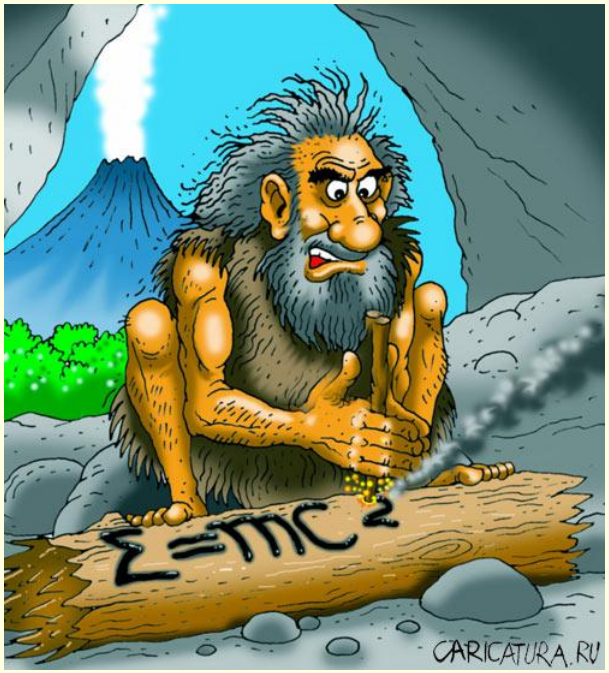
Joint Institute for Nuclear Research

Stellenbosch University

Web Knowledge Base on Low Energy Nuclear Physics

http://nrv.jinr.ru/nrv/ http://nrv.sun.ac.za/

Everybody time to time does the following:



- Search for available experimental data in the databases
- Processing and drawing these data
  - ✓ Use some graphics packages
- Analysis of the experimental data
  - ✓ Finding appropriate theoretical model
  - ✓ Preparation of input data and run the code
  - ✓ Processing of the obtained results

It requires time, resources and experience.

Nuclear Data Resources in the Internet

- These databases provide detailed information on their subject only.
- In order to obtain complete data user needs to visit all databases.

NNDC National Nuclear Data Center
BROOKHAVEN NATIONAL LABORATORY

AMDC Atomic Mass Data Center

LUNDS UNIVERSITET

Triangle Universities Nuclear Laboratory (Duke, UNC, NCSU) TUNL
Energy Levels of Light Nuclei, A = 3 - 20
Nuclear Data Evaluation Project

NUCLEAR DATA VIEWER los alamos

AEN NEA Agence pour l'énergie nucléaire Nuclear Energy Agency

IAEA.org International Atomic Energy Agency

Nuclear Data Center Japan Atomic Energy Agency

γ-Ray Spectra
Radium Institute,
St.-Petersburg

CDFE
MSU, Moscow

Reaction Data Database
Durham, UK

Solution

Combination of
the **databases** on nuclear properties and experimental cross sections of nuclear reactions
along with **computer codes** of theoretical models

in a unique system which we name

the Knowledge Base
on low energy nuclear physics.

We named this specific software the
"Nuclear Reactions Video" (NRV)

Features of the NRV knowledge base

- Databases (nuclear properties and cross sections)
- Computing Codes (OM, CC, DWBA, …)
- Free access for remote user (web-server based)
- Multi-user architecture
- User-friendly interface
- Hypertext and Graphical representation of results
- Processing of the data and obtained results
- Everything is downloadable (text & graphics)

NRV-server

1. Processing of exp. data

- Visualization of all the data
- Adaptation of the data

2. Nuclear Models

- Shell models
- α, β – decays
- Fission

3. Nuclear Dynamics

- Elastic scattering (**Optical** and **Classical** models)
- Inelastic scattering (**DWBA**, CC, DIC)
- Transfer reactions (DWBA, Classical model,…)
- Break-Up (DWBA, CC, Classical model)
- Fusion (**CC**, Langevin equation, **Empirical model**)
- **Fission** (empirical model)
- **Driving potential**
- Nuclear models (**Shell model**, LDM, TCShM)
- **Decay of excited nuclei**
- Kinematics (**2-body, 3-body**, **Q-calculator**)

