Overhauser Effect Applied to the Geomagnetic Measurements

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Initially a proton precession magnetometer (ppm) was built at the Magnetic Sensor Development Laboratory of the National Observatory in Rio de Janeiro, Brazil (LDSM/ON) to be applied in geomagnetic measurements specially to be used in the Brazilian magnetic observatories. Using this ppm platform a new project started seeking to develop an Overhauser magnetometer

In the Overhauser magnetometer a large polarization of the electron magnetic moments is transferred to the protons by several couplings between electrons and protons and this effect can offer an alternative for proton spin alignment. The upper energy level of the free electrons in an external dc magnetic field can be continuously saturated using an RF signal in resonance with the corresponding electron spin resonance (ESR) which is determined by the environmental magnetic field. Is possible to maintain the electron spin resonance in a narrow peak meaning that the RF power needed to the polarization saturation of the electron can be small, even if continuous RF pumping of the electrons is maintained. This is the dynamic nuclear polarization (DNP) and the theoretical enhancement of the proton polarization by DNP is multiple of the natural polarization in the same magnetic field. To have a proton-rich liquid sample and at the same time have some free electrons available for RF-ESR, special free radicals compounds must be used. Such chemical compounds feature single unpaired electrons that can be excited to produce the DNP Overhauser effect. Unfortunately as free radicals these compound usually have a tendency to be chemically unstable.

In some nitroxide free radicals, as Tempone (Tetra-Methyl-Piperidine-Oxyde), one unpaired electron near the nitrogen atom is available for ESR polarization. In this project were using Tempone and two others similar chemical compositions to analysis this Overhauser effects to be applied in the geomagnetic measurements. Some of these nitroxides free radical are basically a carbon ring including one oxidized nitrogen atom, and are used almost universally in Overhauser effect magnetometers. Tempone and its equivalents are long-term chemically stable in a range of solvents and not excessively aggressive to living organisms making handling safe and easy. Over the ppm original platform a RF circuit was assembled to obtain the RF excitation for a new sensor filled with a Tempone doped water.