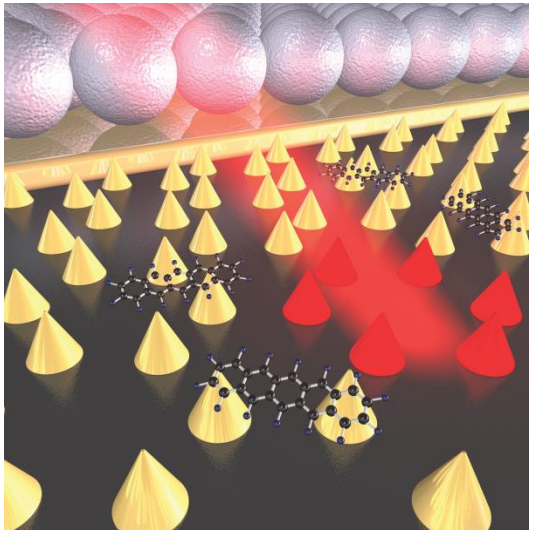
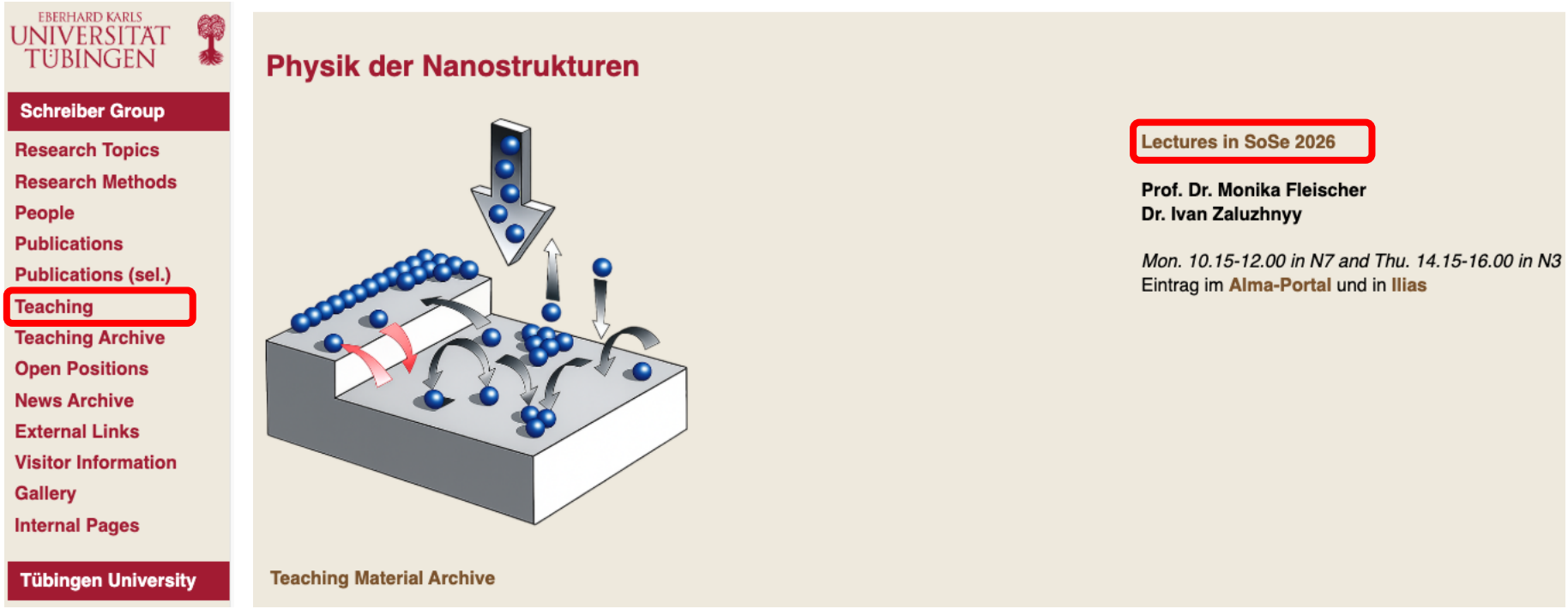
Basic module
Physics of Nanostructures

