

# Nuclear Astrophysics Town Meeting 2012

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# 1 Working group: Data Codes

## 1.1 Data and Codes

1.1.1 What is needed to evaluate and transform nuclear data, astronomy data, and codes reliably and efficiently so that they can be used in nuclear astrophysics?

1.1.2 What are the best evaluation procedures and how can they be developed and implemented?

1.1.3 How should information be distributed – formats?

1.1.4 What additional public codes are needed and how should one develop them?

### 1.1.5 JINA Reaclib Database

- Major data release every year.
- All rates are parameterized
- Public Codes for Nuclear Astrophysics available on JINAWEB

### 1.1.6 Virtual Journal

- Micro archive of nuclear astrophysics papers

### 1.1.7 JINALIB

1.1.8 Clemson nucleosynthesis code tools - meyer

1.1.9 NACRE reaction rates

1.1.10 LLNL reaction rates

- Strong and EM Reaction Rates
- Weak Reaction Rates
- Neutrino Reaction Rates

### 1.1.11 NADS - Nuclear Atomic Data System

- ENDL data format
- Moving toward XML

#### **1.1.12 UNC nuclear reaction rates**

#### **1.1.13 Starlib (UNC)**

- Monte carlo of resonance  $\lambda$  Nuclear reaction rate with uncertainty
- 1 hour per resonance

#### **1.1.14 MESA**

- Modules for Experiments in Stellar Astrophysics ([mesa.sourceforge.net](http://mesa.sourceforge.net))
- Coupled with NuGrid

#### **1.1.15 NuGrid**

- NuGrid is a post processing package that inputs outputs from MESA

#### **1.1.16 AZURE: An R-matrix code for nuclear astrophysics**

- Fitting code

#### **1.1.17 KADONIS n-induced reactions**

- Karlsruhe Astrophysical Database of Nucleosynthesis in Stars

#### **1.1.18 ULB NetGen Network Generator**

- Generates point wise set of reaction rates vs temperatures

#### **1.1.19 TUNL light nuclei evaluations**

- Energy Levels of Light Nuclei, A= 3-20
- Nuclear Data Evaluation Project

#### **1.1.20 Moller - Nix - Kratz nuclear properties**

#### **1.1.21 Nucastrodata.org - COmputational Infrastructure for Nuclear Astrophysics**

- Rate Evaluations
- Dile Repository

- Nuclear Data
- Reaction rates and libraries
- Online simulations with web 2.0 sharability
- Data harvesting - choose a nucleus and ask system to retrieve data

#### **1.1.22 Nuclermasses.org**

- Comparison of models, experimental calculated mass models

#### **1.1.23 bigbangonline.org**

- Run and visualize Custom BBN calculations
- Quickly perform exploratory simulations

## **Transformative Goal**

- FREE online tools to help your research
- Custom views of datasets
- Virtual exper to consult with questions
- *We are in a transformative period right now - using a Cloud Computing approach*

### **1.2 NNDC Web Services**

#### **1.2.1 Web implementation since '94**

- Provides significant usage analytics
- Almost 3M redtrievals in FY 2011 (data retrievals, not crawls)
- More than 13500 different internet addresses

#### **1.2.2 Evaluated Nuclear Data File - ENDF**

- Dec. 2011 ENDF/B-VII.1 was released
- Neutron THERmal Cross Sections, Westcott Factors

### **1.2.3 Evaluated Nuclear Structure Data File**

- Vertical evaluation by mass chain (A)
- Evaluated experimental data, no theory
- NSR based, 3172 nuclides, 17578 data sets
- NuDat 2.6 WEb application is based on ENSDF database

### **1.2.4 Nuclear Science References**

- A prime source for nuclear bibliography, experiment theory (89400 authors, 5188 nuclides)
- More than 60 percent keyworded with topics (indexed quantities: nuclides, incoming outgoing)

### **1.2.5 EXFOR (Experiental format)**

- Compilation of experimental nuclear reaction data
- Mostly Neutrons (charged particles and photonuclear (19610 experiments)
- Needs to be more freidnly for Nuclear Astro – KADoNiS is in EXFOR, Atlas of Neutron Resonances is in EXFOR prelims
- IAEA - Correction of data sets using new monitors, Direct PDF access for evaluators

### **1.2.6 Nuclear Codes - EMPIRE - 3.1 (Rivoli)**

- Live ubuntu usb boot drive

### **1.2.7 Nuclear Codes - Webpage**

- Reaction Structure codes repository with B.A. Brown
- Would like more codes for the community from Alex Brown

### 1.2.8 Nuclear Data 2013 Conference

- New York City Sheraton

## Discussion

- Some things are missing from EXFOR
- NNDC is actually using some theory
- Copyrights thwart research

### 1.3 Modeling Needs Codes

#### 1.3.1 What is needed to evaluate and transform nuclear data, astronomy data, and codes reliably and efficiently so that they can be used in nuclear astrophysics?

- The codes should be OPEN-SOURCE

#### 1.3.2 libnucnet

- Open-source library to store and manage nuclear reaction networks released under GNU GPL
- Goal: streamline the implementation of nuclear data/calculations into network models
- Implemented in NucNet Tools (<http://sourceforge.net/p/nucnet-tools/home/Home>)

#### 1.3.3 Code complexity

- A significant inhibitor to multiuser usage

#### 1.3.4 Develop NucleusHub.org

- Modeled after nanoHUB.org, built on HUBZero web platform

#### 1.3.5 How would one publish a new code/tool for the community?

- Desktop 2 Petascale
- Production necessities – xml file, small wrapper

### 1.3.6 e.g. Open Parks Grid

- Knowledge pipeline for Park Professionals
- The take away: expand our reach by being active in integrating our centralized data/codes with the communities that are already present

## 1.4 Data Evaluation

### 1.4.1 Forms and Data

- Data types: Raw, Evaluated, Input for NA, Output from NA

### 1.4.2 Data Storage, Dissemination and Processing – Focusing on Raw & Evaluated

### 1.4.3 Nuclear Input – Nuclide Properties, Reaction Rates

### 1.4.4 AZURE R-Matrix code

- Establish a generally applicable R-matrix code - open-source, GUI

### 1.4.5 STARLIB: Rate calculator

### 1.4.6 KADONIS

- S-process (n,g)
- Many are renormalized theory
- T. Rausher collaborating w/ KADONIS on proper rate evaluation (what should be done in region of temperature where we don't have data)

### 1.4.7 JINALIB

- = REACLIB + NUCDATALIB + WEAKLIB + VALIDATION + ...

# Discussion points

### 1.4.8 Data Evaluation requires:

- Access to data - Through literature searches, data repositories



- Data selection - What data is acceptable for analysis (Do we understand uncertainties)
- Analysis tools - Several exist, do we need more?
- End product format - What standards should be set?

## 1.5 EMPIRE - BNL

- Graphical user interface tcl/tk

### 1.5.1 Valid options for Nuclear Astrophysics

- Inelastic scattering treatment
- Level densities
- $\gamma$ -ray strength functions

### 1.5.2 P-Process

- EMPIRE is getting better agreement than CIGAR (within 5% *EMPIRE is in very good agreement with data*)

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