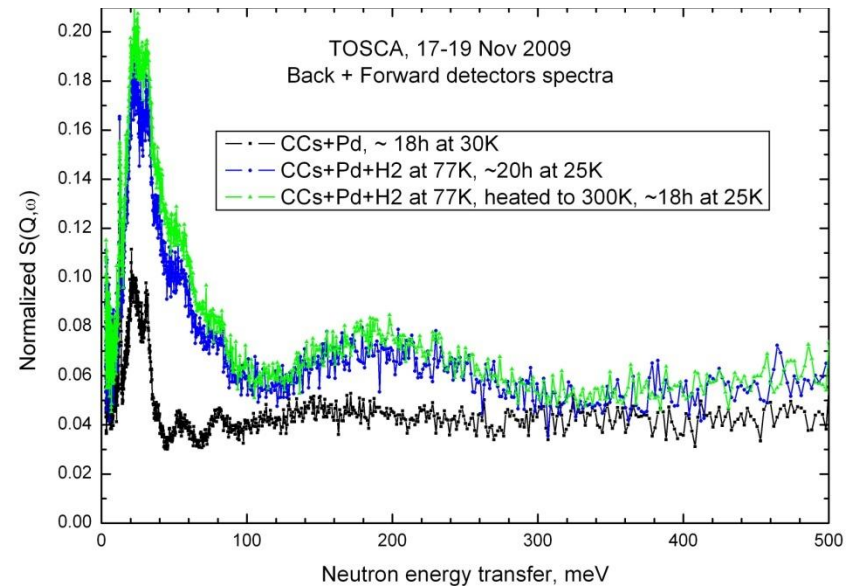
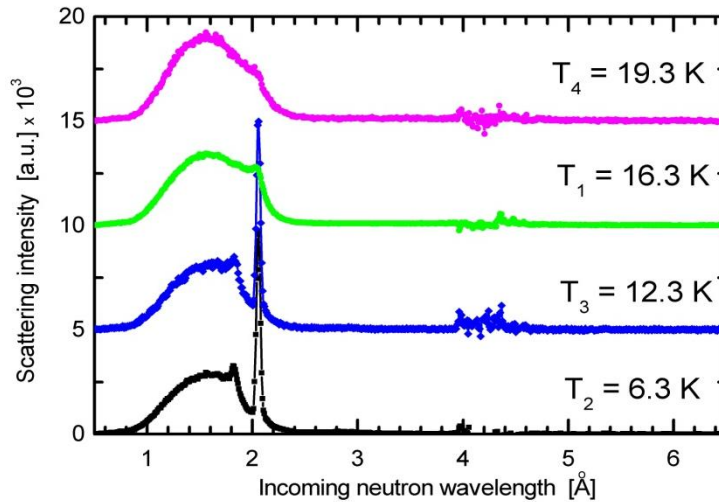
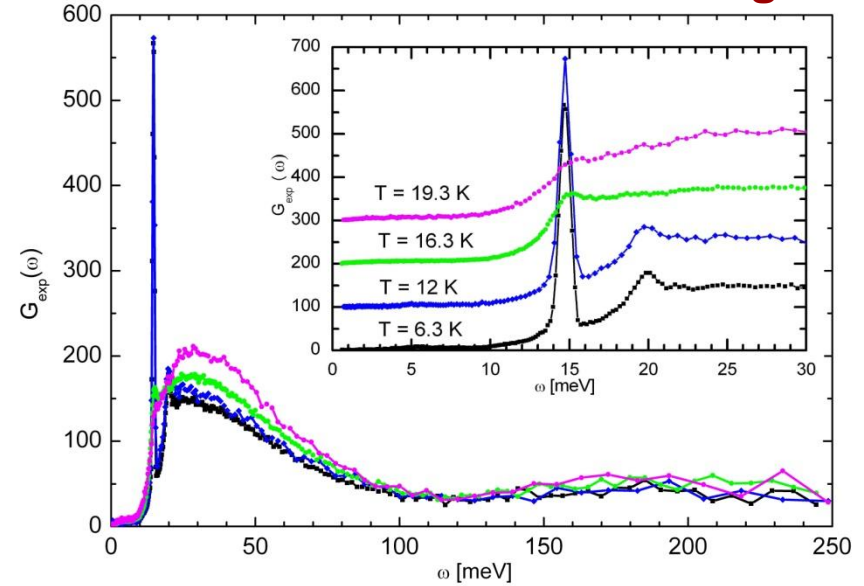


