Karlsruher Institut für Technologie

Superconductivity for Engineers

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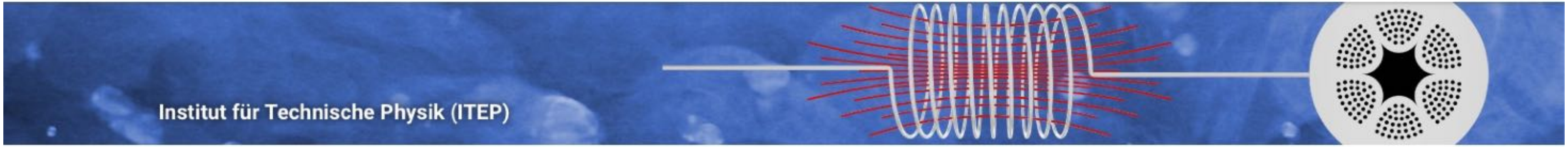
Summer term 2021



(Preliminary) Schedule

Karlsruher Institut für Technologie

	Day	Date	Lecture / Tutorial	Day	Date	Lecture / Tutorial
1	Mon	21-04-12	Lecture 1 (SK)	Wed	21-04-14	
2	Mon	21-04-19	Lecture 2 (BH)	Wed	21-04-21	
3	Mon	21-04-26	Lecture 3 (SK)	Wed	21-04-28	Tutorial 1 (IMS)
4	Mon	21-05-03	Lecture 4 (SK)	Wed	21-05-05	
5	Mon	21-05-10	Lecture 5 (SK)	Wed	21-05-12	~~Tutorial 2 (IMS)~~
6	Mon	21-05-17	Lecture 6 (SK)	Wed	21-05-19	Tutorial 2 (IMS)
7	Mon	21-05-24	---	Wed	21-05-26	
8	Mon	21-05-31	Lecture 7 (BH)	Wed	21-06-02	Tutorial 3 (IMS)
9	Mon	21-06-07	Lecture 8 (BH)	Wed	21-06-09	Tutorial 4 (ITEP)
10	Mon	21-06-14	Lecture 9 (BH)	Wed	21-06-16	
11	Mon	21-06-21	Lecture 10 (BH)	Wed	21-06-23	Tutorial 5 (ITEP)
12	Mon	21-06-28	Lecture 11 (BH)	Wed	21-06-30	
13	Mon	21-07-05	Lecture 12 (BH)	Wed	21-07-07	Tutorial 6 (ITEP)
14	Mon	21-07-12	Lecture 13 (SK)	Wed	21-07-14	
15	Mon	21-07-19	Lecture 14 (SK)	Wed	21-07-21	Tutorial 7 (IMS, ITEP)

(Preliminary) Lecture content

Lecture 1:	(SK)	Introduction and overview
Lecture 2:	(BH)	Superconductor applications
Lecture 3:	(SK)	Normal metals and properties of the normal conducting state
Lecture 4:	(SK)	Perfect conductor, ideal diamagnetism, Two-Fluid-Model, London theory
Lecture 5:	(SK)	Disordered superconductors, Pippard theory, microwave properties
Lecture 6:	(SK)	BCS theory
Lecture 7:	(BH)	Ginzburg-Landau theory
Lecture 8:	(BH)	Typ-I superconductors
Lecture 9:	(BH)	Typ-II superconductors
Lecture 10:	(BH)	Typ-II superconductors
Lecture 11:	(BH)	Current transport, ac-losses, thermal aspects
Lecture 12:	(BH)	Current transport, ac-losses, thermal aspects
Lecture 13:	(SK)	Josephson junctions and SQUIDs
Lecture 14:	(SK)	Josephson junctions and SQUIDs

