- **Macroscopic quantum spin tunnelling with two interacting spins**
  Solomon Akaraka Owerre (Université de Montréal)

We study the simple Hamiltonian, $H = -K(S_{1z}^2 + S_{2z}^2) \pm \lambda \vec{S}_1 \cdot \vec{S}_2$, of two, large, coupled spins which are taken equal of total spin s. The first term corresponds to an external potential which tends to align them along an easy axis. The second term corresponds to an interaction, the standard exchange coupling, which we will assume to be a small perturbation. The $+$ sign is anti-ferromagnetic coupling while the $-$ sign is ferromagnetic. The exact ground state of this simple Hamiltonian is not known for an antiferromagnetic coupling. In the absence of the exchange interaction, the ground state is four fold degenerate, corresponding to the states where the individual spins are in their highest weight or lowest weight states. The four states are labelled as $|\uparrow,\uparrow\rangle, |\downarrow,\downarrow\rangle, |\uparrow,\downarrow\rangle, |\downarrow,\uparrow\rangle$, in obvious notation. The first two remain exact eigenstates of the full Hamiltonian, which is trivially verified. However, we show the that the two states $|\uparrow,\downarrow\rangle, |\downarrow,\uparrow\rangle$ organize themselves into the combinations $|\pm\rangle = \frac{1}{\sqrt{2}}(|\uparrow,\downarrow\rangle \pm |\downarrow\uparrow\rangle)$, up to perturbative corrections. For a ferromagnetic coupling, the two states $|\uparrow,\uparrow\rangle, |\downarrow,\downarrow\rangle$ are the exact, doubly degenerate, ground states while the states $|+\rangle$ is the first excited state and the state $|-\rangle$ is the second excited state. For an anti-ferromagnetic coupling the states $|\uparrow,\uparrow\rangle, |\downarrow,\downarrow\rangle$ remain exact, degenerate, eigenstates, however they are now the second and third excited states. In this case, the ground state is non-degenerate, and we find the interesting result that for integer spins the ground state is $|+\rangle$, and the first excited state is the anti-symmetric combination $|-\rangle$ while for half odd integer spin, these roles are exactly reversed. The energy splitting however, is proportional to λ^{2s}, as expected by perturbation theory to the $2s^{\text{th}}$ order. We obtain these results through the spin coherent state path integral.