V.L.Aksenov, M.V.Avdeev, O.A.Kyzyma, et al., *Cryst. Rep.* (2007)  
O.A.Kyzyma, L.A.Bulavin, V.L.Aksenov, et al., *Fullerenes, Nanotubes and Carbon Nanostructures* (2008)  
O.A.Kyzyma, M.V.Korobov, M.V.Avdeev, et al., *Chem. Phys. Lett.* (2010)

# Dynamics of H<sub>2</sub> adsorbed on *nano*-carbon materials



## Inelastic neutron scattering



# Overview of joint research of nanosystems at BLTP

## and Research Institutes of the JINR Member States

- The PAC heard with interest the overview of the current research at BLTP concerning the physics of nanosystems presented by V. Osipov.
- The PAC was impressed by recent results in the field of carbon nanostructures, atomic clusters, quantum dots, and Josephson junctions.
- **Recommendation.** The PAC recommends continuation of theoretical studies in the field of physical processes in nanostructures and new materials, including those related with experimental work at JINR basic facilities.

# **Theory of Condensed Matter and New Materials**

**Leaders: V.A. Osipov and J. Brankov**

**Project:**

**Physical properties of complex materials  
and nanostructures**

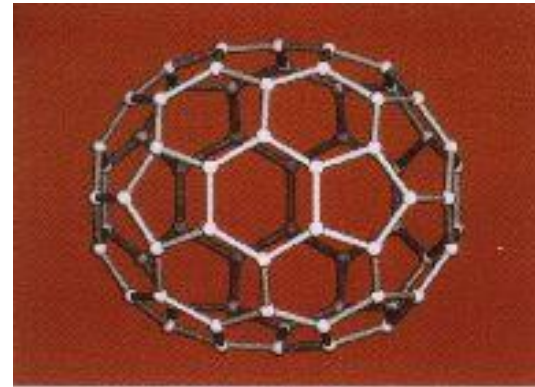
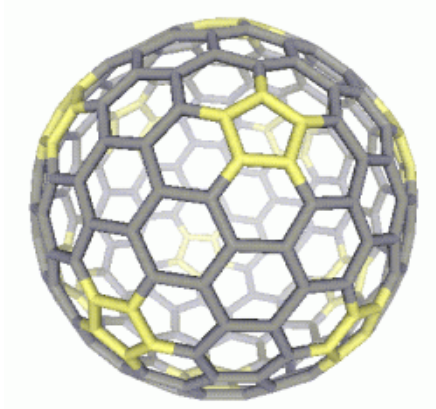
**Sector N16:**

**Nanostructures and nanoscale  
phenomena**

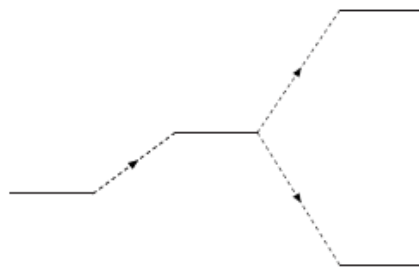
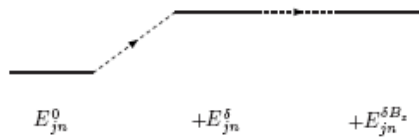
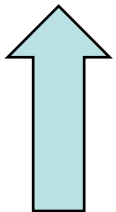