Summer term 2026



M. Fleischer, I. Zaluzhnyy,
Excercises: R. Löffler

Additional content



www.soft-matter.uni-tuebingen.de ➔ teaching

Additional content

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Schreiber Group

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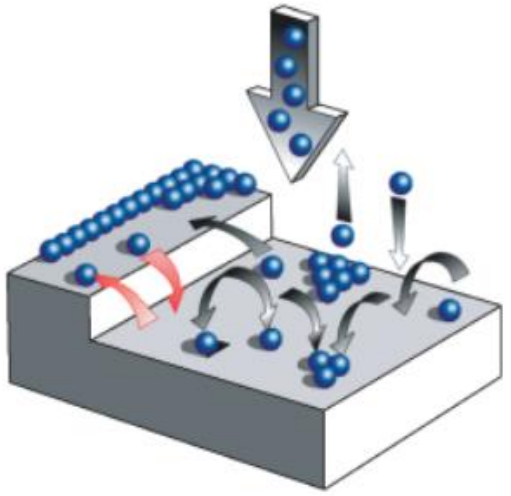
Physics of Nanostructures

Prof. Dr. Monika Fleischer
Dr. Ivan Zaluzhnyy

Mon. 10.15-12.00 in N7
Thu. 14.15-16.00 in N3

Links to **Alma-Portal** and **ILIAS**



Materials for the lectures

(complete list of materials for the whole course is posted on ILIAS)

Superconductivity

Magnetism

Preparation

- Script
- Presentation
- Lecture notes

Characterization

- Script
- Presentation
- Lecture notes

login: `soft`
password: `soft07`

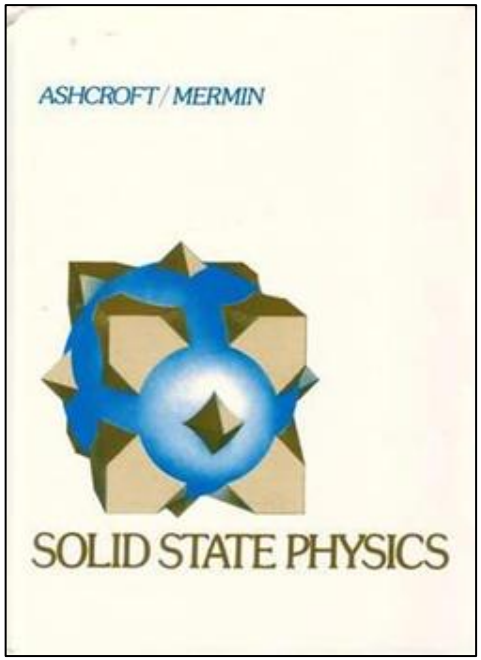
Literature

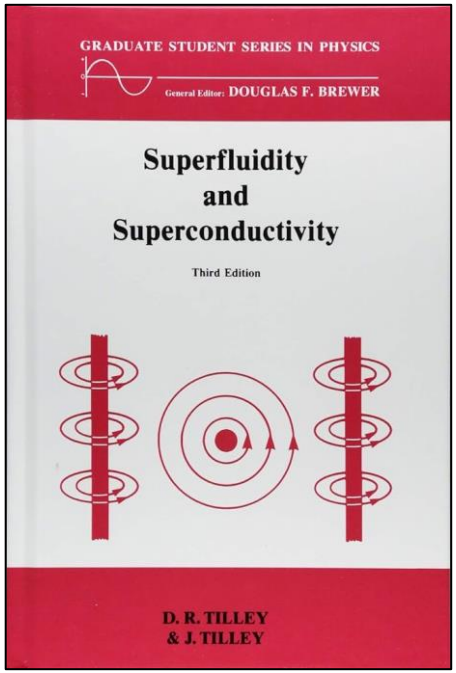
N. Ashcroft and N.D. Mermin, *Solid State Physics*, 1976

