PART VI

The Larmor Equation and the Gyromagnetic Constant

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The Larmor equation allows us to compute the ambient magnetic field from a measured proton precession frequency:

$$\omega = \gamma_p F$$

where ω is the precession frequency in radians per second (angular frequency), γ_p is the gyromagnetic constant, and F is the magnetic field. Angular frequency is related to frequency in Hz by the following equation:

$$\omega = 2\pi f$$

where f is the frequency in Hz. Substituting the second equation into the Larmor equation, we get:

$$f = \frac{\gamma_p F}{2\pi}$$

As per the IAGA[1], $\gamma_p = 2.675\ 153\ 362 \cdot 10^8\ T^{-1}s^{-1}$

Example: For a local magnetic field of 53,730 nT (nano Tesla):

$$f = \frac{(2.675153362 \cdot 10^8\ )(53730 \cdot 10^{-9})}{2\pi}\ \text{Hz}$$

$$f = 2287.629\ \text{Hz}$$

Given a measured frequency of the precession signal, the following equation is used to calculate the magnetic field:

$$F = \frac{2\pi f}{\gamma_p}$$

Example: For measured precession frequency of 2286.698 Hz:

$$F = \frac{2\pi(2286.698)}{2.675153362 \cdot 10^8} \text{ T}$$

$$F = 53{,}708.13 \text{ nT}$$

Useful constants can also be cited from the above equations. For example for converting from precession signal frequency to magnetic field:

$$C = \frac{2\pi}{\gamma_p}$$

$$C = 23.4871966 \frac{\text{nT}}{\text{Hz}}$$

$$F = Cf \text{ nT}$$

Another useful constant for converting from magnetic field to precession signal frequency is:

$$K = \frac{\gamma_p}{2\pi}$$

$$K = 4.257638811 \cdot 10^{-2} \frac{\text{Hz}}{\text{nT}}$$

$$f = KF \text{ Hz}$$

[1] IAGA: In 2010, the International Council for Science, Committee on Data for Science and Technology adopted a new value for the gyromagnetic constant. *See:* http://www.iugg.org/IAGA/iaga_pages/pubs_prods/value.htm .