(M1-6) Magnetic Field of a Helmholtz` Arrangement

Aim of experiment

1. Investigate the superposition of two individual fields to form the combined field of a pair of coils.
2. Measurement of the uniform spatial distribution of the field strength between a pair of coils in the Helmholtz arrangement.

Apparatus

Helmholtz Coil Arrangement- Power Supply- Ammeter- Tesla Meter- Ruler

Theory of experiment

The magnetic flux density, $B(z) = \mu_0 H$, H is the field strength along the z-axis of a circular conductor of radius, R, as shown in *Figure 1*, can be calculated using *Biot* and *Savart* law to be;

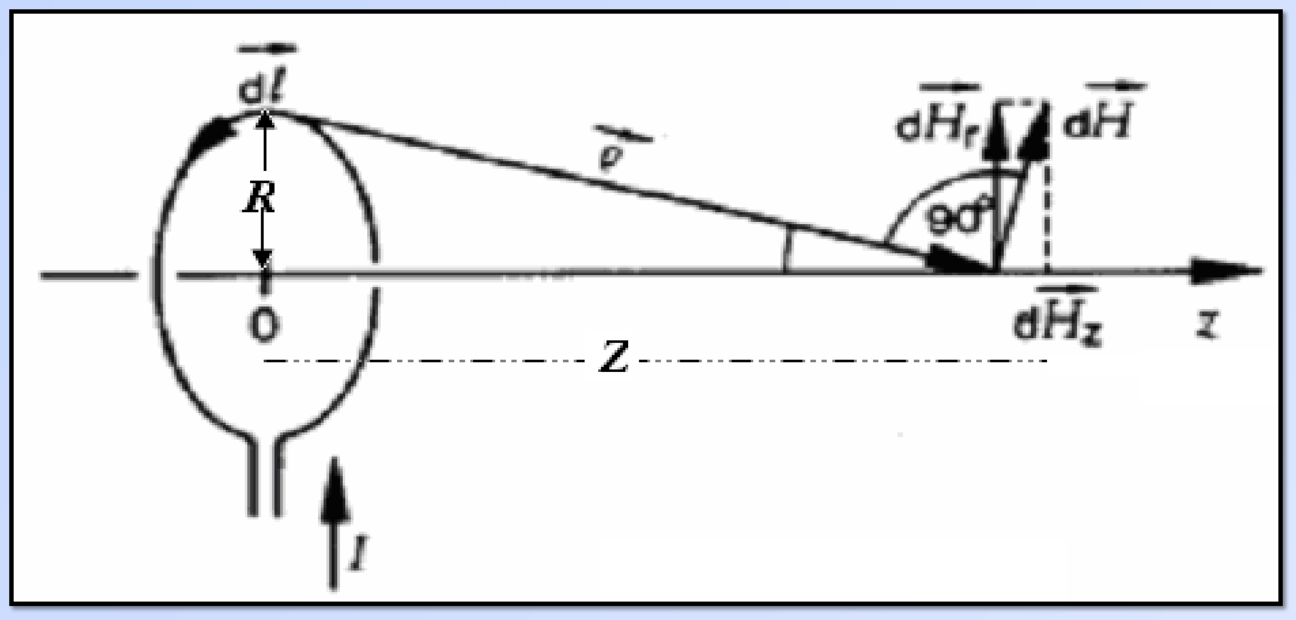

Figure 1. The field strength, along the axis of a wire loop.

$$B(z) = \frac{\mu_0 . IN}{2R} . \frac{1}{\left(1+\left(\frac{z}{R}\right)^2\right)^{3/2}}$$

where, N is the number of turns of the individual coil.

The magnetic flux density along the axis of two identical coils at a distance α apart is:

$$B(z, r=0) = \frac{\mu_0 IN}{2R} . \left[\frac{1}{\left(1+A_1^2\right)^{3/2}} + \frac{1}{\left(1+A_2^2\right)^{3/2}}\right]$$

where

$$A_1 = \frac{z+\alpha/2}{R}, \quad A_2 = \frac{z-\alpha/2}{R}$$

When $z=0$, i.e. at the origin of axis, the flux has a maximum value when $\alpha < R$ and a minimum value when $\alpha > R$, *Figure 3.*

