A8_Q4

November 15, 2018

In [1]:
```
using LinearAlgebra

function HMat(J,N,B)
    Ham = zeros(Float32, 2^N, 2^N)
    for Ket = 0:(2^N - 1) # Loop over the kets
        Diagonal::Float32 = 0
        for SpinIndex = 0:N-2 # loop through the indices
            Spin1 = 2*((Ket>>SpinIndex) & 1)-1
            Spin2 = 2*((Ket>>(SpinIndex+1)) & 1) - 1
            Diagonal = Diagonal - 0.25*Spin1*Spin2
        end
        Ham[Ket+1,Ket+1] = J*Diagonal # Fill the diagonal component
        # Adding in the Bra component
        for SpinIndex = 0:N-1
            bit = 2^SpinIndex
            Bra = Ket  bit # Define our Bra for each Ket
            Ham[Ket+1,Bra+1] = -0.5*B # Fill the off-diagonal components
            #println(Ket, " ", Bra)
        end
    end
    return Ham
end

# (J=1,N=2,B=0.5)
Ham = HMat(1,2,0.5)
display(Ham)
print("Min Eigenvalue: ")
println(eigen(Ham).values[1])
print("Groundstate Eigenvector: ")
println(eigen(Ham).vectors[1:4])
```

```
4×4 Array{Float32,2}:
 -0.25  -0.25  -0.25   0.0
 -0.25   0.25   0.0   -0.25
 -0.25   0.0    0.25  -0.25
  0.0   -0.25  -0.25  -0.25
```

```
Min Eigenvalue: -0.5590167
Groundstate Eigenvector: Float32[-0.601501, -0.371748, -0.371748, -0.601501]
```

```
In [4]: # Q4
        # First the Magnetization without time evolution
        N=4
        Ham = HMat(1,4,0.1)
        eigenvalues = eigen(Ham).values
        Diag = eigen(Ham)
        GroundState = Diag.vectors[:, 1]
        m = 0
        for Ket = 0:(2^N)-1
            SumSz = 0.
            for SpinIndex = 0:N-1
                Spin1 = 2*((Ket>>SpinIndex)&1) - 1
                SumSz += Spin1/2.0
            end
            m += SumSz*GroundState[Ket+1]^2
        end
        println(m/N)
```

```
0.0006797945825383067
```

```
In [6]: # Now we must time evolve. But, we have already diagonalized
        # this hamiltonian, so the time evolution simplifies to
        # multiplying by exp(-i*En*t), but we let t=1
        N=4
        Ham = HMat(1,4,0.1)
        eigenvalues = eigen(Ham).values
        Diag = eigen(Ham)
        GroundState = Diag.vectors[:, 1]
        GroundEigenval = eigenvalues[1]
        m = 0
        for Ket = 0:(2^N)-1
            SumSz = 0.
            for SpinIndex = 0:N-1
                Spin1 = 2*((Ket>>SpinIndex)&1) - 1
                SumSz += Spin1/2.0
            end
            m += SumSz*(exp(GroundEigenval)*GroundState[Ket+1])^2
        end
        println(m/N)
```

```
0.00014707179798278958
```