

SciDAC-C/FUEL software update

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Jlab

QMP

- Latest version: 2.4.0-a6
- Has support for BG/Q low-level SPI communications
 - Current BG/Q driver bug causes some MPI routines to crash if SPI resources were allocated before MPI initialized
 - Bug report filed with IBM, no response yet
- Have some SPI global sum code integrated (~30% faster)
MPI bug is preventing completion

QIO

- Current version 2.3.9 (2.4.0 soon)
- Has single-file parallel I/O with any number of I/O node layout
- I/O node layout very important to performance
- For best performance don't split “x” direction across I/O nodes
- Possibly best to not split “y” too
- Difference between good/bad choice can be order of magnitude

QLA

- Latest version 1.8.0
- Added virtual Nc=1 version of library
- Uses existing Complex field in place of Nc=1 ColorMatrix or ColorVector where possible otherwise use general N version with N=1

QDP

- Latest version 1.10.1
- Added virtual Nc=1 library
- Bug fix in OpenMP (used in communications routine)

QOPQDP

- Current version: 0.19.4 (almost)
- Full support for $N_c=1,2,3,N$ versions of most routines (not all tested)
 - Gauge action, force, heatbath (U(1) from Alexei Bazavov)
 - Asqtad smearing, solver, force
 - HISQ smearing, solver
 - Wilson + clover solver, multigrid
 - Plain Wilson force
 - (Plain) Domain Wall solver
- Currently $N_c=3$ only
 - HISQ force (exists in FUEL, will be moved eventually)
- Missing
 - Clover force
 - DW variants and force
 - Eigenvalue related routines (Lanczos, Rayleigh-Ritz) have codes in QDP/QLUA, need to be moved

FUEL project (Framework for Unified Evolution of Lattices) → qhmc code

- <https://github.com/jcosborn/qhmc>
- Designed to be a lightweight, flexible wrapper for level 3
- Uses Lua scripting language to wrap C (C++,etc.) code libraries
- Original focus on lattice generation
 - solvers, forces, actions, other utility routines needed for HMC
- Expanding analysis capabilities
 - fairly complete staggered spectrum (Evan Weinberg)
 - basic wilson meson spectrum
 - wilson loops, wilson flow
- QOPQDP Wilson MG available
 - being tested in HMC (Meifeng Lin)



FUEL current status

- Only supports QOPQDP (+QDP/C,QLA)
- Staggered support fairly complete (Asqtad, HISQ, Stout, nHYP, ...)
- Plain wilson HMC, clover solver only
- HMC integrator, parameters controlled from Lua
 - Very flexible, easy to tune (at runtime too)
- Lua scripts hacky, not easy to follow for new user



FUEL plans

- Finish new scripts
 - Gauge smearing
 - Existing fermion actions
- Add new actions
 - Clover HMC, DW
 - BSM related actions (naïve implementation of higher representations)
- Continue integration/development improved solvers (MG)
- Integrate other level 3's
 - QUDA, MDWF, Phi, BG/Q
- Integrate with Qlua?



FUEL new Lua scripts

```
L = Lattice{4,4,4,8}
```

```
G = L:GaugeField{group="SU",nc=3}
```

```
G:Load("lattice")
```

```
GA = GaugeAction{kind="plaquette",beta=6,field=G}
```

```
M = G:Momentum()
```

```
I = Integrator{kind="leapfrog",action=GA,field=G,  
              momentum=M,tau=1,nSteps=40}
```

```
E = Evolver{kind="HMC",integrator=I}
```

```
E:Run()
```



FUEL new scripts status

- Gauge action/integration done
 - Will add existing fermion actions next
- Supports dynamic (runtime) N_c and compile-time
 - Can create multiple gauge fields of different groups (still needs routines for combining them)
 - Runtime N_c currently through 'N' color QOPQDP/QDP/QLA (need to hook in specific N_c versions for $N_c=1,2,3$)
 - $N_c=1$ QOPQDP done over virtual $N_c=1$ QDP/QLA (uses C field for M,V)

