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Title: Open-source Release of CGMF 1.1 and Integration into the MCNP6.3(R) Code

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Open-source Release of CGMF 1.1 and Integration into the MCNP6.3[®] Code

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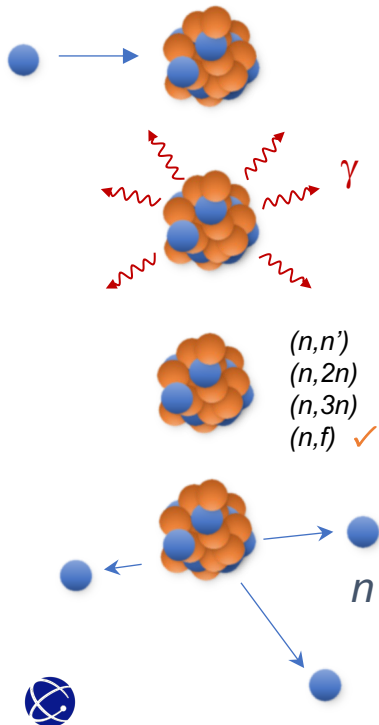
Overview

- Motivation for CGMF in the MCNP6.2 release
- CGMF on GitHub
 - Source code and Python toolkit
 - ReadTheDocs documentation
 - Computer Physics Communications publication
- Updates for the MCNP6.3 release
 - CGMF updates
 - New CGMF-MCNP integration
 - Verification
- Summary and Future Plans



Motivation for CGMF in the MCNP6.2 release

Default MCNP Calculations



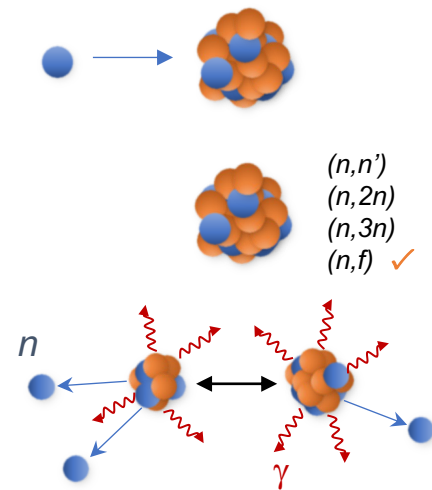
• Limitations

- OK on average \rightarrow criticality safety, shielding, reactor physics applications, etc.
- Wrong order for selection of reaction channels and reaction output
- Cannot perform correlated simulations or time-coincident detector response calculations

• Previous workarounds:

- Sampling $P(\nu)$ in MCNP
- LLNL fission library
- Detector response simulations in MCNPX-PoliMi

