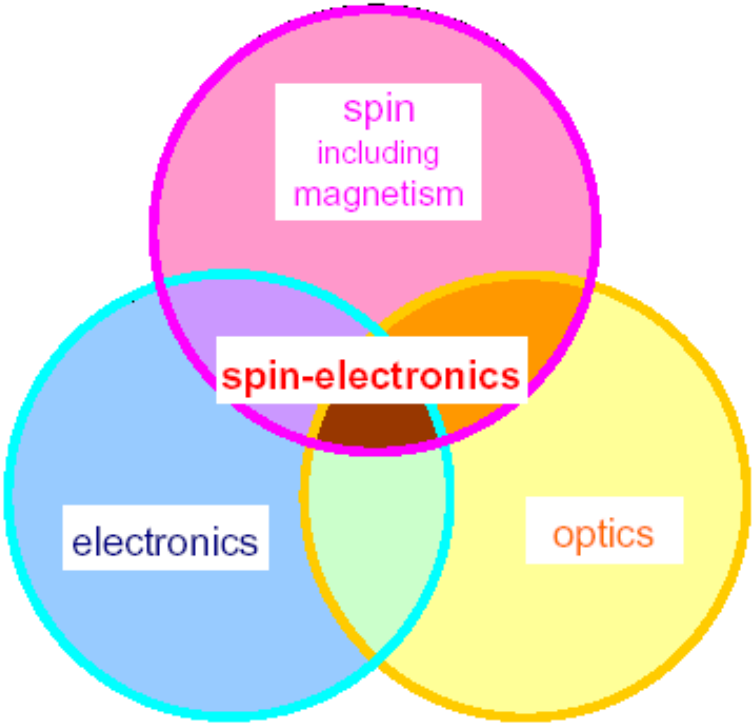
DMS based spintronics

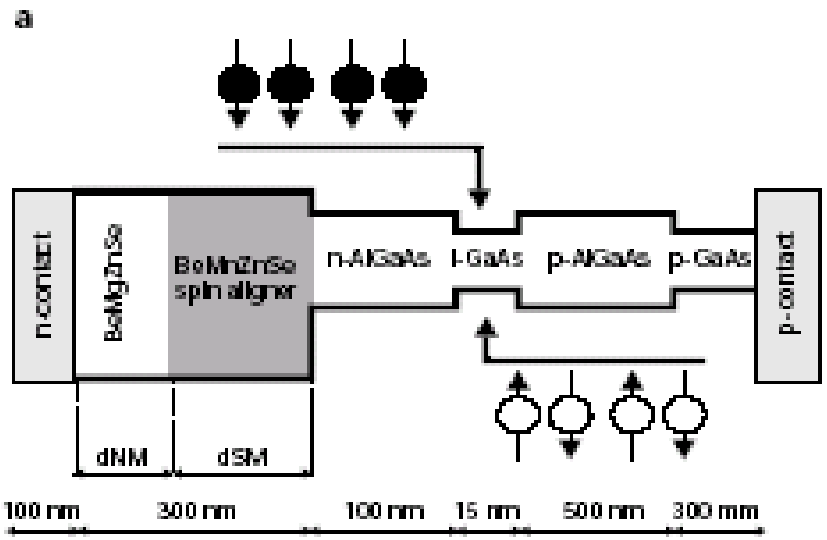


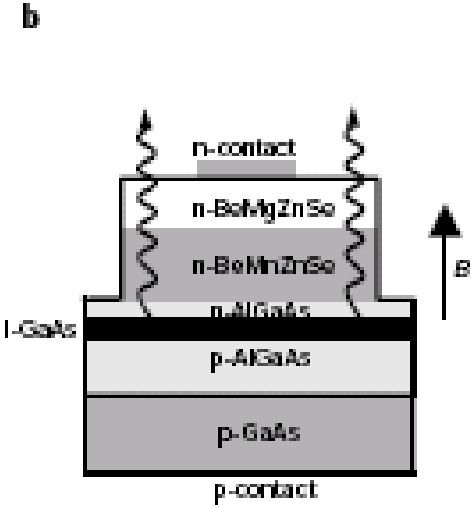
Injection and detection of a spin-polarized current in a light-emitting diode

