Vienna University of Technology

Faculty of Physics

Laboratory III

Laboratory Report

Electron Spin Resonance

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conducted on:
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1 Resonanceabsorbtion of a passive HF-Osscilator

1.1 Setup

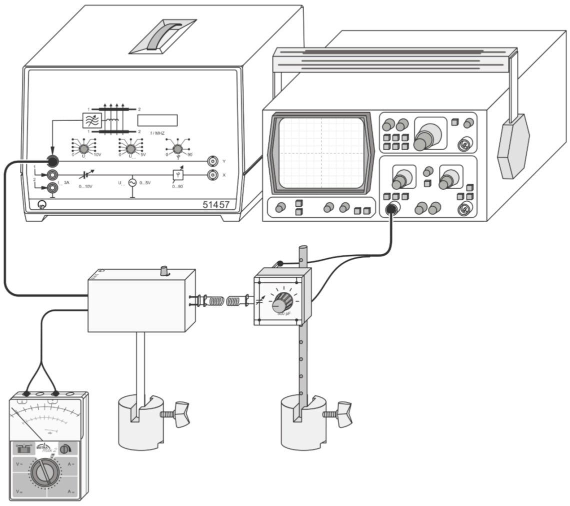

Figure 1: Experimental setup

- Connect the ESR base unit to the ESR operating unit via a 6-pin cable and set the rotary potentiometer to maximum sensitivity.
- Plug in the 30–75 MHz plug-in coil and connect the ammeter to output I via an adapter cable (measurement range 100 µA).
- Position the coil of the passive resonant circuit coaxially opposite the plug-in coil and connect via a BNC/4 mm measurement cable to channel I of the dual-channel oscilloscope.

1.2 Procedure

- Set the variable capacitor of the passive resonant circuit to position Skt. = 3/6.
- Adjust the minimum frequency on the ESR base unit.
- At the operating frequency, measure and record:
  - the frequency,
  - the voltage U_2 of the “passive” coil on the oscilloscope,
  - and the voltage $U_1 = 56\mathrm{k}\Omega \cdot I_1$ of the RF coil.
- Increase the frequency stepwise and repeat the measurement.
- Perform additional measurement series with Skt. = 2/6 and 1/6.
- Remove the passive resonant circuit and record another measurement series.

1.3 Measurement values

freq / MHz	U_2 / V
11.5	1
12	1.01
12.5	1.15
13	1.2
13.5	1.4
14	1.6
14.5	1.8
15	2.2
15.5	2.35
16	2.2
16.5	2
17	1.8
17.5	1.25
18	1
18.5	0.8
19	0.7

Table 1: Tab. 1: Spannungen U_2 und U_1 bei Skt. = 3/6

freq / MHz	U_2 / V
11.5	0.8
12.5	0.85
13.5	0.9
14.5	0.97
15.5	1.05
16.5	1.2
17	1.3
17.5	1.4
18	1.5
18.5	1.6
19	1.7
19.5	1.6
20	1.5
20.5	1.35
21	0.95
21.5	0.8

Table 2: Tab. 2: Spannungen U_2 und U_1 bei Skt. = 2/6

freq / MHz	U_2 / V
18	0.75
19	0.8
20	0.85
21	0.9
22	0.95
23	1
23.5	1.05
24	1.1
24.5	1.15
25	1.1
25.5	1.05
26	1
26.5	0.95
27	0.9
27.5	0.8

Table 3: Tab. 3: Spannungen U_2 und U_1 bei Skt. = 1/6

Es konnte ebenso die Messreihe mit keinem passiven nicht durchgeführt werden!

