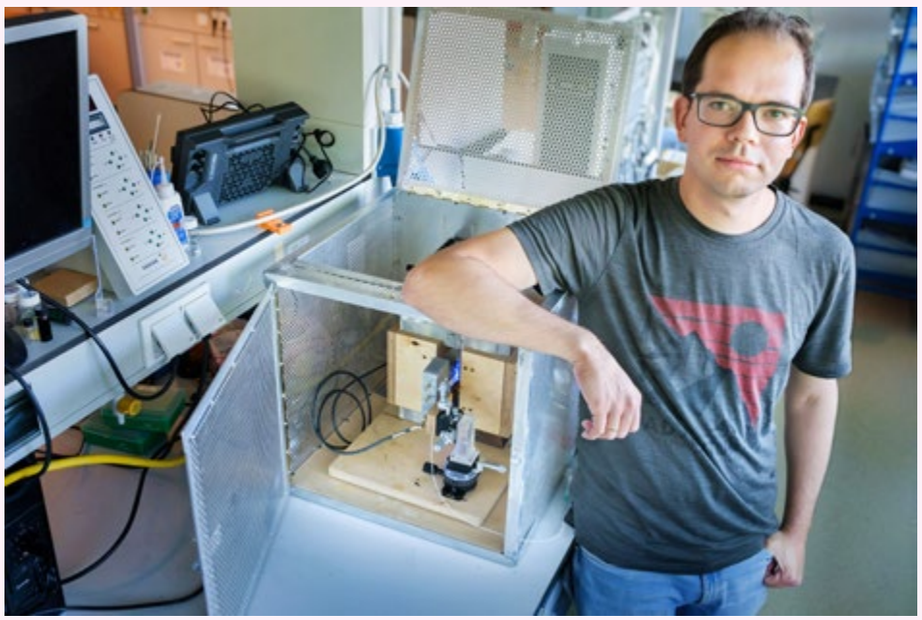
NMR on the cheap

NMR spectroscopy uses nuclear magnetic resonance, the same principle as an MRI scan. NMR spectra reveal the structure of a molecule. This currently requires extremely expensive equipment, but Sander Baas shows it can be done a lot cheaper. Text Roelof Kleis

Baas got his PhD in early May for his thesis entitled *DIY NMR*, in which he shows you can build an NMR spectrometer using everyday materials. According to Baas, the materials for his prototype cost 1500 to 2000 euros, which is a lot less than the million euros for the 'real thing' in the lab. Baas: 'Plus you have to pour in several thousand euros worth of liquid helium every four months to keep the magnet cool.'

It is precisely the magnet that makes NMR spectrometers so expensive. The NMR signal is obtained by putting a substance in a very strong magnetic field and subjecting it to pulses of radio waves. The signal emitted by the substance contains information about its molecular structure. That signal is weak but can be enhanced by using stronger magnets. 'A rather crude method,' says Baas. 'It works, but it's incredibly expensive.'



The NMR spectrometer stands in a metal cage in the lab to protect it from interfering FM radio waves. Researcher Sander Baas, the designer of the instrument, explains, 'The NMR radio pulses are at around 90 MHz, and FM radio broadcasts at 87-108 MHz. That's why we have this Faraday cage.' ◆ Photo Guy Ackermans

Tiny coils

Baas takes a totally different approach. First, he has gone for miniaturization of the probe, the coil that contains the sample as well as emitting the radio pulses and picking up the returning signal. 'If you make that coil smaller, the voltage of the pulse it emits (and receives) per unit volume increases. So a smaller coil increases the sensitivity of the detection.' And a smaller coil also means you need less of the substance in question. Baas: 'In a normal NMR measurement, you have a tube with a diameter of 5 millimetres and a volume of half a millilitre. I use tubes with diameters of 0.3 to 0.8 millimetres and volumes of 40 nanolitres to 0.5 microlitres. That difference is a factor of between 1000 and 10,000.' In fact, the coils Baas uses can barely be seen with the naked eye.

Dye

In addition to scaling down the probe, Baas used hyperpolarization to increase the strength of the NMR signal. He added a dye to the sample. The light falling on the sample then puts the dye in an 'excited' state, making it interact with the sample, which makes the NMR signal stronger. 'You can amplify the signal by a factor of up to 1000 this way.'

Thanks to the miniaturization and hyperpolarization, the instrument Baas designed doesn't need such a strong magnet. He has called his device an LF NMR, where LF stands for 'Low Field'. It is not yet as sensitive as the standard, expensive apparatus, but Baas is working on that. 'Anyway, you don't always need really sharp spectra,' he adds. 'Certainly not for NMR practicals, for instance. It would be fun and educational for students if they were given a kit to build such an instrument.'