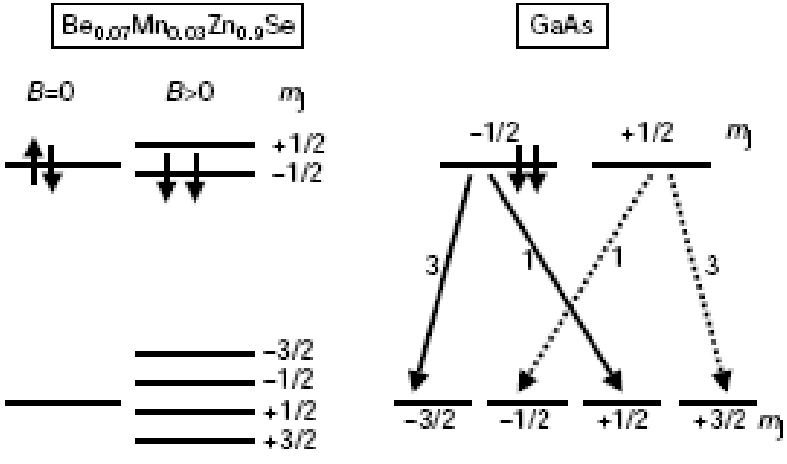
Nature 402, p787 (1999)

R. Fiederling, M. Keim, G. Reuscher, W. Ossau, G. Schmidt, A. Waag & L. W. Molenkamp

Physikalisches Institut, EP III, Universität Würzburg, 97074 Würzburg, Germany







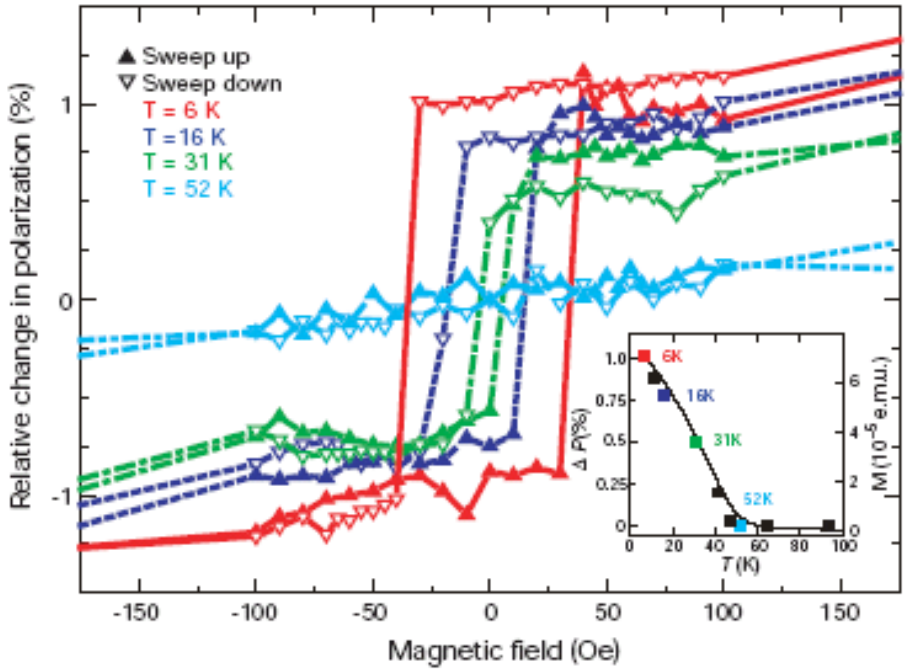
Electrical spin injection in a ferromagnetic semiconductor heterostructure