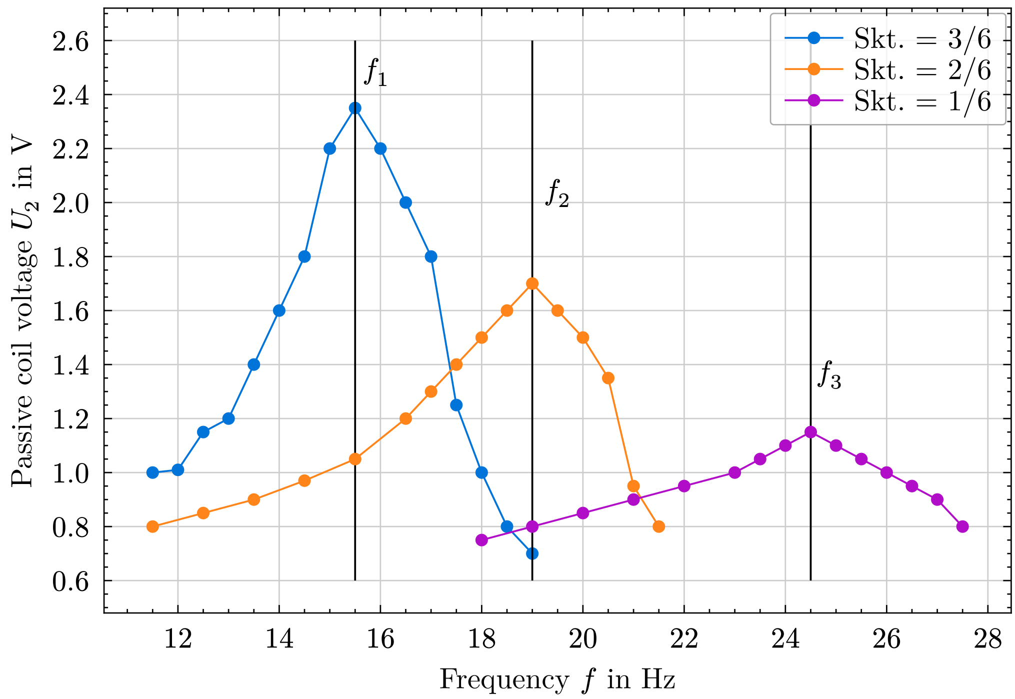

Figure 2: The resonance frequencies f_n can be determined by measuring voltage peaks in the passive coil voltage $U_2(f)$. The measurement apparatus for the current through the active coil was broken. Thus, the active voltage $U_1(f)$ couldn't be determined. It would usually correspond to a damped oscillation thus creating corresponding local minima in U_1 at the same resonace frequencies

1.4 Data

2 Electronspinresonance on DPPH

2.1 Setup

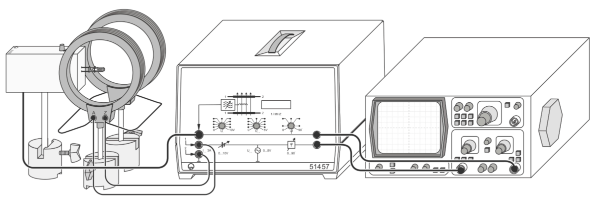

Figure 3: Experimental setup

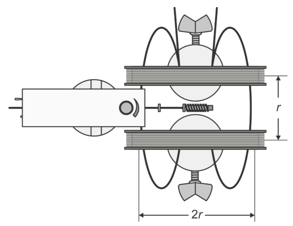

Figure 4: Experimental setup

The experimental setup is shown in Fig. 4 and 5.

- Place the Helmholtz coils parallel to each other at a center distance of 6.8 cm (equal to the mean radius r).
- Connect both Helmholtz coils in series with the ammeter to the ESR operating unit.
- Connect the ESR base unit to the ESR operating unit via a 6-pin cable.
- Connect output Y of the ESR operating unit via a BNC cable to channel I of the dual-channel oscilloscope, and output X to channel II.

