

Autocorrelation analysis

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1 General setup

```
1 using DelimitedFiles, Printf
2
3 versioninfo()
```

Julia Version 1.5.2
Commit 539f3ce943 (2020-09-23 23:17 UTC)
Platform Info:
 OS: Linux (x86_64-pc-linux-gnu)
 CPU: AMD Ryzen 7 PRO 4750U with Radeon Graphics
 WORD_SIZE: 64
 LIBM: libopenlibm
 LLVM: libLLVM-9.0.1 (ORCJIT, znver2)

2 I/O

```
1 function read_tet(fname::String, tag::String; Q::Union{Nothing,Int64} = nothing)
2
3     data = readdlm(fname)
4
5     tval = [1.0,5.0,7.0]
6     tet = Vector{uwreal}(undef,5)
7     if Q == nothing
8         for i in 1:3
9             tet[i] = uwreal(tval[i]^2 .* data[:,i], tag)
10        end
11    else
12        n = size(data,1)
13        rw = Vector{Float64}(undef, n)
14        for i in 1:n
15            if abs(abs(data[i,4])-Q) < 0.5
16                rw[i] = 1.0
17            else
18                rw[i] = 0.0
19            end
20        end
21    end
22 end
```

```

21
22     b = uwreal(rw, tag)
23     for i in 1:3
24         a = uwreal(tval[i]^2 .* data[:,i].*rw, tag)
25
26         tet[i] = a/b
27     end
28 end
29 tet[4] = uwreal(data[:,4] .^ 2, tag)
30 tet[5] = uwreal(data[:,4] .^ 4, tag)
31
32 return tet
33 end

```

read_tet (generic function with 1 method)

Test the reading and print table

```

1  function ana_file(fname, tag) Code (Julia)
2
3      tet_hmc_Qall = read_tet(fname, tag)
4      tet_hmc_Q0 = read_tet(fname, tag,Q=0)
5      tet_hmc_Q1 = read_tet(fname, tag,Q=1)
6      tet_hmc_Q2 = read_tet(fname, tag,Q=2)
7      for uwd in (tet_hmc_Qall, tet_hmc_Q0, tet_hmc_Q1, tet_hmc_Q2)
8          uwerr.(uwd)
9      end
10
11     tval = [1.0,5.0,7.0]
12     Qstr = ["All Q", "Q = 0", "Q = 1", "Q = 2", "<Q^2>", "<Q^4>"]
13     for i in 1:3
14         k = 0
15         for uwd in (tet_hmc_Qall, tet_hmc_Q0, tet_hmc_Q1, tet_hmc_Q2)
16             k = k + 1
17             @printf(" %s:          %4.2f %20.15e +/- %10.4e (tauint: %10.4e +/- %10.4e) \n",
18                 Qstr[k], tval[i],
19                 value(uwd[i]), err(uwd[i]),
20                 tau(uwd[i], tag), dtau(uwd[i], tag))
21         end
22         println("")
23     end
24     @printf(" %s:          %4.2f %20.15e +/- %10.4e (tauint: %10.4e +/- %10.4e) \n",
25         Qstr[5], 0.0,
26         value(tet_hmc_Qall[4]), err(tet_hmc_Qall[4]),
27         tau(tet_hmc_Qall[4], tag), dtau(tet_hmc_Qall[4], tag))
28     @printf(" %s:          %4.2f %20.15e +/- %10.4e (tauint: %10.4e +/- %10.4e) \n",
29         Qstr[6], 0.0,
30         value(tet_hmc_Qall[5]), err(tet_hmc_Qall[5]),
31         tau(tet_hmc_Qall[5], tag), dtau(tet_hmc_Qall[5], tag))
32

```

```

33     return nothing
34 end
35
36 files = Dict(
37     "BASIC HMC" => "datahmc.txt",
38     "LEFT INSTANTON HIT" => "dataaltw.txt",
39     "ALTERNATING INSTANTON HIT" => "dataalti.txt",
40     "ALTERNATING WINDING SEMILADO 5" => "dataaltw.txt",
41     "ALTERNATING WINDING SEMILADO 2" => "dataaltw2.txt",
42     "DOUBLE ALTERNATING WINDING DE SEMILADOS 2 Y 6" => "datadoubaltw.txt"
43 )
44
45 for k in keys(files)
46     println("## " * k)
47     ana_file("/home/alberto/projects/sampling/data/" * files[k], k)
48     println("## ")
49     println("")
50 end