# Electronic structure

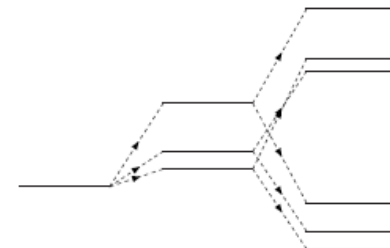
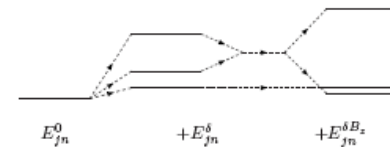
## Spherical and spheroidal fullerenes



**B**



The first electronic level

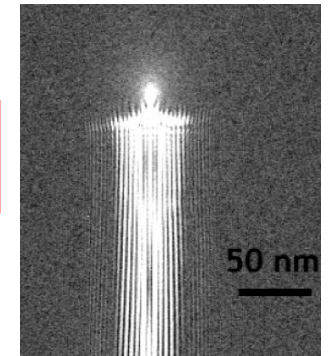


The second electronic level

Zeeman  
splitting

# EFFECT OF BAND STRUCTURE ON FIELD EMISSION

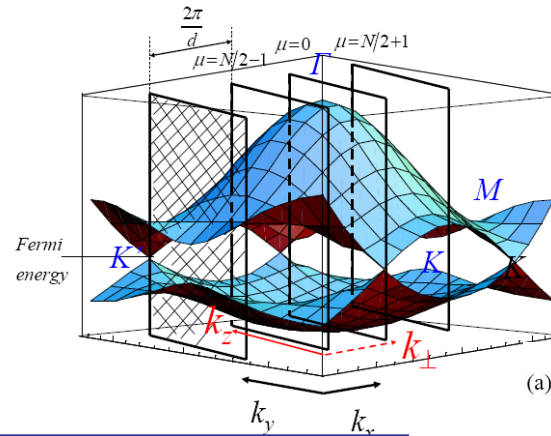
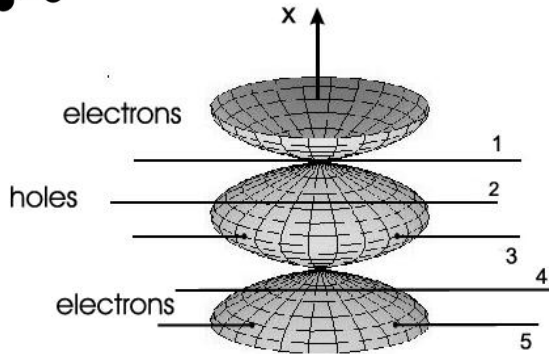
Collaboration: V. Osipov, E. Kochetov, D. Kolesnikov, V. Katkov (JINR); and M. Pudlak, R. Pincak (Slovakia)