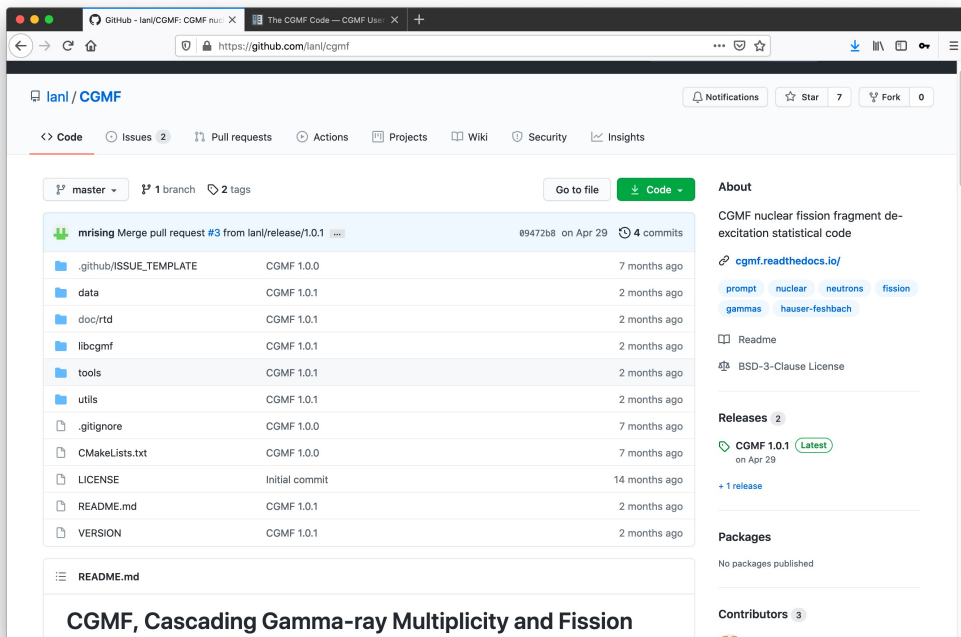
MCNP with CGMF Calculations



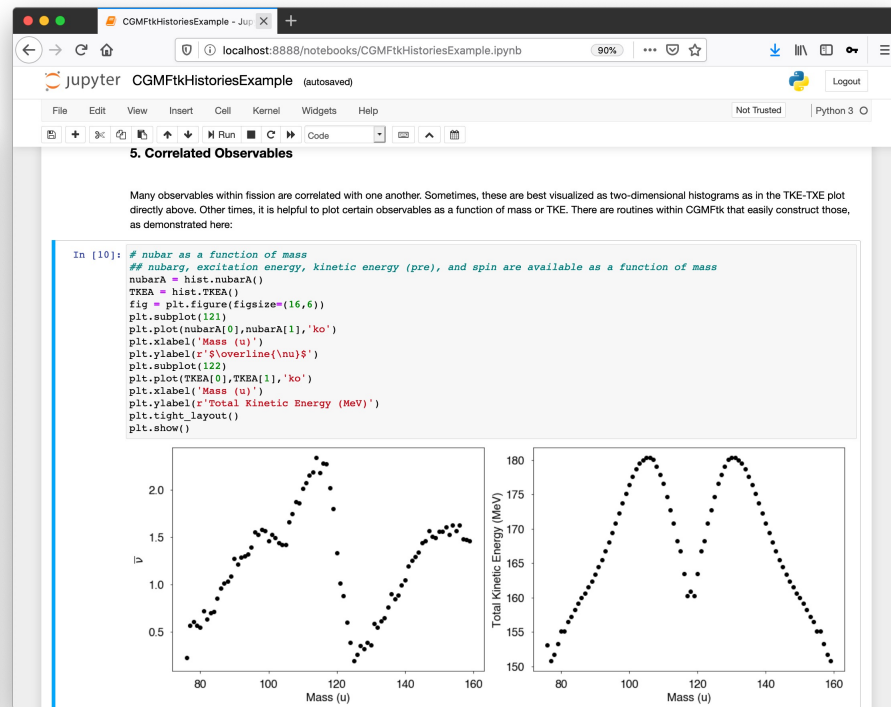
Developed a new paradigm to simulate nuclear reactions on an event-by-event basis for “low-energy” fission physics applications

CGMF on GitHub - <https://github.com/lanl/cgmf>

Source code, data, and Python tools



The screenshot shows the GitHub repository page for `lanl/CGMF`. The repository is a public project with 7 stars and 0 forks. It has 1 branch and 2 tags. The repository description is "CGMF nuclear fission fragment de-excitation statistical code". The repository contains a file tree with the following files and folders: `.github/ISSUE_TEMPLATE`, `data`, `doc/rtd`, `libcgmf`, `tools`, `utils`, `.gitignore`, `CMakeLists.txt`, `LICENSE`, `README.md`, and `VERSION`. The repository also has a README.md file. The repository is licensed under the BSD-3-Clause License. The repository has 4 commits and 1 release (CGMF 1.0.1) on April 29. The repository has 3 contributors.



Python Jupyter notebooks distributed



CGMF on GitHub - <https://cgmf.readthedocs.io/en/latest/index.html>

- ReadTheDocs documentation
- Computer Physics Communications available

Patrick Talou, Ionel Stetcu, Patrick Jaffke, Michael E. Rising, Amy E. Lovell, and Toshihiko Kawano, "Fission Fragment Decay Simulations with the CGMF Code," *Comp. Phys. Comm.*, **269** (2021).

<https://doi.org/10.1016/j.cpc.2021.108087>

The screenshot shows a web browser displaying the CGMF User Manual and The CGMF Code page. The left sidebar contains a navigation menu with links: Introduction, Getting Started, Physics Models, Code Details, Python Tools, Example Jupyter Notebooks, Publications, Copyright Notice, and BSD License Text. The main content area is titled "The CGMF Code" and includes a description of the code, a recommended publication for citing, and support information. The bottom of the page shows the "Read the Docs" logo and a version selector set to "latest".