```

BASIC HMC

```

All Q:    1.00 4.605568155718363e-02 +/- 5.3801e-05 (tauint: 4.2547e+01 +/- 6.3059e+00)
Q = 0:    1.00 4.558577477258590e-02 +/- 6.4443e-05 (tauint: 2.7782e+01 +/- 3.4309e+00)
Q = 1:    1.00 4.626205382051282e-02 +/- 4.4349e-05 (tauint: 1.4476e+01 +/- 1.3485e+00)
Q = 2:    1.00 4.715444228765202e-02 +/- 6.9885e-05 (tauint: 7.7691e+00 +/- 5.5163e-01)

```

```

All Q:    5.00 3.208102861535677e+00 +/- 2.8298e-02 (tauint: 7.4765e+01 +/- 1.4044e+01)
Q = 0:    5.00 2.906796743461616e+00 +/- 3.2167e-02 (tauint: 4.3425e+01 +/- 6.4875e+00)
Q = 1:    5.00 3.342126510254036e+00 +/- 2.3178e-02 (tauint: 3.1946e+01 +/- 4.1883e+00)
Q = 2:    5.00 3.905516625222170e+00 +/- 2.8739e-02 (tauint: 1.3549e+01 +/- 1.2263e+00)

```

```

All Q:    7.00 8.634890116956887e+00 +/- 1.0398e-01 (tauint: 7.8227e+01 +/- 1.4972e+01)
Q = 0:    7.00 7.453365666566651e+00 +/- 1.1659e-01 (tauint: 4.4482e+01 +/- 6.7172e+00)
Q = 1:    7.00 9.167000974277586e+00 +/- 8.1423e-02 (tauint: 3.2990e+01 +/- 4.3858e+00)
Q = 2:    7.00 1.134171957422825e+01 +/- 9.6611e-02 (tauint: 1.3818e+01 +/- 1.2630e+00)

```

```

<Q^2>:    0.00 7.930374336748971e-01 +/- 3.5310e-02 (tauint: 4.4543e+01 +/- 6.7263e+00)
<Q^4>:    0.00 2.300123097087746e+00 +/- 2.3379e-01 (tauint: 3.3950e+01 +/- 4.5708e+00)

```

##

ALTERNATING WINDING SEMILADO 2

```

All Q:    1.00 4.598515153466222e-02 +/- 8.2567e-05 (tauint: 4.7612e+01 +/- 1.0116e+01)
Q = 0:    1.00 4.550119030187186e-02 +/- 8.3535e-05 (tauint: 2.2610e+01 +/- 3.5215e+00)
Q = 1:    1.00 4.624697235164155e-02 +/- 6.7144e-05 (tauint: 1.5471e+01 +/- 2.0515e+00)
Q = 2:    1.00 4.700972080285714e-02 +/- 8.4984e-05 (tauint: 5.6839e+00 +/- 4.9121e-01)

```

```

All Q:    5.00 3.162469186140416e+00 +/- 4.8112e-02 (tauint: 1.0410e+02 +/- 3.0336e+01)
Q = 0:    5.00 2.853232293115137e+00 +/- 4.9625e-02 (tauint: 5.2052e+01 +/- 1.1474e+01)
Q = 1:    5.00 3.322925064990708e+00 +/- 3.4598e-02 (tauint: 3.3848e+01 +/- 6.2449e+00)
Q = 2:    5.00 3.840833985952381e+00 +/- 3.3783e-02 (tauint: 9.0707e+00 +/- 9.5848e-01)

```

All Q: 7.00 8.453706318162276e+00 +/- 1.7605e-01 (tauint: 1.0861e+02 +/- 3.2183e+01)
 Q = 0: 7.00 7.244112435212234e+00 +/- 1.7941e-01 (tauint: 5.3743e+01 +/- 1.2003e+01)
 Q = 1: 7.00 9.074245708995045e+00 +/- 1.2098e-01 (tauint: 3.4993e+01 +/- 6.5455e+00)
 Q = 2: 7.00 1.113585864673333e+01 +/- 1.1277e-01 (tauint: 9.3581e+00 +/- 1.0009e+00)

 <Q^2>: 0.00 7.721291460874140e-01 +/- 4.3378e-02 (tauint: 3.4077e+01 +/- 6.3061e+00)
 <Q^4>: 0.00 2.156658414275315e+00 +/- 2.4709e-01 (tauint: 2.1742e+01 +/- 3.3338e+00)
 ##

