1 Fermion Field File Formats

We note at the beginning, that we do not use a different format for source or sink fermion fields. They are both stored using the same lime records. The meta-data stored in the same lime-packed file is supposed to clarify all other things.

1.1 Propagators

Here we mainly concentrate on storing propagators (sink). The file can contain only sources, or both, source and sink. We (plan to) support four different formats

1. (arbitrary number of) sink, no sources
2. (arbitrary number of) source/sink pairs
3. one source, 12 sink
4. one source, 4 sink

This is very similar to the formats in use in parts of the US community. However, they use XML as a markup language, which we don't (yet) use.

We adopt the SCIDAC chechsum for gauge and propagator files.

Every source and sink has to be in a seperate lime record. The order in one file for the four formats mentioned above is supposed to be

1. sink, no sources: -
2. source/sink pairs: first source, then sink
3. one source, 12 sink: first source, then 12 sinks
4. one source, 4 sink: first source, then 4 sinks

All fermion field files must have a record indicating the type. The record itself is of type `propagator-type` and the record has a single entry (ascii string) which can contain one of

- `DiracFermion_Sink`
- `DiracFermion_Source_Sink_Pairs`

- `DiracFermion_ScalarSource_TwelveSink`
- `DiracFermion_ScalarSource_FourSink`

Those strings are also used in the input files of the hmc code for the input parameter `PropagatorType`. The binary data corresponding to one Dirac fermion field (source or sink) is then stored with at least two (three) records. The first is of type
`etmc-propagator-format`
and should contain the following information:

```
<?xml version="1.0" encoding="UTF-8"?>
<etmcFormat>
  <field>diracFermion</field>
  <precision>32</precision>
  <flavours>1</flavours>
  <lx>4</lx>
  <ly>4</ly>
  <lz>4</lz>
  <lt>4</lt>
</etmcFormat>
```

The `flavours` entry must be set to `1` for a one flavour propagator (flavour diagonal case) and to `2` for a two flavour propagator (flavour non-diagonal 2-flavour operator). In the former case there follows one record of type `scidac-binary-data`, which is identical to the SCIDAC format, containing the fermion field. In the latter case there follow two of such records, the first of which is the upper flavour. Any number of other records can be added for convenience.

The first two types are by now supported. In the future the other two might follow.

The indices in the binary data `scidac-binary-data` are in the following order:

$$t, z, y, x, s, c\,,$$

where t is the slowest and colour the fastest running index. The binary data is stored big endian and either in single or in double precision, depending on the `precision` parameter in the `etmc-propagator-format` record.

The γ-matrix convention is the one of the HMC code: γ_5 is defined as follows:

$$\gamma_5 = \begin{pmatrix} +1 & 0 & 0 & 0 \\ 0 & +1 & 0 & 0 \\ 0 & 0 & -1 & 0 \\ 0 & 0 & 0 & -1 \end{pmatrix} .$$

In the operator the following notation for the matrices is used:

$$\gamma_0 = \begin{pmatrix} 0 & 0 & -1 & 0 \\ 0 & 0 & 0 & -1 \\ -1 & 0 & 0 & 0 \\ 0 & -1 & 0 & 0 \end{pmatrix}, \quad \gamma_1 = \begin{pmatrix} 0 & 0 & 0 & -i \\ 0 & 0 & -i & 0 \\ 0 & +i & 0 & 0 \\ +i & 0 & 0 & 0 \end{pmatrix},$$

$$\gamma_2 = \begin{pmatrix} 0 & 0 & 0 & -1 \\ 0 & 0 & +1 & 0 \\ 0 & +1 & 0 & 0 \\ -1 & 0 & 0 & 0 \end{pmatrix}, \quad \gamma_3 = \begin{pmatrix} 0 & 0 & -i & 0 \\ 0 & 0 & 0 & +i \\ +i & 0 & 0 & 0 \\ 0 & -i & 0 & 0 \end{pmatrix} .$$

The Dirac operator is normalised to

$$D = \frac{1}{2}[\gamma_\mu(\nabla_\mu + \nabla^*_\mu) - a\nabla^*_\mu\nabla_\mu] + m_0 + i\mu\gamma_5\tau^3 .$$

For the non-degenerate case with the two flavour operator the following operator is inverted:

$$D_{\mathrm{nd}} = \frac{1}{2}[\gamma_\mu(\nabla_\mu + \nabla^*_\mu) - a\nabla^*_\mu\nabla_\mu] + m_0 + i\bar{\mu}\gamma_5\tau_1 + \bar{\epsilon}\tau_3$$

1.2 Source Fields

Source fields are, as mentioned before, stored with the same binary data format. There are again several types of source files possible:

- `DiracFermion_Source`
- `DiracFermion_ScalarSource`
- `DiracFermion_FourScalarSource`
- `DiracFermion_TwelveScalarSource`

This type is stored in a record called `source-type` in the lime file. There might be several sources stored within the same file. We add a format reacord `etmc-source-format` looking like

```
<?xml version="1.0" encoding="UTF-8"?>
<etmcFormat>
  <field>diracFermion</field>
  <precision>32</precision>
  <flavours>1</flavours>
  <lx>4</lx>
  <ly>4</ly>
  <lz>4</lz>
  <lt>4</lt>
  <spin>4</spin>
  <colour>3</colour>
</etmcFormat>
```

with obvious meaning for every `scidac-binary-data` record within the lime packed file. This format record also allows to store a subset of the whole field, e.g. a timeslize.