

CGMF practical session for FIESTA 2024

FIESTA 2024

Nov. 18th 2024 - Nov. 22nd 2024



Ionel Stetcu
Theoretical Division, T-2
11/23/2024

Cascading Gamma-ray Multiplicity and Fission

- Open source: <https://github.com/lanl/cgmf>
 - Include the C++ source code, CGMFtk (postprocessing) and tests
 - Fission reactions handled: spontaneous fission of Pu-238,240,242,244 and Cf-252,254; neutron-induced fission reactions from thermal up to 20 MeV for n+U-233,234,235,238, n+Np-237, and n+Pu-239,241.
 - Instructions for compiling the code
 - Instructions for running the code

P. Talou, *et al.*, *Fission fragment decay simulations with the CGMF code*, Comput. Phys. Commun. **269**, 108087 (2021)

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

The screenshot displays the GitHub repository for **lanl/CGMF**. The repository is public and has 2 branches and 5 tags. The file browser shows the following structure:

File/Folder	Version	Commit Date
.github/ISSUE_TEMPLATE	CGMF 1.0.0	4 years ago
data	CGMF 1.1.2	8 months ago
doc/rtd	CGMF 1.1.2	8 months ago
libcgmf	CGMF 1.1.2	8 months ago
tools	CGMF 1.1.2	8 months ago
utils	CGMF 1.1.0	3 years ago
.gitignore	CGMF 1.0.0	4 years ago
CMakeLists.txt	CGMF 1.1.0	3 years ago
LICENSE	Initial commit	4 years ago
README.md	CGMF 1.1.2	8 months ago
VERSION	CGMF 1.1.2	8 months ago

The right sidebar contains the following information:

- About:** CGMF nuclear fission fragment de-excitation statistical code. Link: cgmf.readthedocs.io/. Tags: prompt, nuclear, neutrons, fission, gammas, hauser-feshbach.
- Readme:** BSD-3-Clause license, Activity, Custom properties, 25 stars, 6 watching, 7 forks.
- Releases:** 4 releases. Latest release: **CGMF 1.1.2** on Feb 6.
- Packages:** No packages published.

Running CGMF

`./cgmf.x [options]`

- `-i $ZAIDt` [required] 1000*Z+A of target nucleus, or fissioning nucleus if spontaneous fission
- `-e $Einc` [required] incident neutron energy in MeV (0.0 for spontaneous fission)
- `-n $nevents` [optional] number of Monte Carlo fission events to run or to be read. If \$nevents is negative, produces initial fission fragments yields Y(A,Z,KE,U,J,p)
- `-s $startingEvent` [optional] skip ahead to particular Monte Carlo event (1 is default)
- `-f $filename` [optional] fission histories or yields result file (default: "histories.cgmf" or "yields.cgmf")
- `-t $timeCoinc` [optional] time coincidence window for long-lived isomer gamma-ray emission cutoff (in sec)
- `-d $datapath` [optional] overrides the environment variable CGMFDATA and default datapath

```
time ./cgmf.x -i 92235 -e 2.53e-8 -n 100000 -t 2e-9
time srun -n 10 ./cgmf.mpi.x -i 92235 -e 2.53e-8 -n 10000 -t 2e-8
```

(default time coincidence window: 10 ns, all times: `-t -1`)

Screen output

```
//// CGMF Results ////

Reaction: (n,f) on (92,235) at En=2.53e-08 MeV

Average Light Fragment (Z,A) = (38.24,96.88)
Average Heavy Fragment (Z,A) = (53.76,139.12)

Average Kinetic Energies: LF = 101.16 MeV ; HF = 70.65 MeV ; <TKE> = 171.81 MeV
Average Excitation Energies: LF = 12.50 MeV ; HF = 9.18 MeV ; <TXE> = 21.68 MeV

Average Fragment Spins: <J>_LF = 8.29 hbar ; <J>_HF = 9.59 hbar ; <J> = 8.94 hbar

*** Prompt Fission Neutrons ***

Multiplicities (n/f): <nu>_LF = 1.41 ; <nu>_HF = 1.01 ; <nu>_prefission = 0.00 ; <nu>_tot = 2.41
c-o-m Energies: <Ecm>_LF = 1.18 MeV ; <Ecm>_HF = 1.15 MeV ; <Ecm>_prefission = 0.00 MeV ; <Ecm>_tot = 1.17 MeV
Lab. Energies: <Elab>_LF = 2.24 MeV ; <Elab>_HF = 1.64 MeV ; <Elab>_prefission = 0.00 MeV ; <Elab>_tot = 1.99 MeV

*** Prompt Fission Gammas ***

Multiplicities (g/f): <nu_g>_LF = 4.24 ; <nu_g>_HF = 4.14 ; <nu_g>_tot = 8.39
Gamma Energies: <Eg>_LF = 0.77 MeV ; <Eg>_HF = 0.77 MeV ; <Eg>_tot = 0.77 MeV

//// THE END ////
```

Output for $-t$ 1e-8 (default)

```
# 92235 2.53e-08 1e-08
96 38 14.149 10.0 1 101.623 98.700 1 6 0
3756.219 110.090 -2009.678 3683.769 123.223 -2013.087
0.757 -0.329 0.564 1.007
0.983 -0.178 0.046 2.891
-0.967 -0.253 -0.028 1.455 0.081 -0.301 0.950 1.823 -0.630 0.495 -0.599 1.665
-0.911 0.356 0.206 0.709 -0.961 -0.258 0.095 0.213 0.624 0.713 0.320 0.703
140 54 9.474 3.0 1 69.666 69.737 1 2 0
-3756.219 -110.090 2009.684 -3774.757 -131.866 1977.968
0.849 0.420 0.321 1.536
0.434 0.510 0.743 0.971
0.045 0.383 0.923 1.856 -0.050 0.822 -0.567 0.637
```

Output for $-t -1$

```
# 92235 2.53e-08 -1
 96 38 14.149 10.0 1 101.623 100.080 1 8 0
 3756.219 110.090 -2009.678 3729.807 67.599 -1992.087
-0.301 0.950 0.081 1.007
0.498 0.801 -0.332 1.497
-0.630 0.495 -0.599 1.478 0 -0.911 0.356 0.206 1.741 0 -0.961 -0.258
0.095 1.639 0 0.624 0.713 0.320 0.7
63 0 0.546 -0.549 -0.633 0.229 0 -0.524 -0.234 -0.819 0.665 0 -0.438
0.864 0.248 0.200 1.08794e-07 -0.85
4 0.345 -0.390 0.338 1.08794e-07
 140 54 9.474 3.0 1 69.666 68.742 1 1 0
 -3756.219 -110.090 2009.684 -3752.343 -76.072 1957.864
0.421 -0.603 0.678 1.616
-0.062 -0.548 0.834 2.053
0.081 0.639 0.765 2.418 0
```

CGMFtk: postprocessing tools in Python