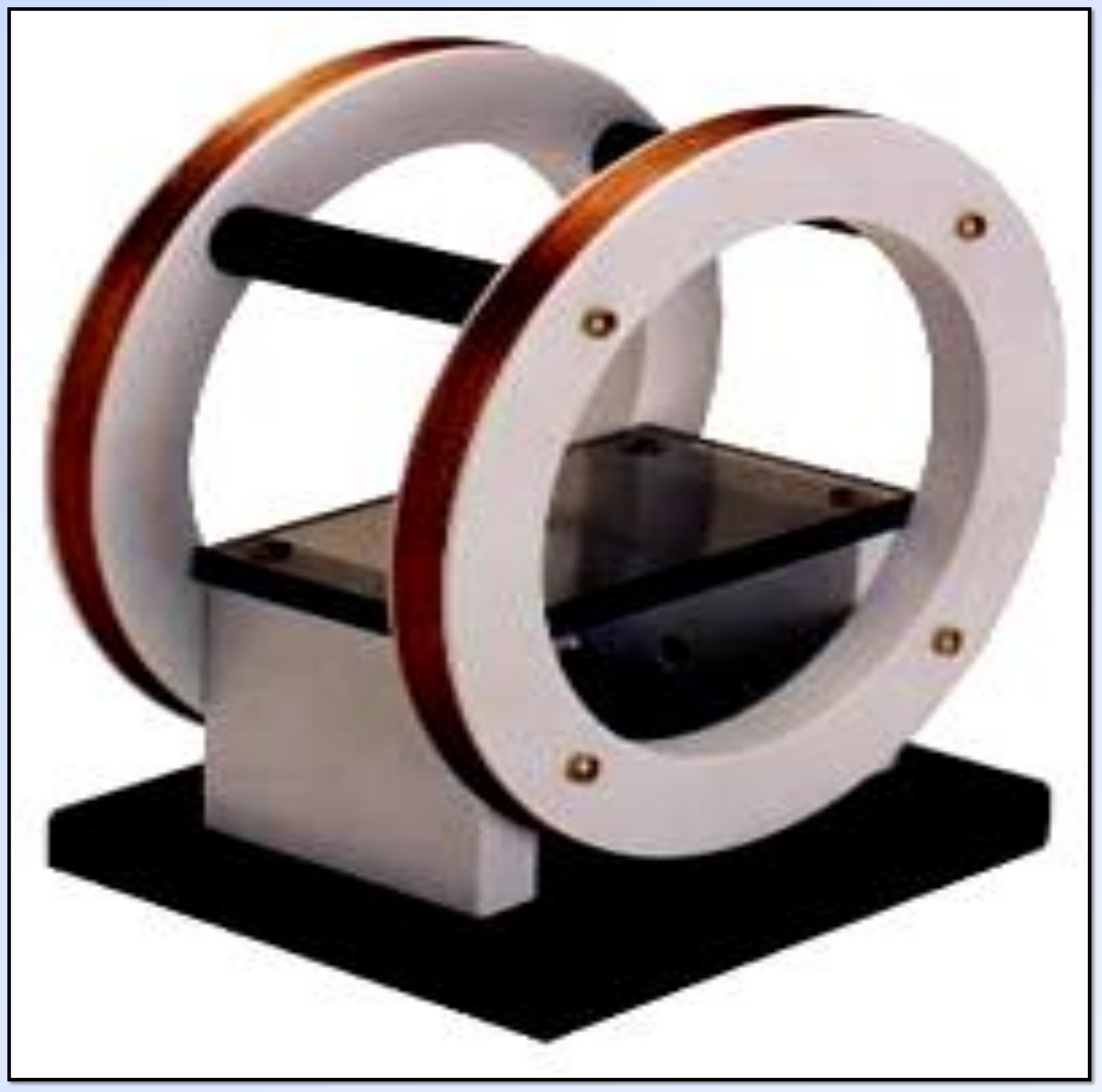

Figure 2. Helmholtz coils arrangement

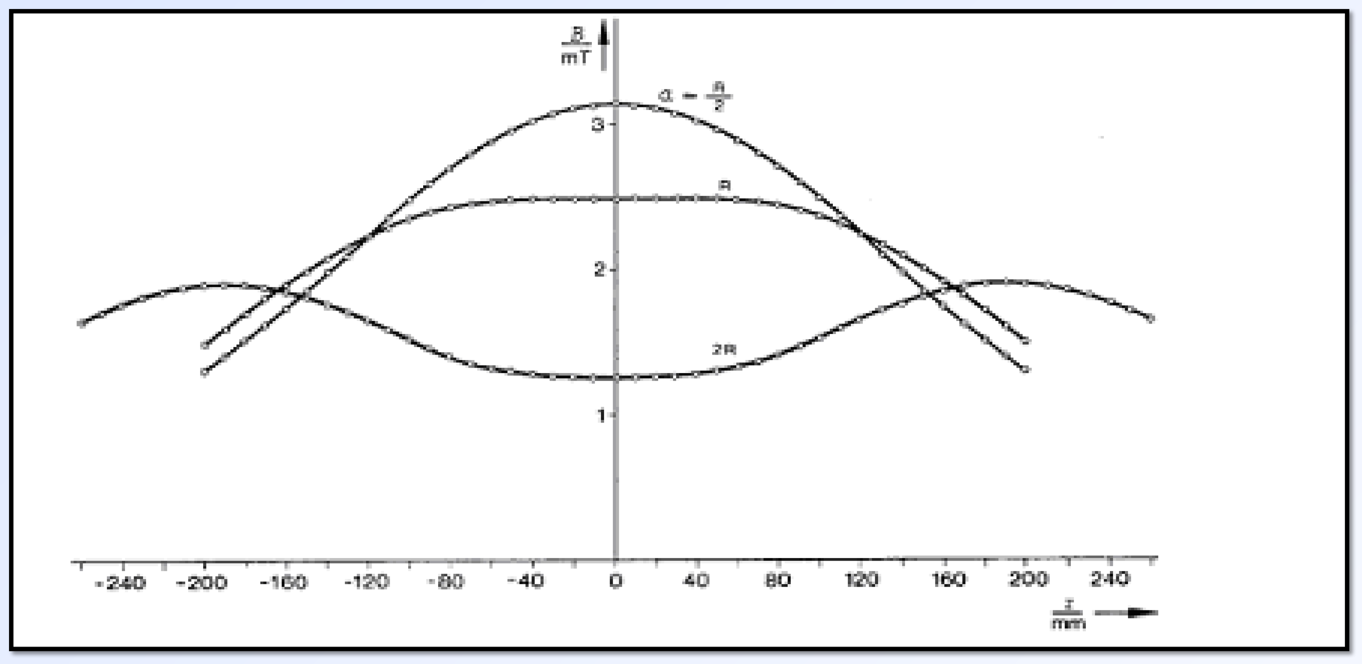

Figure 3. B (r = 0) as a function of z with different α parameters.

Figure 3 shows a typical distribution of B at three different values of α at $r = 0$, *i.e. along the coil axis,* with changing the distances along the Z direction.

