1. INTRODUCTION TO THE LAB AND THE SPECTROMETER

Hello.
Welcome to the Schulich Faculty of Chemistry NMR lab at the Technion.
I'm Dr. Yael Balazs. I am one of the NMR facility managers.

This series of short videos will explain how to acquire a proton pulsed FT NMR spectrum using our current training instrument, a Bruker DPX200 NMR spectrometer.

You can find information on how to prepare samples for solution NMR at our facility website (nmrlab.technion.ac.il). Navigate to Instructions and then Beginners.

Let's try to understand the NMR spectrometer, by simplifying it. Let's look at each of its three distinct, basic components one-by-one. First, here's the external, static, and homogeneous magnetic field. This particular magnet was charged in 1987 to 4.7 Tesla. That is five orders of magnitude stronger than the earth's magnetic field. It is a superconducting magnetic, which means we don't turn the field off.

We want to do NMR spectroscopy. What is spectroscopy? It is the interaction between matter and energy. Our protons will be in a 4.7 T magnetic field. To interact we will supply energy at a matching, or resonant frequency, which is ~ 200 MHz.

How do we do that? With the second part of our instrument. The electronic components for RF-transmission and detection are housed in the console. We start the NMR experiment. The timing control unit clocks a delay. Then an RF-pulse of defined shape, frequency, power, duration, and phase is generated and transmitted through those cables on the ground from the cabinet to the probe inside the magnet. Today we have a “qnp” or quatro-nuclear probe inside the bore of the magnet. This qnp has the capacity to measure the precession frequencies of: ^{1}H, ^{2}H, and ^{13}C, ^{31}P, or ^{19}F.

The third component is probably the most familiar, the PC. We'll also call it the “user interface.” This PC is running a program called “Topspin.” We'll use Topspin to control the electronic components of the instrument and to process our results.

So when does the action really begin? When we place our NMR sample into the magnet. When nuclei with non-zero quantum spins are in a magnetic field they immediately begin to precess. And also, but more slowly (say a few seconds to a few minutes for most of our typical solutions), a slight bias in the spin distribution is established. Another phrase we use to describe the population bias is “the net magnetization.” Here's a great visual aid suggested by Lars Hanson. The small arrows of the spiky ball represent the distribution of all the individual precessing spins, that's the set of protons in the same chemical environment. The fat arrow pointing “north” is the net magnetization vector. The net magnetization itself is not precessing here, because the phases of each of the individual spins are different, so that the x- and y- components average to zero.

So how do we run an NMR experiment? We'll want to gently place our sample into the magnet and then we'll settle down at the computer here and use Topspin to tell the console what to do in order to interact with our sample. In these demonstration videos we'll be running the most basic pulse-acquire NMR experiment. Lars Hanson has an excellent five minute video explaining how this works. It's entitled, “Simple demonstration of magnetic resonance as used in NMR and MRI.”

In the remaining videos of this series, we'll see how to can acquire an NMR spectrum.