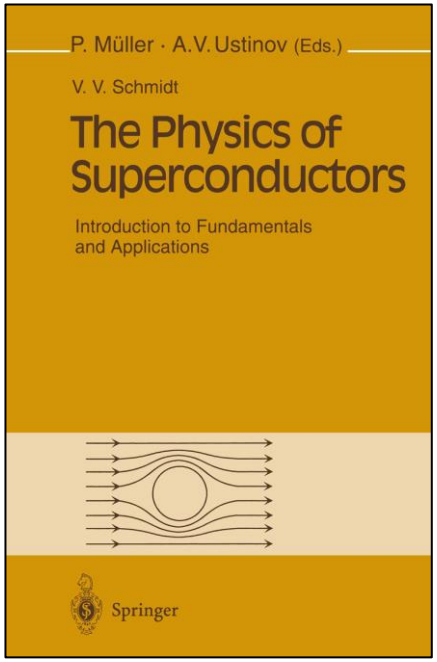
D.R. Tilley and J. Tilley, *Superfluidity and superconductivity,* 1986

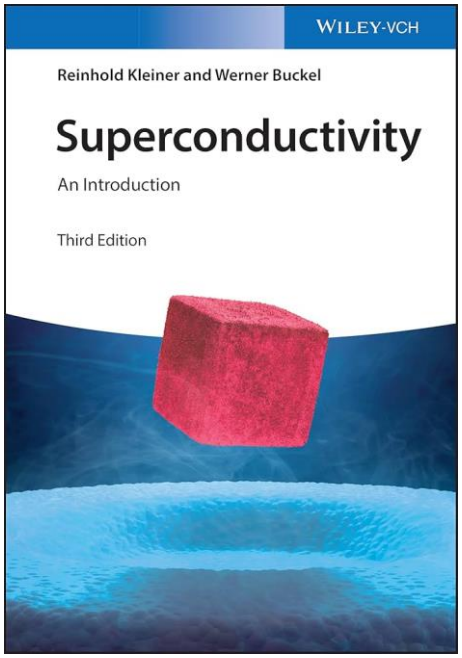
V.V. Schmidt, *The Physics of Superconductors*, 1997

R. Kleiner and W. Buckel, *Superconductivity,* 2015









Intermediate state

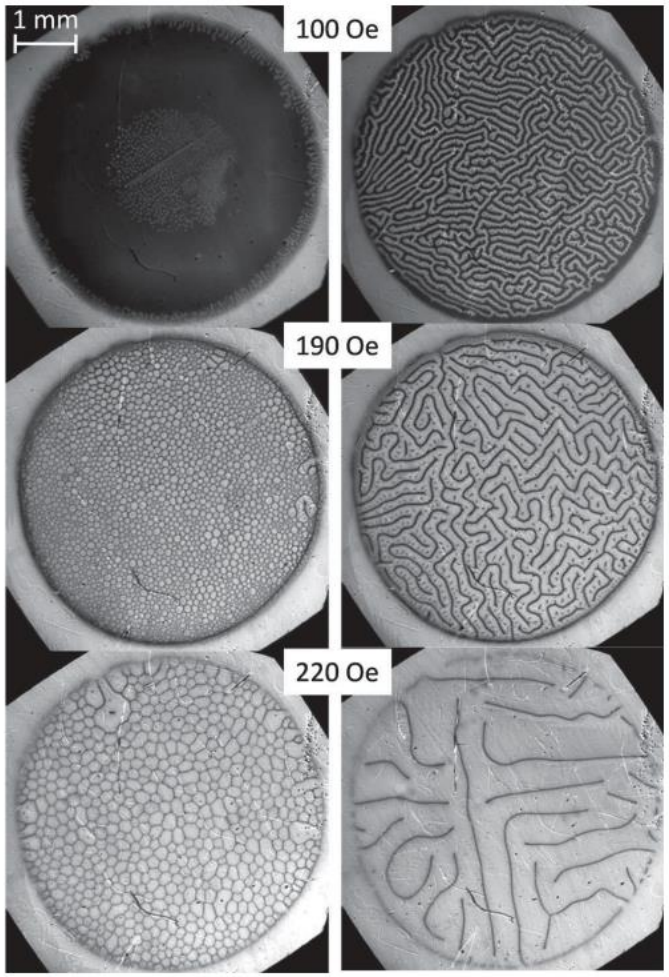


FIG. 2. Structure of the intermediate state in a disc-shaped Pb single crystal at 5 K. Left column—increasing magnetic field after ZFC. Right column—decreasing field.