Reminder: London equations

Reminder: Magnetic field penetration

London gauge

Gauge invariance

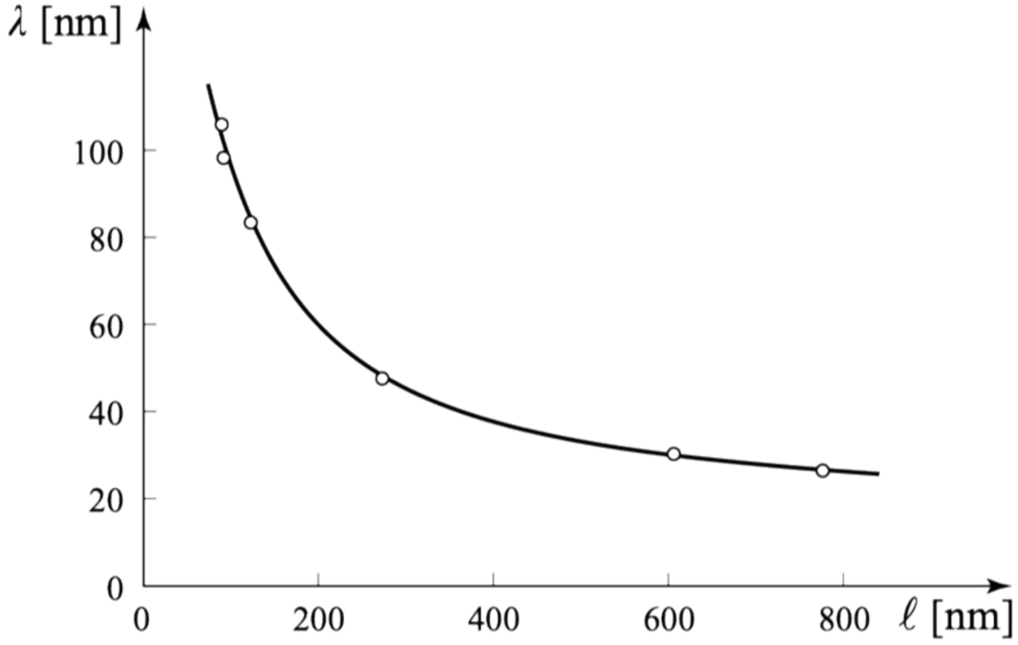
London gauge

Second London equation in the London gauge

Pippard‘s penetration depth measurements

Pippard‘s penetration depth measurements

Pippard‘s penetration depth measurements



Normal and anomalous skin effect

Pippard theory

Penetration depth of the magnetic field

Penetration depth of the magnetic field

Penetration depth of the magnetic field

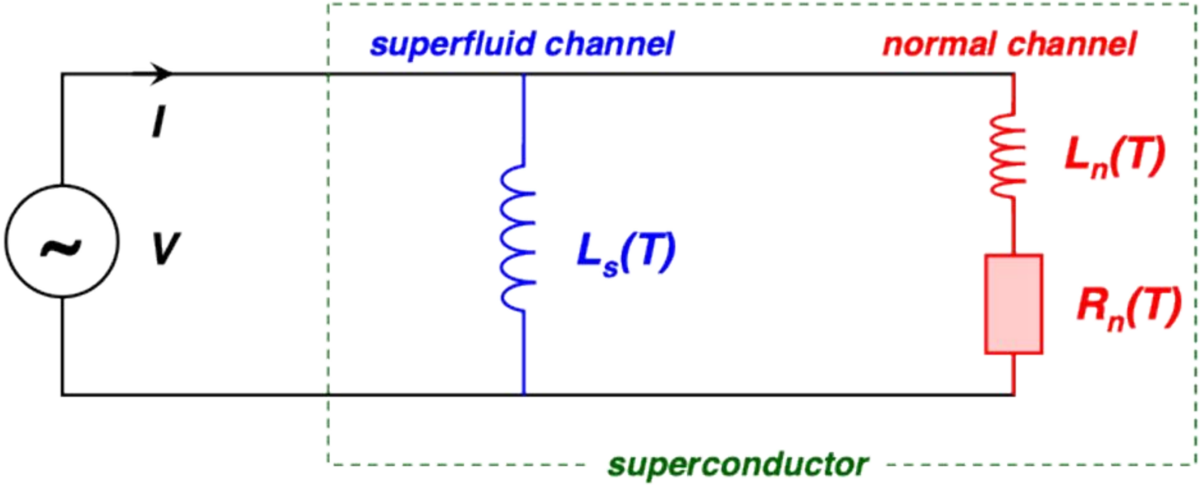
Dirty superconductors

Pippard length

High frequency properties of superconductors

High frequency properties of superconductors

Equivalent circuit

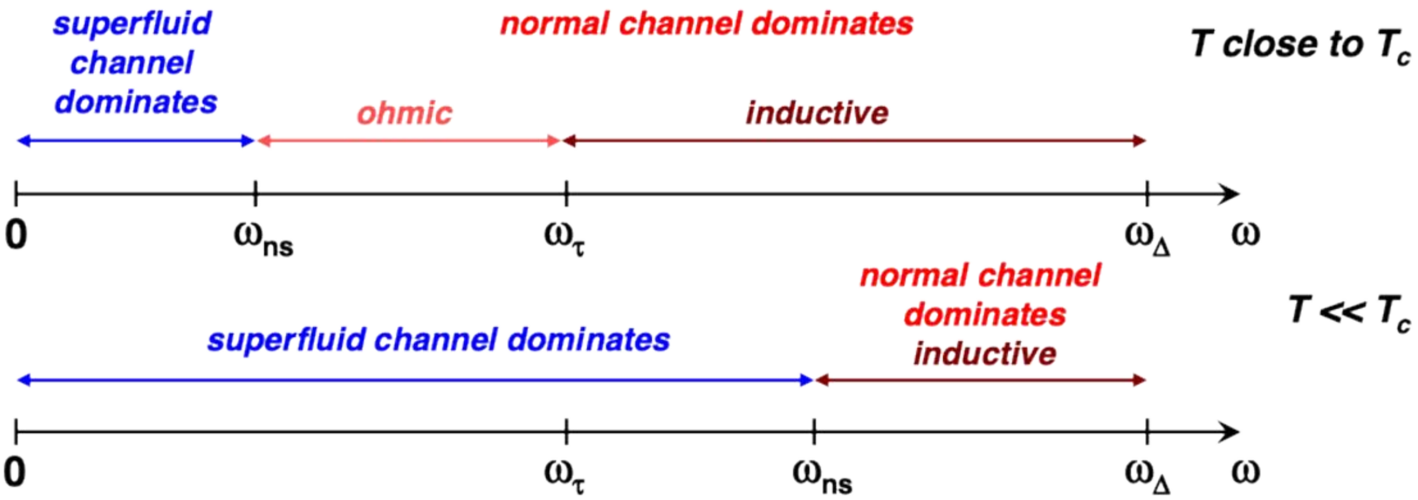


Characteristic frequency regimes

Characteristic frequency regimes

Temperature dependence

Characteristic frequency regimes



