your name(s)_____

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Physics 852 Exercise #8 - Friday, March. 18th

BCS theory is built on a simplified assumption of an interaction with a fixed density of states over a finite energy range, with an interaction that mixes all states (with a given total momentum) equally. To mimic this, consider the following Hamiltonian in matrix form,

$$\begin{aligned} \boldsymbol{H_{ii}} &= \boldsymbol{E_0}(\boldsymbol{i/M}), \quad \boldsymbol{E_0 = 1.0} \\ \boldsymbol{H_{i\neq j}} &= \boldsymbol{-g/M}, \quad \boldsymbol{g = 0.1;} \end{aligned} \tag{0.1}$$

where $\boldsymbol{M}$ is the dimensionality of the matrix with $\boldsymbol{0 \leq i < M}$.

1. Write a program that finds the eigenvalues of the matrix and prints out the lowest 10 eigenvalues.
2. Run the program for $\boldsymbol{M = 5, 20, 80, 320}$ and compare results.
3. For $\boldsymbol{M = 320}$, compare the lowest eigenvalues for $\boldsymbol{g = 0.1, 0.01, 0.001}$.
4. What happens under the interchange $\boldsymbol{g \to -g}$?