R. Pozorov, *Phys. Rev. Lett.* ***98****, 257001 (2007)*

Mixed state

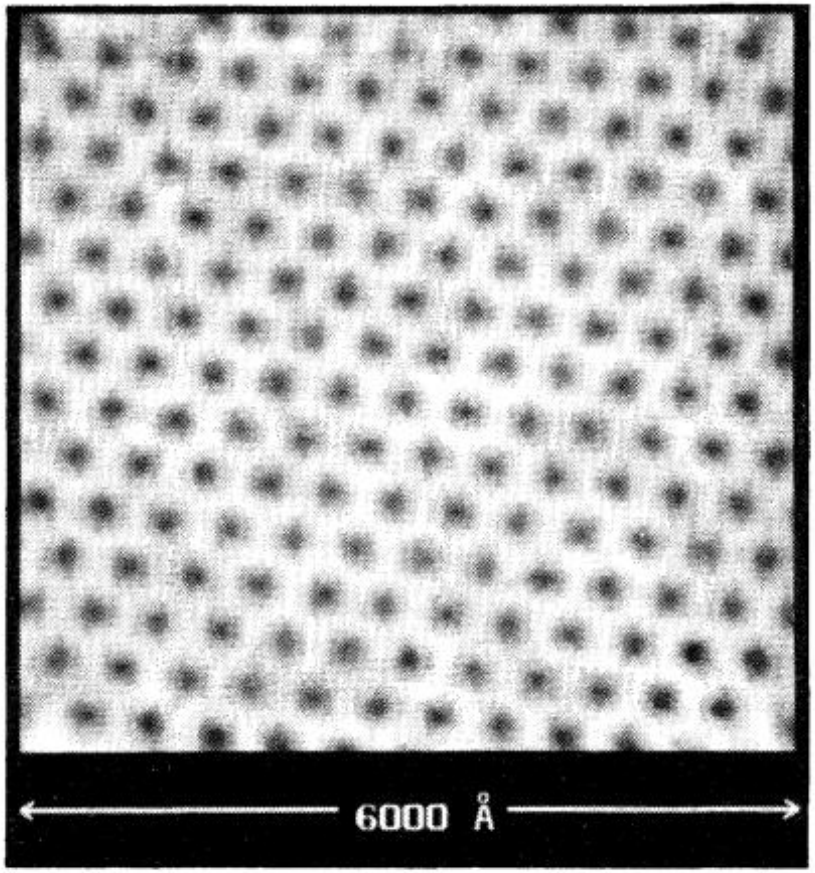


FIG. 2. Abrikosov flux lattice produced by a 1-T magnetic field in $NbSe_2$ at 1.8 K. The scan range is about 6000 Å. The gray scale corresponds to dI/dV ranging from approximately 1×10^{-8} mho (black) to 1.5×10^{-9} mho (white).