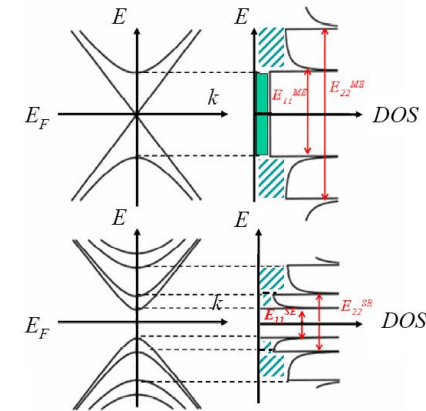
## GRAPHITE

## NANOTUBES

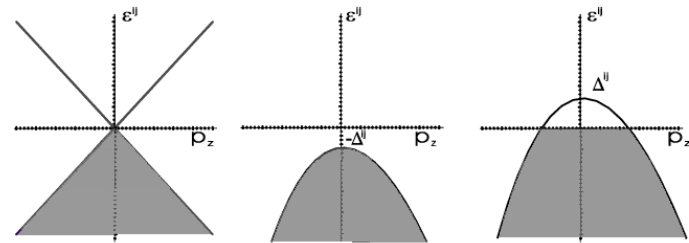
3D



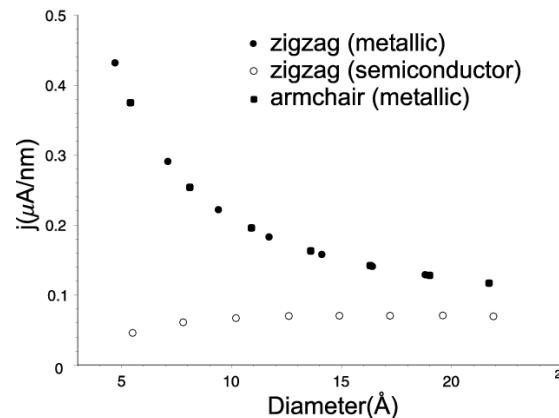
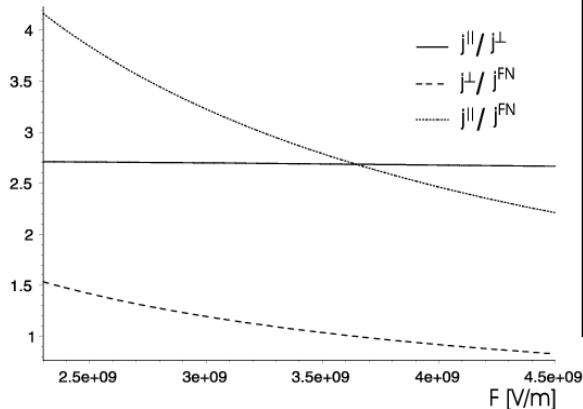
2D



Both cases were reduced to 1D problem.

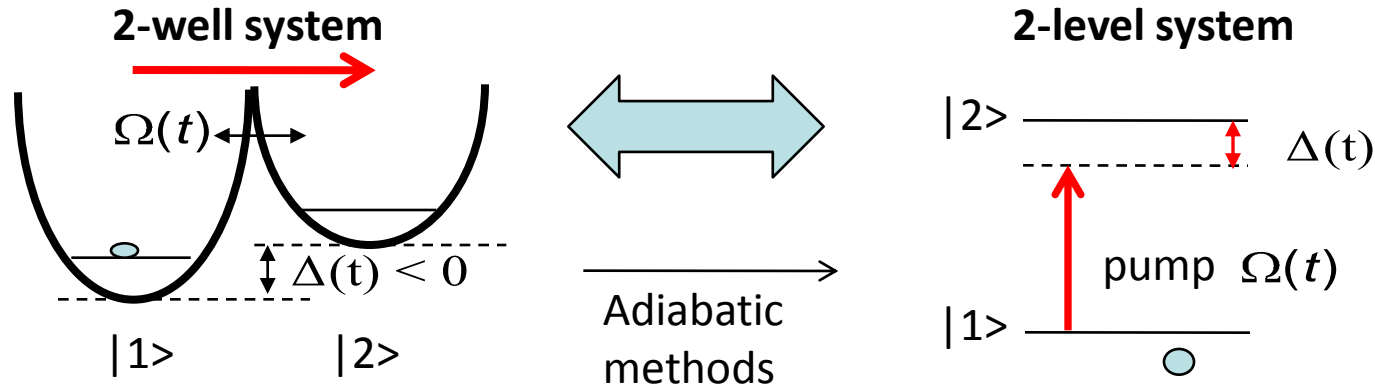


Field emission law for graphite in two orientations.



Analytical expressions explain numerical calculations.