ALTERNATING WINDING SEMILADO 5

All Q: 1.00 4.588797445643762e-02 +/- 6.1610e-05 (tauint: 4.6603e+01 +/- 7.7515e+00)
 Q = 0: 1.00 4.541670161225905e-02 +/- 7.0766e-05 (tauint: 2.8908e+01 +/- 3.9270e+00)
 Q = 1: 1.00 4.616974276067352e-02 +/- 5.0303e-05 (tauint: 1.5285e+01 +/- 1.5801e+00)
 Q = 2: 1.00 4.689627653722069e-02 +/- 7.0917e-05 (tauint: 6.4025e+00 +/- 4.5440e-01)

All Q: 5.00 3.108039940263163e+00 +/- 3.4308e-02 (tauint: 9.1932e+01 +/- 2.0288e+01)
 Q = 0: 5.00 2.803323674970572e+00 +/- 3.7726e-02 (tauint: 5.2066e+01 +/- 9.0736e+00)
 Q = 1: 5.00 3.284325055216993e+00 +/- 2.7022e-02 (tauint: 3.6332e+01 +/- 5.4432e+00)
 Q = 2: 5.00 3.791976632721950e+00 +/- 2.9311e-02 (tauint: 1.1396e+01 +/- 1.0366e+00)

All Q: 7.00 8.262975649630757e+00 +/- 1.2753e-01 (tauint: 9.8006e+01 +/- 2.2201e+01)
 Q = 0: 7.00 7.073144098560634e+00 +/- 1.3863e-01 (tauint: 5.4553e+01 +/- 9.6986e+00)
 Q = 1: 7.00 8.944528350771101e+00 +/- 9.6419e-02 (tauint: 3.8888e+01 +/- 5.9945e+00)
 Q = 2: 7.00 1.096680949787908e+01 +/- 9.9055e-02 (tauint: 1.1740e+01 +/- 1.0829e+00)

<Q^2>: 0.00 7.394708352785152e-01 +/- 3.0910e-02 (tauint: 3.2426e+01 +/- 4.6260e+00)
 <Q^4>: 0.00 2.011804748760802e+00 +/- 1.7428e-01 (tauint: 2.0984e+01 +/- 2.4856e+00)
 ##

DOUBLE ALTERNATING WINDING DE SEMILADOS 2 Y 6

All Q: 1.00 4.602245327623685e-02 +/- 1.5316e-04 (tauint: 3.2318e+01 +/- 1.1135e+01)
 Q = 0: 1.00 4.557818349297942e-02 +/- 1.6120e-04 (tauint: 1.6945e+01 +/- 4.5470e+00)
 Q = 1: 1.00 4.622644547948165e-02 +/- 1.9611e-04 (tauint: 2.1810e+01 +/- 6.4515e+00)
 Q = 2: 1.00 4.679670858776059e-02 +/- 1.9976e-04 (tauint: 8.1531e+00 +/- 1.6264e+00)

All Q: 5.00 3.230196310690374e+00 +/- 7.7854e-02 (tauint: 5.2300e+01 +/- 2.1576e+01)
 Q = 0: 5.00 2.924301669696095e+00 +/- 1.0092e-01 (tauint: 4.1380e+01 +/- 1.5641e+01)
 Q = 1: 5.00 3.339095453509719e+00 +/- 9.5001e-02 (tauint: 4.0708e+01 +/- 1.5300e+01)
 Q = 2: 5.00 3.833272767316746e+00 +/- 9.0101e-02 (tauint: 1.4473e+01 +/- 3.6440e+00)

All Q: 7.00 8.732649965499087e+00 +/- 2.8099e-01 (tauint: 5.1984e+01 +/- 2.1405e+01)
 Q = 0: 7.00 7.517183194437391e+00 +/- 3.8976e-01 (tauint: 4.6427e+01 +/- 1.8332e+01)
 Q = 1: 7.00 9.145533695210585e+00 +/- 3.1368e-01 (tauint: 3.8053e+01 +/- 1.3951e+01)
 Q = 2: 7.00 1.116884856186954e+01 +/- 3.0473e-01 (tauint: 1.4382e+01 +/- 3.6116e+00)

<Q^2>: 0.00 9.254346526196116e-01 +/- 1.1193e-01 (tauint: 3.5286e+01 +/- 1.2587e+01)
 <Q^4>: 0.00 2.886107891936130e+00 +/- 6.4815e-01 (tauint: 2.9800e+01 +/- 9.9507e+00)
 ##