2.2 Procedure

Determination of the Resonance Magnetic Field B_0

- Insert the 15–30 MHz plug-in coil and place the DPPH sample centrally.
- Switch on the ESR base unit and position it so that the plug-in coil with DPPH sample is in the center of the Helmholtz-coil pair (see Fig. 5).
- Set the resonance frequency $\nu = 15$ MHz.
- Set the modulation amplitude U_{mod} to the second scale division.
- Set the phase shift to 0°.
- Operate the oscilloscope in dual-channel mode:
  - Dual on
  - Time base $2\frac{\text{ms}}{\text{cm}}$
  - Amplitude I and II $0.5\frac{\text{V}}{\text{cm}}$ AC
- Slowly increase the DC voltage U_0 to the Helmholtz coils until the resonance signals are equidistant (see Fig. 6).
- Switch the oscilloscope to XY mode and adjust the phase shift so that the two resonance peaks coincide (see Fig. 3).
- Vary U_0 until the resonance signal is symmetric, keeping the modulation voltage as low as possible.
- Measure the DC current $2I_0$ through the Helmholtz-coil pair and record it together with the resonance frequency ν.
- Increase ν by 5 MHz and adjust U_0 to reestablish resonance.
- Again measure and record the current $2I_0$.
- Continue raising ν in 5 MHz steps (switch to the 30–75 MHz coil at 30 MHz, and to the 75–130 MHz coil at 75 MHz) and repeat the measurements.

Determination of the Half-Width δB_0

- Operate the oscilloscope in XY mode:
  - Amplitude II $0.5\frac{\text{V}}{\text{cm}}$ AC
- Reestablish the resonance condition for $\nu = 50$ MHz (middle plug-in coil).

- Vary the modulation voltage U_{mod} until the resonance trace spans the full screen width (10 cm) in the X-direction.
- Switch the ammeter to AC mode and measure the effective current $2I_{\text{mod}}$ corresponding to U_{mod}.
- Increase the X-deflection, read off the width ΔU of the resonance peak at half its height, and record it.

2.3 Measurement values

ν / MHz	$2\,I_0$ / A	Steckspule
30	0.53	middle
35	0.63	middle
40	0.71	middle
45	0.79	middle
50	0.89	middle
55	0.97	middle
60	1.06	middle
65	1.15	middle
70	1.23	middle
75	1.33	middle
80	1.41	middle
80	1.53	small
90	1.65	small
95	1.67	small
100	1.7	small
105	1.74	small
110	1.79	small
115	2.05	small
120	2.16	small

Table 4: Tab. 1: Stromstärke $2I_0$ in Abhängigkeit von der Frequenz ν des Wechselfeldes

ν / MHz	B_0 / mT
30	1.12
35	1.33
40	1.5
45	1.67
50	1.88
55	2.05
60	2.24
65	2.43
70	2.6
75	2.81
80	2.98
80	3.24
90	3.49
95	3.53
100	3.6
105	3.68
110	3.79
115	4.34
120	4.57

Table 5: Tab. 2: Magnetfeld B_0 in Abhängigkeit von der Frequenz ν des Wechselfeldes

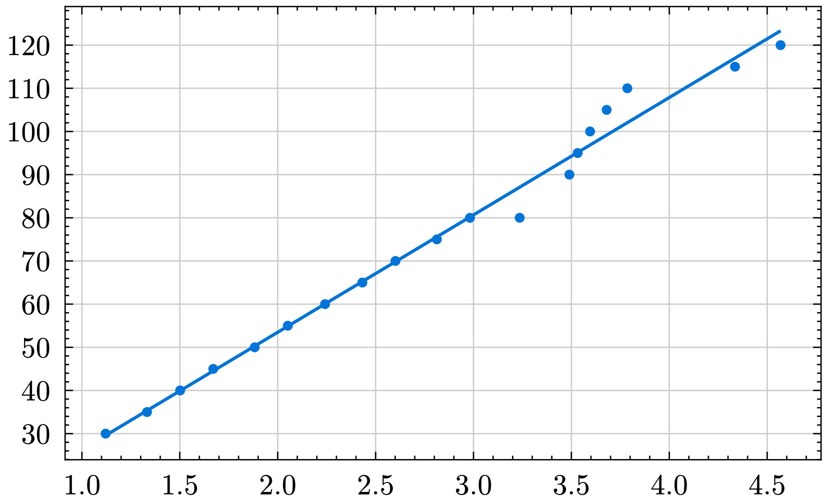

Figure 5: Some Caption

Abgelesene halbwertsbreite:

$\delta U = 0.95$V

$\delta I = 0.078$A

$\delta B_0 = 0.33$ mT

Slope: 27.19 $\frac{\text{MHz}}{\text{mT}}$

Gfactor:

$g = 1.9426$

from literature:

$g = 2,0036$

2.4 Data