CGMF User Manual

latest

Search docs

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The CGMF Code

CGMF is a code that simulates the emission of prompt fission neutrons and gamma rays from excited fission fragments right after scission. It implements a Monte Carlo version of the Hauser-Feshbach statistical theory of nuclear reactions to follow the decay of the fission fragments on an event-by-event basis. Probabilities for emitting neutrons and gamma rays are computed at each stage of the decay. Each fission event history records characteristics of the parent fragment (mass, charge, kinetic energy, momentum vector, excitation energy, spin, parity) and the number (multiplicity) and characteristics (energy, direction) of the prompt neutrons and gamma rays emitted in this event.

Recommended publication for citing

Patrick Talou, Ionel Stetcu, Patrick Jaffke, Michael E. Rising, Amy E. Lovell, and Toshihiko Kawano, "Fission Fragment Decay Simulations with the CGMF Code," to be submitted to *Comp. Phys. Comm.* (2020).

Support

For any questions related to CGMF, its use, and its code source, please email us at: `:email:`cgmf-help@lanl.gov` <cgmf-help@lanl.gov>`.`

Contents

- Introduction
 - Motivation and Physics Background
 - Synopsis of the CGMF code
 - For more information



Updates for the MCNP6.3 release

- CGMF updates

- Spontaneous fission

- 238, **240**, 242, **244**Pu
 - 252, **254**Cf

New Fissionable
Systems Compared to
MCNP6.2 Release

- Neutron-induced fission

- **233**, **234**, 235, 238U, **237Np**, and 239, **241**Pu

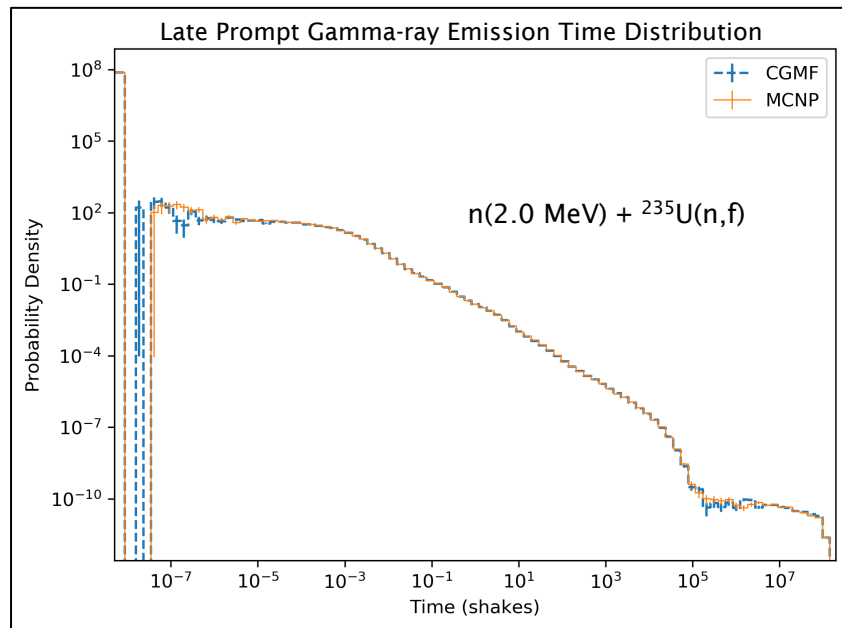
- Late-time prompt fission gamma rays

- Fission fragment angular distributions

- Pre-equilibrium neutron emission

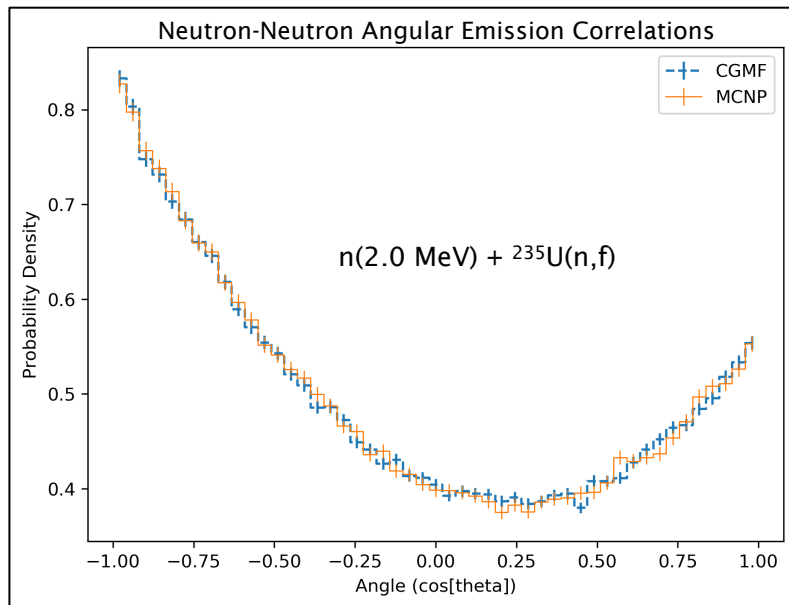
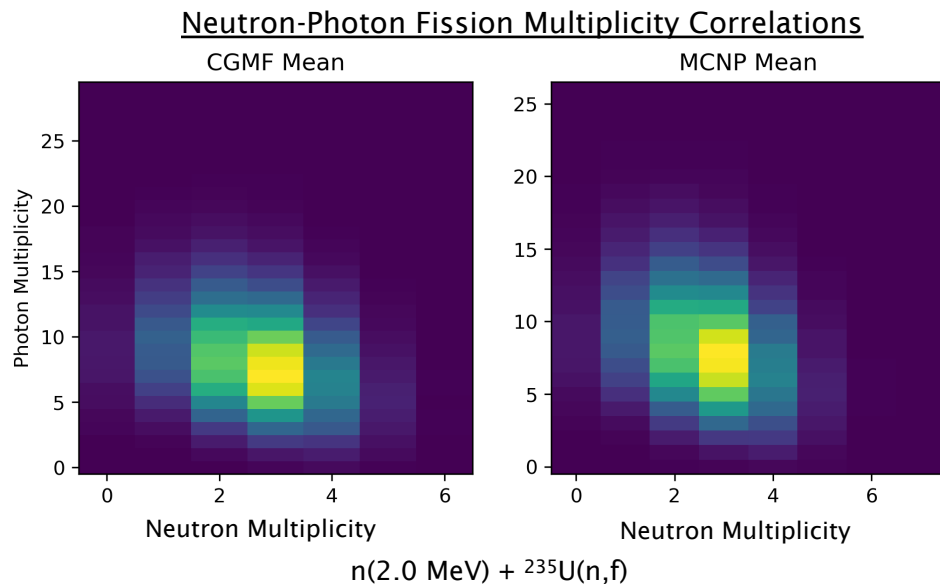
- New CGMF-MCNP integration

- Through the new MCNP CMake build system (`find_package`)
 - Built as a library, linked to MCNP executable
