QP_A5_Q3

October 18, 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

# Q3 a)
# First Let's Try the diagonal matrix
# (J=0,N=2,B=1)
Ham = HMat(1,2,0)
display(Ham)
println(eigvals(Ham))
```

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


Float32[-0.25, -0.25, 0.25, 0.25]
```

In [2]:
```
# Now Lets try with J=0 and B=1
Ham = HMat(0,2,1)
display(Ham)
println(eigvals(Ham))
```

```
4×4 Array{Float32,2}:
 -0.0  -0.5  -0.5   0.0
 -0.5   0.0   0.0  -0.5
 -0.5   0.0   0.0  -0.5
  0.0  -0.5  -0.5  -0.0


Float32[-1.0, -0.0, 1.53668e-8, 1.0]
```

In [ ]:
```
We notice that the minimum eigenvalue is -1.0.
This is exactly the minimum eigenvalue we get
with the spin-2 system, hence is exactly expected.
```

In [3]:
```
# b)
# Now we focus on looking at the tendency of the
# minimum eigenvalue as N tends to infinity for B = 0.5 and J = 1
Nmax = 10
for n = 2:Nmax
    if n == 2
        print(eigmin(HMat(1,n,0.5)))
        else print(',', eigmin(HMat(1,n,0.5)))
    end
end
```

```
-0.55901706,-0.8734898,-1.1896927,-1.5066681,-1.8240582,-2.1416922,-2.45949,-2.7773886,-3.0953
```

In [ ]:
```
As we can see, the minimum eigenvalues are tending towards -infinity as N tends to inf
```