Computing Codes

C++, Java, Fortran

Databases

MySQL, Java-Script, PHP

1. Available databases
2. Publications

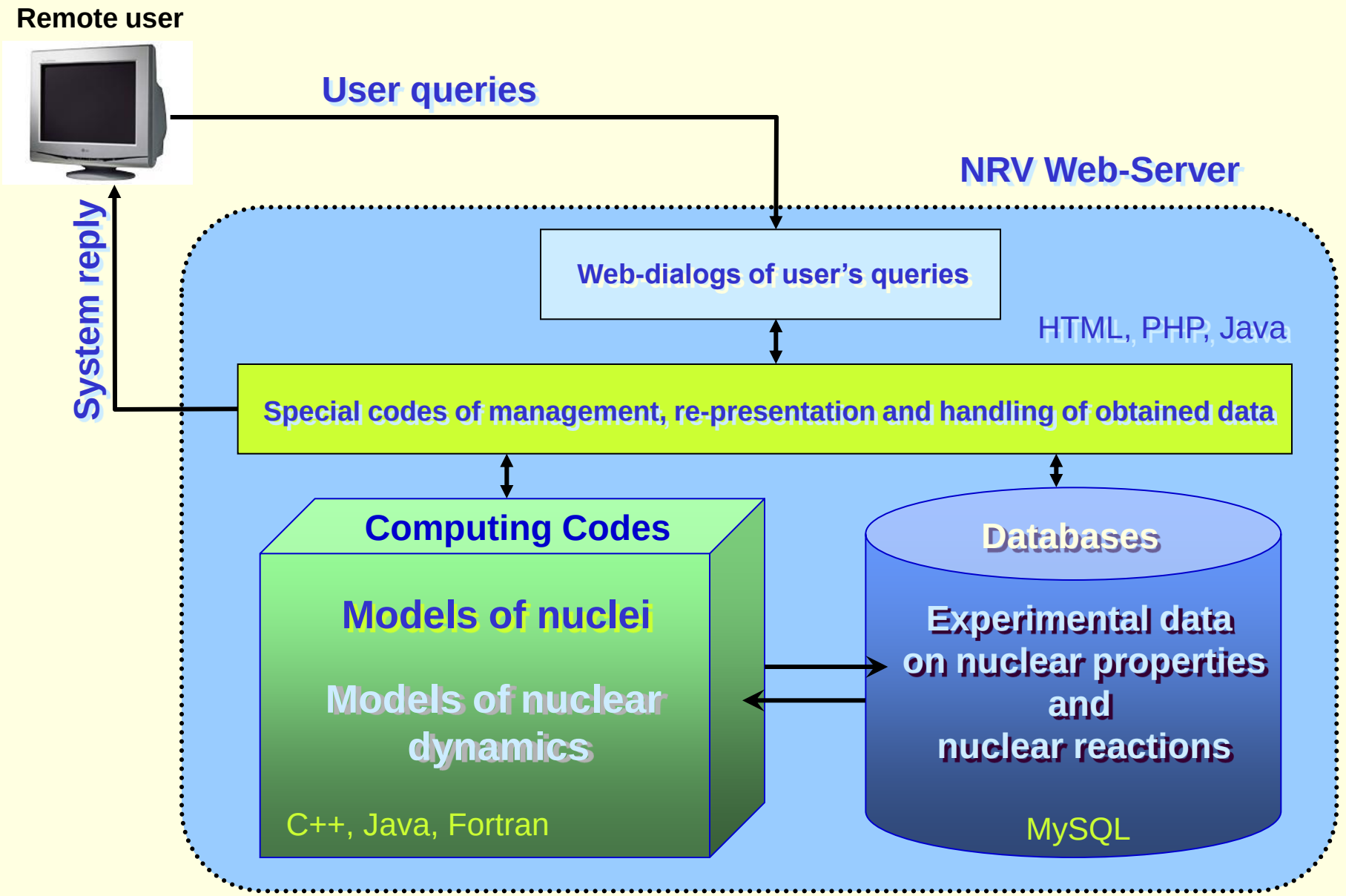
1. Properties of nuclides

- Spin, Parity, Half-life, Decay modes
- Mass, Q-values, Excited states
- Radius, Deformation
- …

