2021 - PHY 981 - Homework set 12 (due Apr 11)

1. **link to lecture notes**
   link to nushellx.zip
   link to toi.zip link to mingw-w64.zip

2. **Read Chapters 26,31,32.**

3. **Read the attached help.pdf pages 1-11.**

4. **Use NuShellX to obtain the wavefunctions for ^{19}O in the sd model space with the usdb Hamiltonian for J up to 13/2. Are the results for the partitions and maximum J value consistent with the answer to HW11.8?**

5. **Use NuShellX to obtain the wavefunctions for ^{19}F in the $0d_{5/2}$ model space and the usdb Hamiltonian for J up to 13/2. Are the J scheme dimensions consistent with the answer to HW11.4? (This information is printed on the screen and is in the *.dim files.)**

6. **Modify the *ans file from the previous problem to calculate the T values. Are the (J, T) values in the *.lpt file consistent with the answer to HW11.4? Compare the calculated energy levels to experiment.**

7. **The Hamiltonian for a system of two basis states is: $H_{11} = -10$, $H_{12} = -2$ and $H_{22} = -2$. Find the second-order perturbation correction to the wavefunction and energy for state 1.**

8. **In a different directory, obtain the (J, T) wavefunctions for ^{19}F in the full sd model space wth the usdb Hamiltonian. Compare the calculated energy levels to experiment. How does the excitation energy of the lowest $T = 3/2$ state with experiment?**

9. **A simple model for the "pairing" part of the Hamiltonian is that all components of the wavefunction are connected by the same attractive interaction. For example for three basis states, the two-body interaction part of the matrix would look like**

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a a a
a a a
a a a
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where a is the many-body interaction strength. Using $a = -1$ MeV, what are the eigenvalues and wavefunctions for this matrix.

10. **For this last problem, find the ground state energy and wavefunction using the Lanczos method. Start with the random vector $(1, 2, 3)/\sqrt{14}$.**