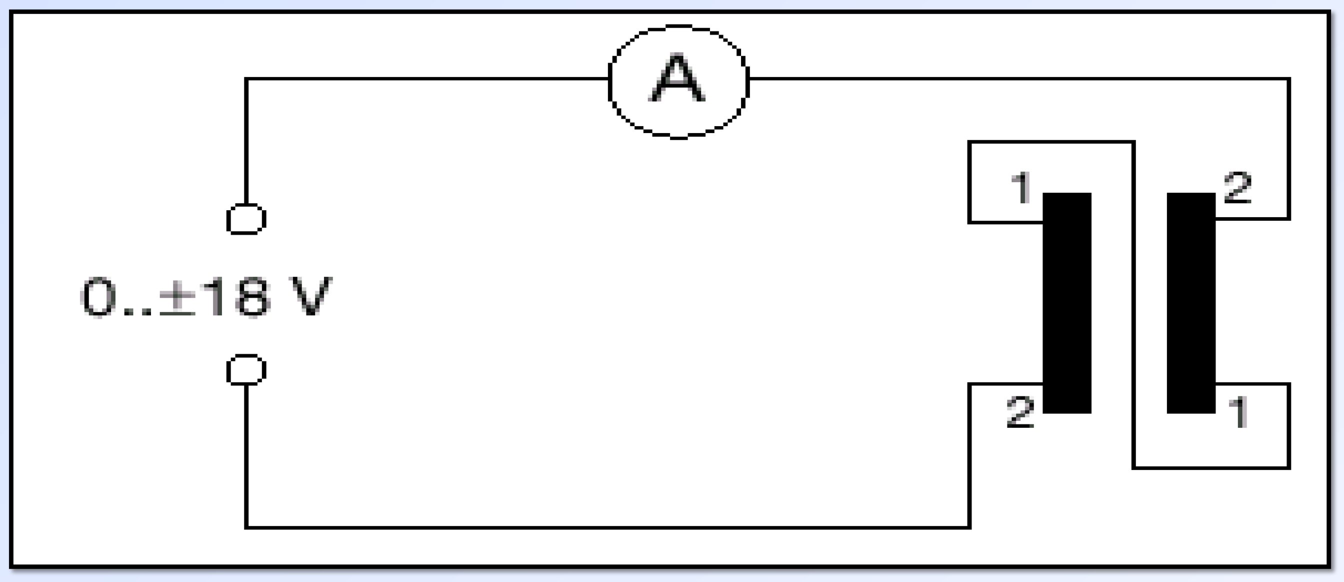

Figure 4. Wiring diagram of the Helmholtz coils

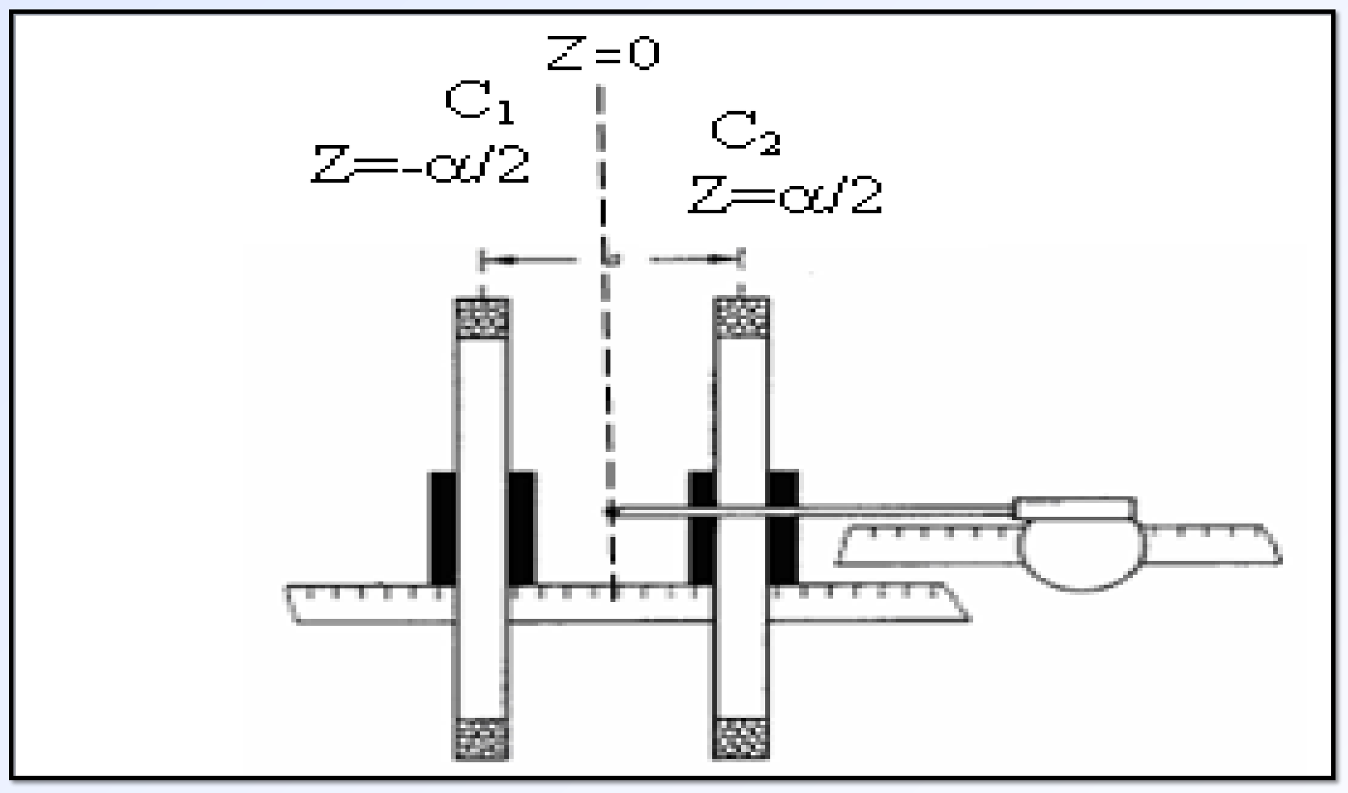

Figure 5. measuring B (z,r=0) at different distance α between the coils

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Procedure

1. Arrange the coils such that *α =R,* Helmholtz arrangement; *figures 4 and 5..*
2. Apply constant current *I* to the coils through out the experiment
3. Measure the magnetic field B_1 along the z-axis starting at $z = -\alpha/2$ i.e. at the center of the first coil C_1 , *figure 5,* to the center of the other coil, C_2; i.e. at $z = \alpha/2$ ..
4. Tabulate your results
5. Repeat above steps at $\alpha = 2R$ *and* $\alpha = R/2$
6. Draw the relation between *z* and $B_1(z)$, $B_2(z)$, $B_3(z)$
7. Comment on these results

Results

z(m)	$B_1(T)$	*z(m)*	$B_2(T)$	*z(m)*	$B_3(T)$
$-\alpha/2 =$		$-\alpha$		$-\alpha/4=$	
$\alpha/2=$		$\alpha =$		$\alpha/4=$	