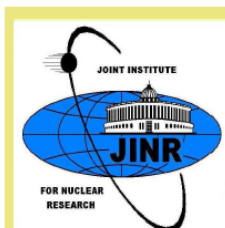
# Complete irreversible adiabatic transport of individual atoms and Bose-Einstein condensates in multi-well traps



- **Analogy** between multi-well and multi-level systems
- **Adiabatic** population transfer schemes from quantum optics (STIRAP, Landau-Zener, Rosen-Zener)
- Development of effective **transport protocols** which **work even under strong nonlinearity (!!!)** caused by interaction between the atoms
- **Universality** (attractive/repulsive interaction, left-right transport)

V.O. Nesterenko, A.N. Novikov, F.F. de Souza Cruz, and E.L. Lapolli, *Laser Phys.* **19**, 616-624 (2009).  
V.O. Nesterenko, A.N. Novikov, A.Yu. Cherny, F.F. Souza Cruz, and E. Suraud, *JPB* **42**, 235303(2009).  
V.O. Nesterenko, A.N. Novikov, and E. Suraud, *Laser Phys.* **20**, 1149 (2010).

# Fractal systems



## The Scattering From Generalized Cantor Fractals

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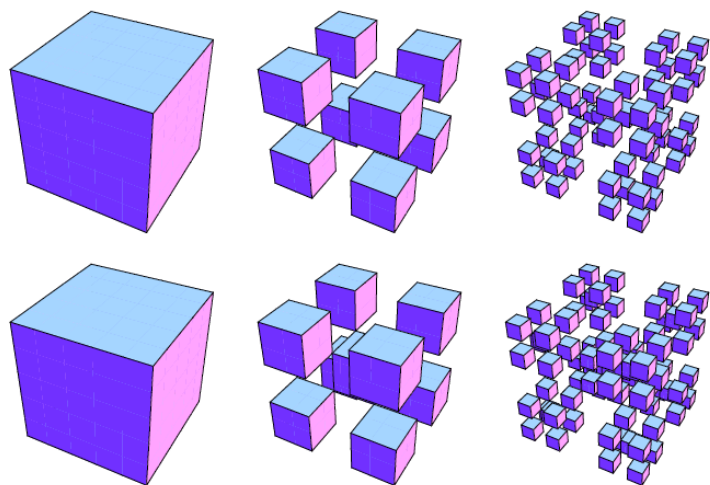


FIG. 1: Zeroth, first, and second iterations (approximants) for the three dimensional Cantor set (upper panel) and Vicsek set (lower panel).

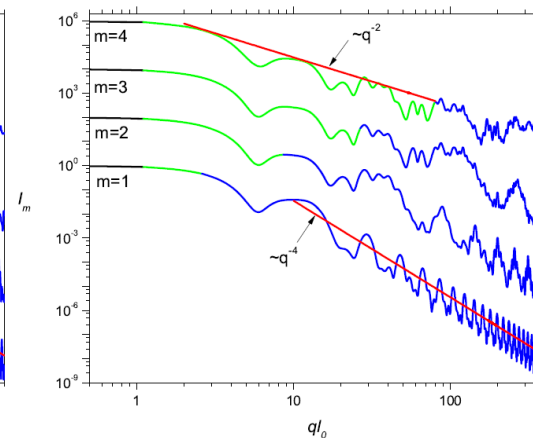
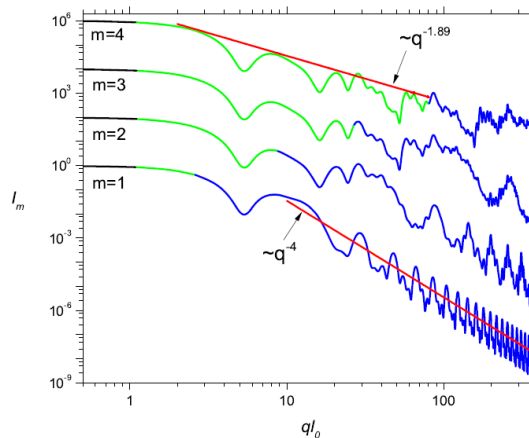


FIG. 2: Scattering intensities for first four iterations of triadic Cantor set (left panel) and Vicsek sets (right panel). The intensity iterations with  $n > 1$  are scaled-up for clarity by a factor of  $100^{n-1}$  relative to the first iteration. Black (dark) part of curves at low  $q$  show the Guinier regions, green (light gray) part represents the fractal regions, and blue (dark) color at high  $q$  indicates the Porod regions.

