TRIUMF CMMS TSI 2011, Experimental Practical Session at M9B

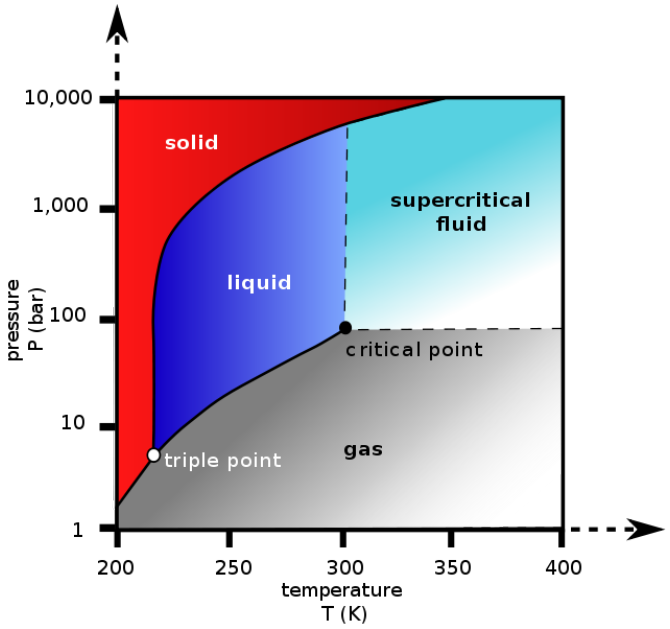
Apparatus: Omni' μSR spectrometer, Pressure cell

Sample: Supercritical carbon dioxide ($scCO_2$)

Objective: Determine the isotropic muon hyperfine coupling constant (A_μ) of muonium

Background:

Supercritical CO_2 has been found to be a useful "green" solvent for a wide variety of chemical applications. $scCO_2$ can adopt properties midway between a gas and a liquid. Carbon dioxide is inexpensive, is nonflammable, and has a readily accessible supercritical region (P_c = 7.38 MPa, Tc = 304.15 K). It has a large muonium fraction at low densities, which makes it an ideal material to study muonium.



At the start:

*Record information about the experimental conditions in the logbook provided. It is important to get into the habit of recording important status indicators and observations in the logbook. This makes it much easier to troubleshoot or to identify problematic data or to reproduce conditions later.

1. What is the current incident muon rate per second? This is the rate of light pulses in the thin muon counter that give a signal sufficient to trigger the descriminator.
2. What is the current sample temperature and pressure??
3. What is the momentum of the muon beam?
4. What is the muon beam polarization?

The Measurements:

Tune the beam so that the muon momentum is 70 MeV/c and has transverse polarization.

Set a transverse field of 5 G and begin a run. Examine the time domain spectrum. How many precession frequencies do you see? Confirm this by looking at the Fourier transform spectrum.

Obtain TF-μSR spectra at several applied fields. How many precession frequencies are present? Determine how the precession frequencies depend on the magnetic field. Relate this to the Breit-Rabi diagram.

Conclusions:

What is the value of A_μ in $scCO_2$?

Questions:

1. What is the density of the $scCO_2$ sample?
2. Given the density of CO_2 calculated above and the muon beam momentum, what is the range of the muons?
3. How would you measure A_μ with either longitudinal or transverse muon polarization. Which way is more accurate?
4. Why did we not measure A_μ directly in zero field but rather calculate it from the ν_{12} and ν_{23} frequencies?