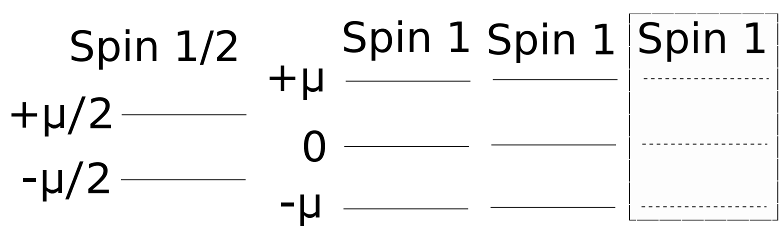
SMA: Consider a quantum system consisting of one spin-1/2 particle and two spin-1 particles (three in part (c)) in a uniform magnetic field. The energy levels of the particles are Zeeman split so that the energies of the spin-1/2 are $E_{1/2} = \pm\mu/2$ while the energies of the spin-1 particles are each $E_1 = -\mu, 0, \mu,$. Here μ has units of energy and depends on the magnitude of the applied magnetic field. Assume that when a spin is pointing in the $+z$-direction it has the higher energy. The system is thermally isolated, but the spins can exchange energy with each other.

a) Plot the entropy of this system as a function of the total energy E_T at all allowed discrete values in the range $E_T = -5\mu/2$ to $E_T = +5\mu/2$.

b) Fix the total energy to be $E_T = \mu/2$. Calculate the average energy and average z-component of the spin of *just the spin-1/2 subsystem.*

c) Keep the total energy fixed at $E_T = \mu/2$, but add an extra spin-1 to the system that can exchange energy with all of the others. Re-calculate the average z-component of the spin of *the spin-1/2 subsystem* and compare it to the previous calculated value.

d) If instead we remove the spin-1's and couple the spin-1/2 system to a heat reservoir at temperature T, estimate the limiting values of the z-component of the spin of the spin-1/2 system when $T = 0$ and $T = \infty$.



The discrete energy levels of the Zeeman split energy spectrum.