The oral talk was presented at June, 2010 Meeting by Dr E. Anitas

# Scientific reports

- **The PAC outlines high level of 6 scientific reports presented at PAC June meeting:**
  1. “The stopping and range of slow heavy ions in light targets”, presented by V. Kuzmin,
  2. “Studies of properties and modification of multilayered nanostructures by swift heavy ions”, presented by A. Didyk,
  3. “Computer analysis of dynamics of low-dimensional nanostructures in external fields”, presented by A. Gusev,
  4. “Resonant mechanisms of optical generation of terahertz radiation and their relation to biological systems”, presented by A. Bugay,
  5. “Small-angle scattering from deterministic fractal systems”, presented by E. Anitas,
  1. “Internal dynamics studies in selected steroid hormones”, presented by D. Nowak.

**Appreciations and Recommendation. The PAC notes the wide spectrum of the scientific directions presented, highly appreciates the quality of research in JINR, and looks forward to hearing new reports by JINR scientists at its future meetings, with emphasis on the obtained results rather than on detailed methodological aspects.**

# Poster presentations by young scientists

- The PAC was pleased with the poster presentations by LRB young scientists in the various fields of radiobiology, and with the concluding report presented by O. Belov.
- The poster “A stochastic approach to the mathematical modeling of the SOS system in *Escherichia coli* bacterial cells under ultraviolet irradiation” presented by M. Lyashko was selected as the best poster at the session.
- The PAC also noted two other high-quality posters:
  - “Established calibration curves for radiation of different LET for potential retrospective dose estimation”, presented by M. Deperas-Kamińska,
  - “Effects of *rad53* mutation on deletion induction in haploid yeast *Saccharomyces cerevisiae* after UV- and  $\gamma$ -irradiation”, presented by A. Kokoreva.
- The PAC asks the JINR Directorate to award the authors of this work at its next meeting.
- **The PAC looks forward to this type of presentations in the future.**

# Scientific meetings

- The PAC heard with interest the information, presented by V. Krylov, about the Workshop "Application of Charged Particle Accelerators in Studying Radiation Damage in Systems with a High Level of Organization (Space, Medical, Biological, and Technical Aspects)" (29-30 March 2010, Dubna).
- Recommendation 1. The PAC recommends supporting further regular holding of such Workshop. The PAC recommends that LRB present at its next meeting information concerning a special beam channel at the Nuclotron-M for medical and radiobiological experiments.
- Recommendation 2. The PAC supports the JINR Directorate's initiative to establish an International Joint Scientific Council of the Russian Academy of Sciences on the issues of general and space radiobiology

# Next meeting of the PAC

- The next meeting of the PAC for Condensed Matter Physics will be held on 27–28 January 2011. The next meeting of the PAC for Condensed Matter Physics will be held on 24-25 June 2010.
- Its tentative agenda will include:
- Information by the PAC Chairperson on the report at the JINR Scientific Council session, and the implementation of the recommendations of the current PAC meeting
- Information by the JINR Directorate on the sessions of the Scientific Council (September 2010) and of the Committee of Plenipotentiaries (November 2010)
- Reports and recommendations on the projects and themes to be completed in 2011 and consideration of new proposals and themes, including the interdisciplinary theme “Nanobiophotonics”
- Information by FLNP on the physical start-up of the IBR-2M reactor and on the first tests as well as on the user policy principles
- Status reports on the modernization of FLNP instruments and experiments initiated in 2011
- Status of the JINR Grid activities and Grid environment of JINR Member States
- Information on the project “Investigation of the interaction of polarized muons with matter” (MUON)
- Scientific reports
- Information by BLTP on Nanophysics Conference
- Poster session.



**Thank you for your attention !**