ALTERNATING INSTANTON HIT

All Q: 1.00 4.598635217303030e-02 +/- 7.6891e-05 (tauint: 3.5106e+01 +/- 6.9568e+00)
 Q = 0: 1.00 4.548057345464434e-02 +/- 8.8347e-05 (tauint: 2.1708e+01 +/- 3.5160e+00)
 Q = 1: 1.00 4.620722017138670e-02 +/- 6.1177e-05 (tauint: 1.0858e+01 +/- 1.3134e+00)
 Q = 2: 1.00 4.714603893522438e-02 +/- 9.3234e-05 (tauint: 6.3258e+00 +/- 6.0538e-01)

All Q: 5.00 3.155232010959596e+00 +/- 4.0391e-02 (tauint: 6.1747e+01 +/- 1.5419e+01)
 Q = 0: 5.00 2.831187166086578e+00 +/- 4.9701e-02 (tauint: 4.4570e+01 +/- 9.7418e+00)
 Q = 1: 5.00 3.303301295092431e+00 +/- 3.2576e-02 (tauint: 2.5936e+01 +/- 4.5300e+00)
 Q = 2: 5.00 3.872206691363251e+00 +/- 4.3092e-02 (tauint: 1.2754e+01 +/- 1.6500e+00)

All Q: 7.00 8.441005306357273e+00 +/- 1.4777e-01 (tauint: 6.4186e+01 +/- 1.6273e+01)
 Q = 0: 7.00 7.180625344429629e+00 +/- 1.8243e-01 (tauint: 4.7184e+01 +/- 1.0561e+01)
 Q = 1: 7.00 9.016505690448207e+00 +/- 1.1697e-01 (tauint: 2.8478e+01 +/- 5.1726e+00)
 Q = 2: 7.00 1.123071869620025e+01 +/- 1.4982e-01 (tauint: 1.3447e+01 +/- 1.7797e+00)

<Q^2>: 0.00 8.035929467617887e-01 +/- 4.9701e-02 (tauint: 3.6061e+01 +/- 7.2229e+00)
 <Q^4>: 0.00 2.338747264063560e+00 +/- 2.4612e-01 (tauint: 1.7088e+01 +/- 2.5051e+00)

##

LEFT INSTANTON HIT

All Q: 1.00 4.588797445643762e-02 +/- 6.1610e-05 (tauint: 4.6603e+01 +/- 7.7515e+00)
 Q = 0: 1.00 4.541670161225905e-02 +/- 7.0766e-05 (tauint: 2.8908e+01 +/- 3.9270e+00)
 Q = 1: 1.00 4.616974276067352e-02 +/- 5.0303e-05 (tauint: 1.5285e+01 +/- 1.5801e+00)
 Q = 2: 1.00 4.689627653722069e-02 +/- 7.0917e-05 (tauint: 6.4025e+00 +/- 4.5440e-01)

All Q: 5.00 3.108039940263163e+00 +/- 3.4308e-02 (tauint: 9.1932e+01 +/- 2.0288e+01)
 Q = 0: 5.00 2.803323674970572e+00 +/- 3.7726e-02 (tauint: 5.2066e+01 +/- 9.0736e+00)
 Q = 1: 5.00 3.284325055216993e+00 +/- 2.7022e-02 (tauint: 3.6332e+01 +/- 5.4432e+00)
 Q = 2: 5.00 3.791976632721950e+00 +/- 2.9311e-02 (tauint: 1.1396e+01 +/- 1.0366e+00)

All Q: 7.00 8.262975649630757e+00 +/- 1.2753e-01 (tauint: 9.8006e+01 +/- 2.2201e+01)
 Q = 0: 7.00 7.073144098560634e+00 +/- 1.3863e-01 (tauint: 5.4553e+01 +/- 9.6986e+00)
 Q = 1: 7.00 8.944528350771101e+00 +/- 9.6419e-02 (tauint: 3.8888e+01 +/- 5.9945e+00)
 Q = 2: 7.00 1.096680949787908e+01 +/- 9.9055e-02 (tauint: 1.1740e+01 +/- 1.0829e+00)

<Q^2>: 0.00 7.394708352785152e-01 +/- 3.0910e-02 (tauint: 3.2426e+01 +/- 4.6260e+00)
 <Q^4>: 0.00 2.011804748760802e+00 +/- 1.7428e-01 (tauint: 2.0984e+01 +/- 2.4856e+00)

##