H.F. Hess et al., *Phys. Rev. Lett.* ***62****, 214 (1989)*

Mixed state

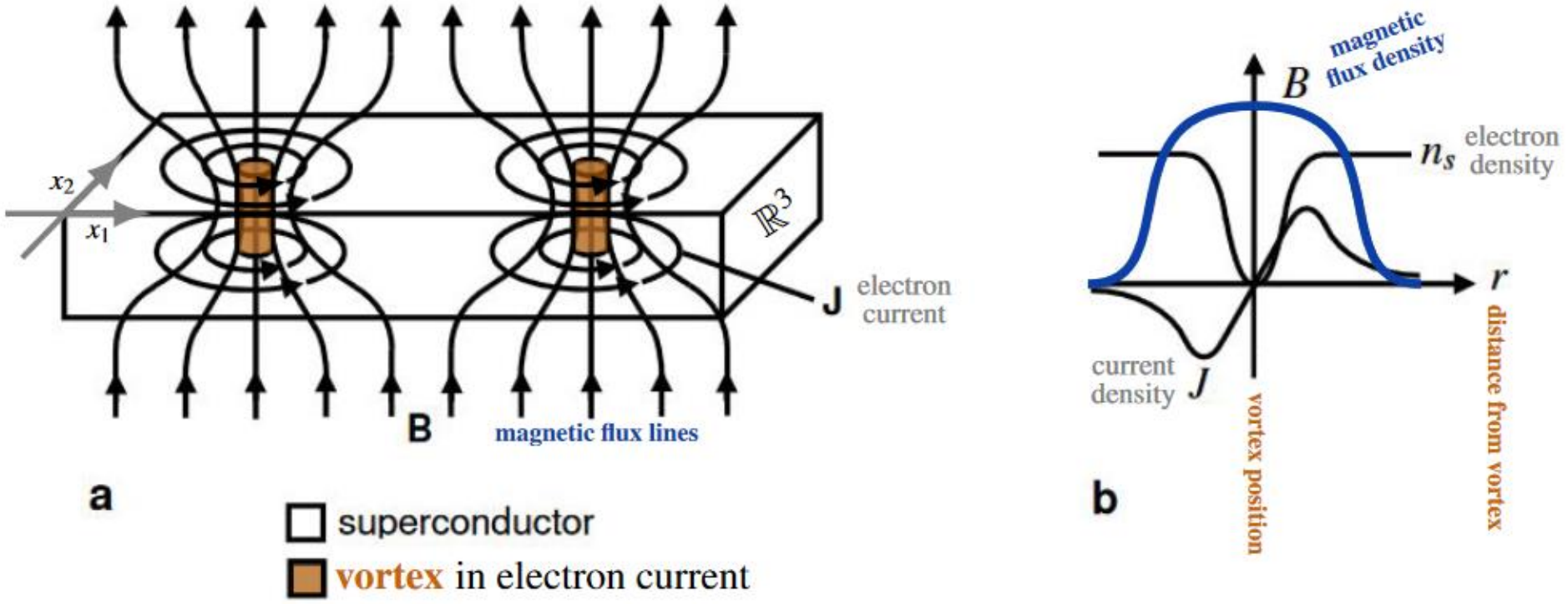
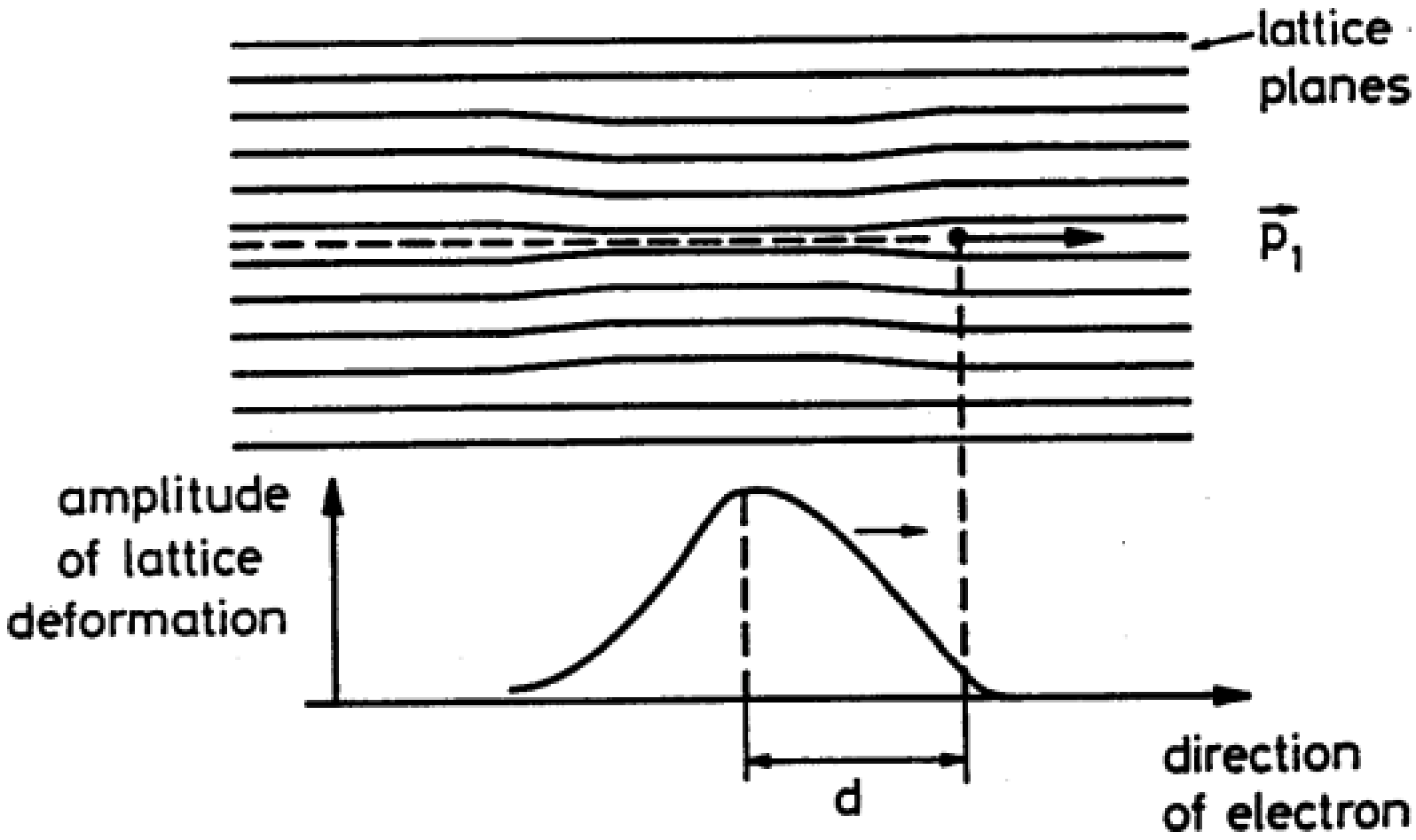