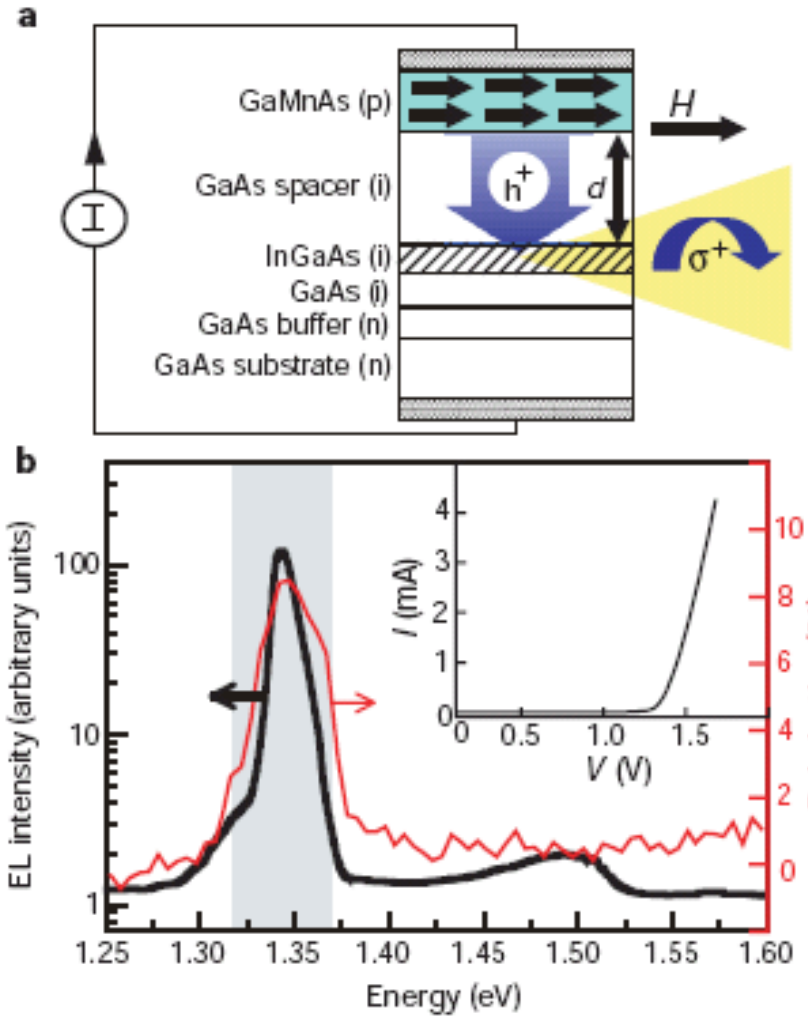
Y. Ohno*, D. K. Young†, B. Beschoten†, F. Matsukura*, H. Ohno* & D. D. Awschalom†

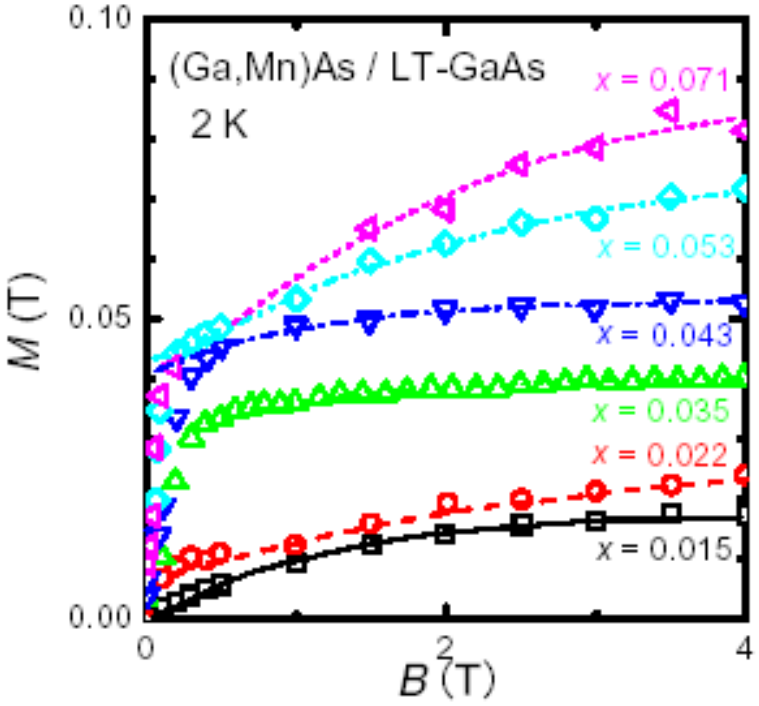
* *Laboratory for Electronic Intelligent Systems, Research Institute of Electrical Communication, Tohoku University, Katahira 2-1-1, Aoba-ku, Sendai 980-8577, Japan*

† *Center for Spintronics and Quantum Computation, Quantum Institute, University of California, Santa Barbara, California 93106, USA*

Nature 402, p790 (1999)