Conductivity of a superconductor

Surface impedance

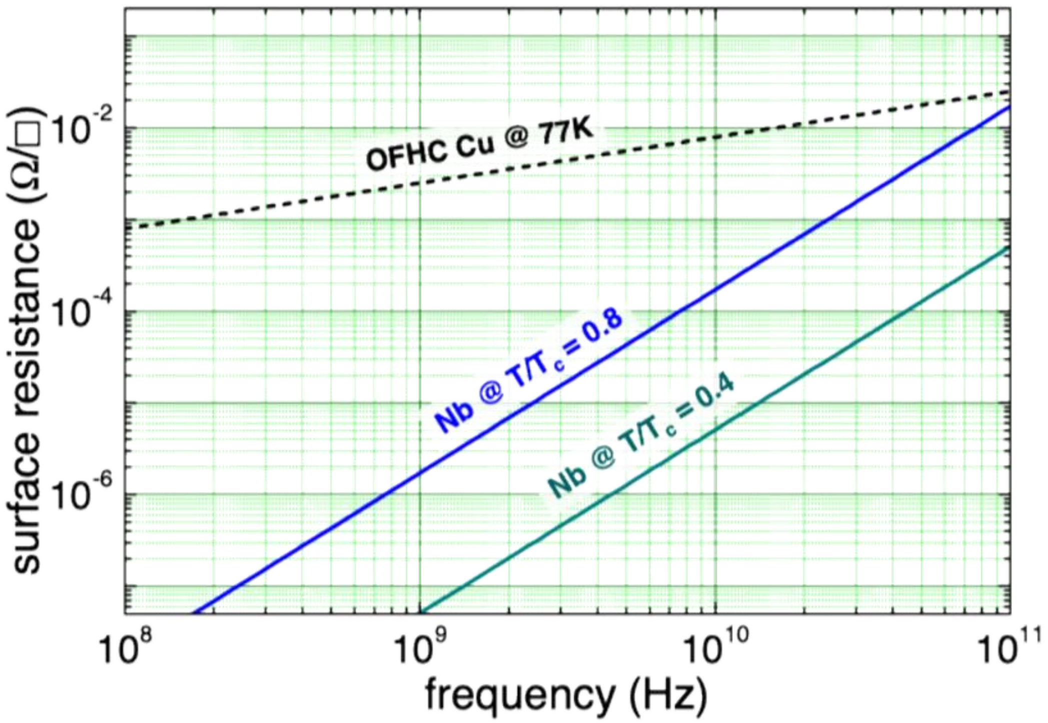
Surface impedance

Surface impedance

Normal conductor vs. superconductor

	normal conductor	superconductor
conductivity	$\sigma_0 = \frac{ne^2\tau}{m_n^\star}$	$\sigma_1 + \imath\sigma_2 = \frac{ne^2\tau}{m_n^\star}\left(\frac{n_n}{n}\right) - \imath\frac{1}{\omega\mu_0\lambda_L^2}$
field penetration depth	$\delta_0 = \sqrt{2/\omega\mu_0\sigma_0}$	$\delta_s = \lambda_L$
surface resistance	$R_s = \frac{1}{2}\omega\mu_0\delta_0 = \sqrt{\frac{\omega\mu_0}{2\sigma_0}}$	$R_s = \frac{1}{2}\omega^2\mu_0^2\lambda_L^3\sigma_0\left(\frac{n_n}{n}\right)$
surface reactance	$X_s = \frac{1}{2}\omega\mu_0\delta_0 = \sqrt{\frac{\omega\mu_0}{2\sigma_0}}$	$X_s = \omega\mu_0\lambda_L$

Comparison of surface resistance



Kinetic inductance

Superconducting resonators and filters