2. Cross sections of nuclear reactions

- Elastic Scattering
- Heavy-Ion Fusion
- Evaporation Residues
- …

How it works


Remote user
User queries
System reply
NRV Web-Server
Web-dialogs of user's queries
HTML, PHP, Java
Special codes of management, re-presentation and handling of obtained data
Computing Codes
Models of nuclei
Models of nuclear dynamics
C++, Java, Fortran
Databases
Experimental data on nuclear properties and nuclear reactions
MySQL

Nuclear Map

- **Include all available data on properties of overall nuclei**
  - Spin, Parity, Half-life, Decay modes
  - Mass, Q-values, Excited states
  - Radius, Deformations, …
- **Show data on each nuclide on one screen in hypertext and graphics representation**
- **Compare the properties of different nuclei (Systematics)**

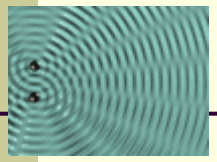
Nuclear Reactions Data

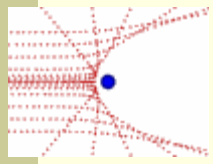
- **Experimental Data on Heavy Ions Fusion Cross sections**
  - ✓ Digitized excitation functions of more than 400 nuclear reactions (about 5000 experimental points)
  - ✓ Search capabilities
  - ✓ Short description of the experimental data (authors, Ref., details of experiment, …)
  - ✓ Text and Graphical representation
  - ✓ “Comparison” engine
  - ✓ Downloading (ASCII text) and export (GIF, JPEG, PDF, …)
- **Experimental Data on Evaporation Residues Cross sections**
  - ✓ Digitized excitation functions of about 40 nuclear reactions (about 580 experimental points)
  - ✓ All others features
- **Experimental Data on Elastic scattering Cross sections**
  - ✓ Digitized excitation functions of about 60 nuclear reactions (about 2000 experimental points)
  - ✓ All others features

User may analyze experimental data on fusion and elastic scattering reactions within available theoretical model (e.g. Coupled Channels, Optical model, …)

Nuclear Dynamics: Elastic Scattering

Optical model of the elastic scattering of nuclear particles





The Schrodinger equation

$$\left[-\frac{\hbar^2}{2\mu}\vec{\nabla}^2 + V_{OM}\right]\Psi^{(+)}(\vec{r},\vec{k}) = E_k\Psi^{(+)}(\vec{r},\vec{k})$$

with phenomenological Optical Potential

$$V_{OM}(r) = V_C(r) + V_N(r) + iW(r) + \left[V_{SO}(r) + iW_{SO}(r)\right](\vec{l}\cdot\vec{s})$$

and boundary condition at infinity (for uncharged particles)

$$\Psi^{(+)}(\vec{r},\vec{k}) \to e^{ikr\cos\vartheta} + f(\vartheta)\frac{e^{ikr}}{r}$$

Elastic scattering cross section in general case is

$$\frac{d\sigma}{d\Omega}(\vartheta) = \left|f_C(\vartheta) + f'(\vartheta)\right|^2$$

$$f'(\vartheta) = \frac{1}{2ik}\sum_l (2l+1)e^{2i\sigma_l}(S_l - 1)P_l(\cos\vartheta)$$

Lets go on to the demonstration now

Concluding remarks:

Nearest plans for future :

- Including new models of nuclear dynamics
  - ✓ DIC and Fusion-fission within Langevin equations
  - ✓ Transfer processes (DWBA)
  - ✓ α-decay, β-decay
  - ✓ and others

- Filling the databases on heavy-ions nuclear reactions

Nuclear Reaction Video

Thank you for attention.

People involved in the project:

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