Figure 1: (a) Schematic diagram showing magnetic flux penetrating a superconductor via flux vortices. (b) Schematic cross section showing the B-field, number density of electrons contributing to superconductivity, n_s and supercurrent J as a function of distance r from the centre of a vortex.

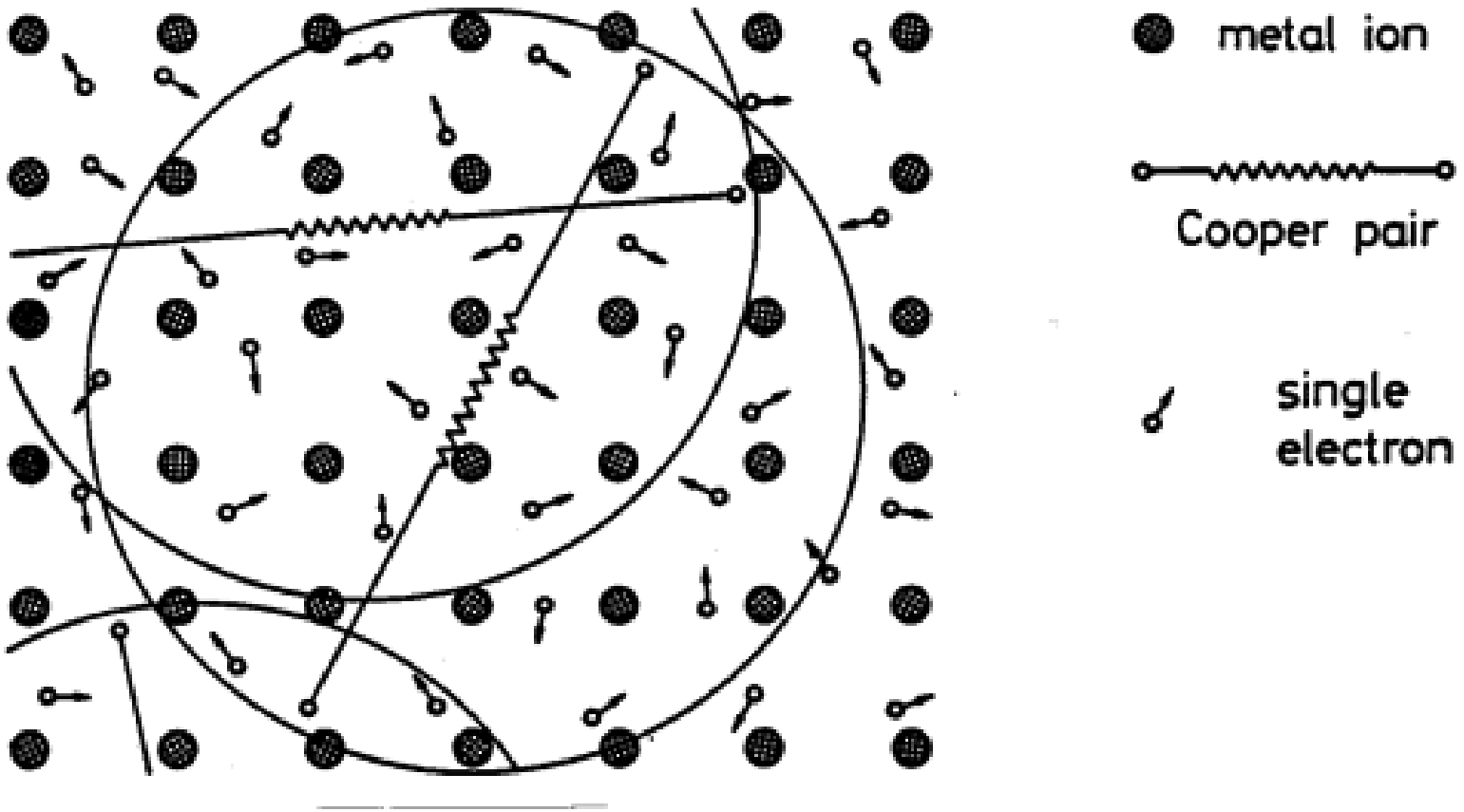
J.C. Loudon and P.A. Midgley, *Ultramicroscopy* ***109****, 700-729 (2009)*