 - Same library can also be linked to make the CGMF executable



Updates for the MCNP6.3 release

- Verification of the integrated CGMF code and MCNP interface
 - Done with new HDF5 PTRAC and MPI



Note: No change to MCNP input options. To use CGMF → **FMULT METHOD=7**

Additional minor updates

- For MCNP6.3
 - The logic in MCNP6.2 to handle the combination of prompt neutrons from the correlated fission models (CGMF, FREYA, and LLNL Fission Library) and delayed neutrons from ACE data tables is flawed. This has been corrected in MCNP6.3.
- For CGMF 1.1
 - A patch to fix data file reading in mixed Windows/Linux environments (e.g. WSL) was pushed to GitHub. This patch version CGMF 1.1.1 was released in April 2022.
- Moving forward with MCNP6.3 + CGMF 1.1.x should be *easy* to manage if you have the MCNP6.3 source code
 - The CGMF 1.1.x interface will not change
 - Therefore, future patch releases of CGMF 1.1.x should be drop-in replacements without changes required to the MCNP6.3 source code itself



Summary and Future Plans

Contact the LANL
CGMF Developers at
cgmf-help@lanl.gov

- As a result of a multi-year NA-22 project,
 - CGMF was integrated into MCNP6.2 and publicly released
 - CGMF was open-sourced and publicly released
 - MCNP6.3 was updated to include the latest version and is in the process of being publicly released
- Current and future plans
 - A.E. Lovell was awarded a LANL Early Career LDRD to work on global optimization and uncertainty quantification within CGMF
 - D. Neudecker and A.E. Lovell have been working on model parameter fitting such that CGMF may be used in ENDF/B evaluations
 - T. Kawano and M.E. Rising are collaborating with RPI to improve both standalone and MCNP-integrated CGM (non-fission) simulations



Acknowledgements

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Questions?

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