Attraction of electrons



H. Ibach and H. Luth, ”Solid State Physics”, 1996

Cooper pairs



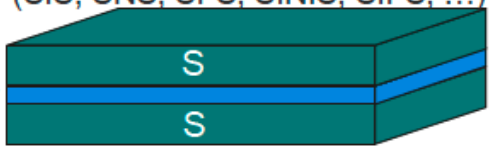
U. Essmann and H. Trauble, Phys. Lett. **24A**, 526 (1967)

Josephson junctions

Types of Josephson junctions (JJs)

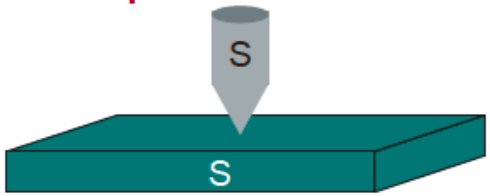
(a) **planar sandwich-type JJ**

(SIS, SNS, SFS, SINIS, SIFS, …)



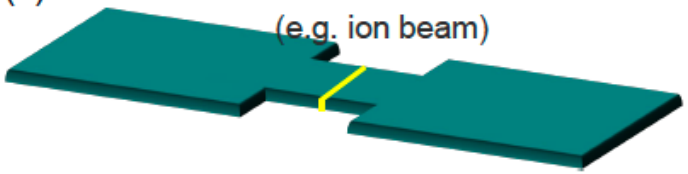
insulator (I), normal conductor (N), ferromagnet (F)

point contact (b)



(c) **irradiation-induced barrier JJ**

(e.g. ion beam)

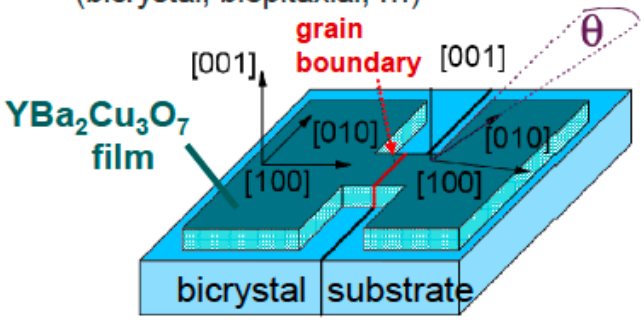


constriction junction (d)

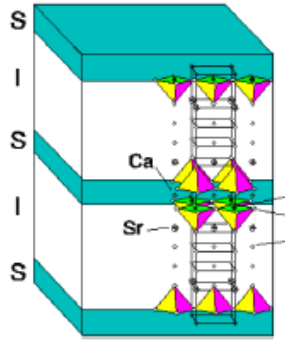
(Dayem bridge)

(e) **grain boundary junction (cuprates)**

(bicrystal, biepitaxial, …)



intrinsic Josephson junctions (f)



(strongly anisotropic cuprates)

$Bi_2Sr_2CaCu_2O_8$