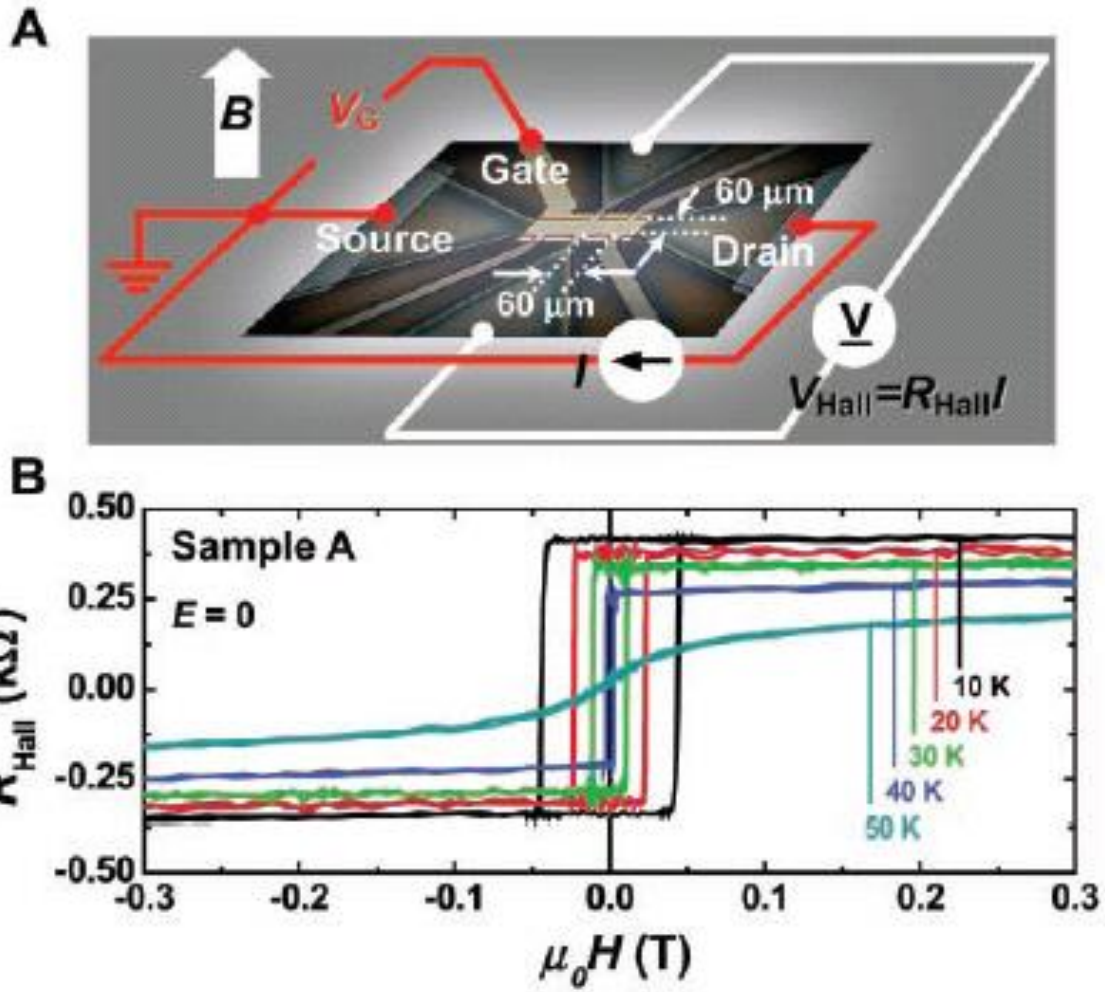


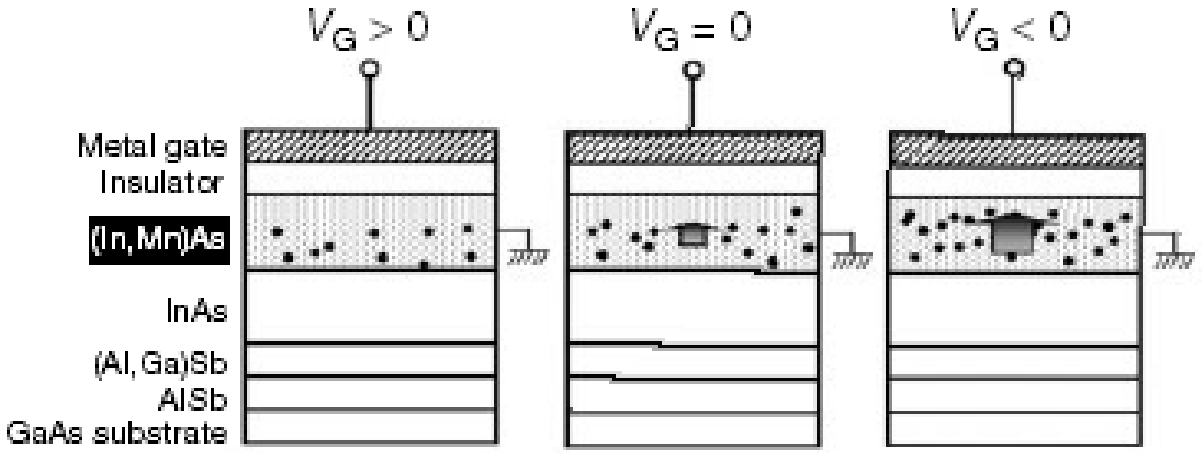

(Ga,Mn)As / LT-GaAs
2 K
x = 0.071
x = 0.053
x = 0.043
x = 0.035
x = 0.022
x = 0.015
M (T)
B (T)
0.10
0.05
0.00
0
2
4

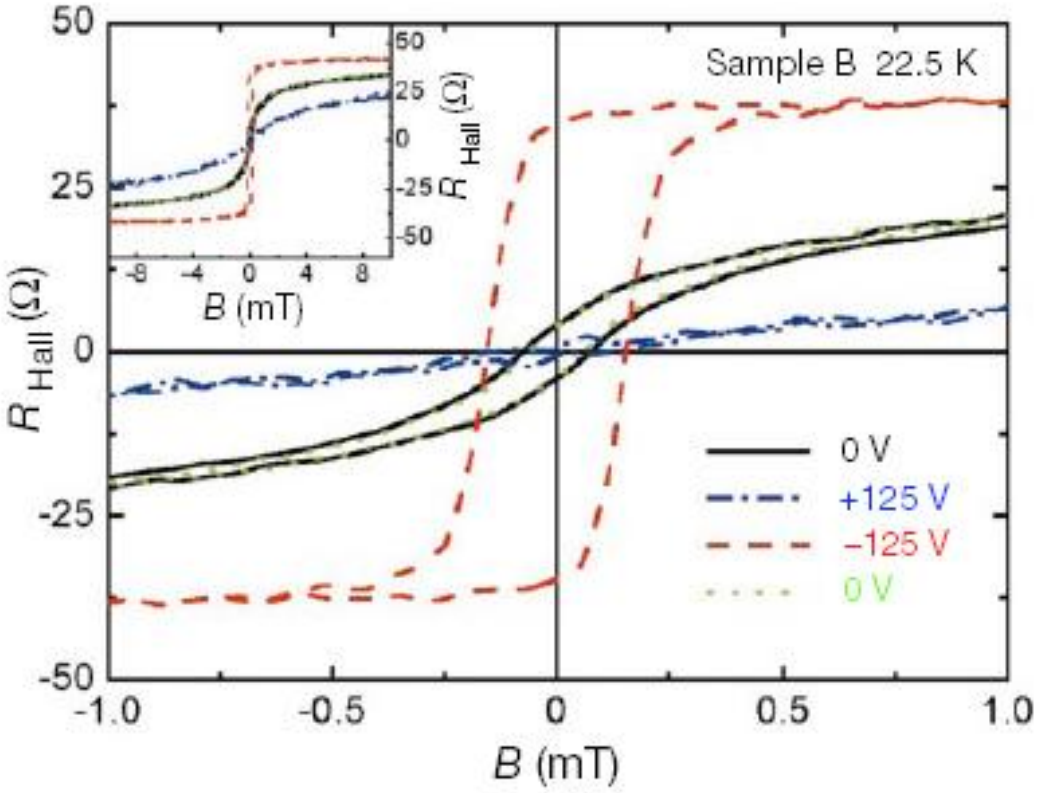
SCIENCE VOL 301 15 AUGUST 2003

Electrical Manipulation of Magnetization Reversal in a Ferromagnetic Semiconductor

D. Chiba,[1] M. Yamanouchi,[1] F. Matsukura,[1] H. Ohno[1,2]*




$V_G > 0$
$V_G = 0$
$V_G < 0$
Metal gate
Insulator
(In,Mn)As
InAs
(Al,Ga)Sb
AlSb
GaAs substrate


Sample B 22.5 K
R_{Hall} (Ω)
B (mT)
0 V
+125 V
−125 V
0 V

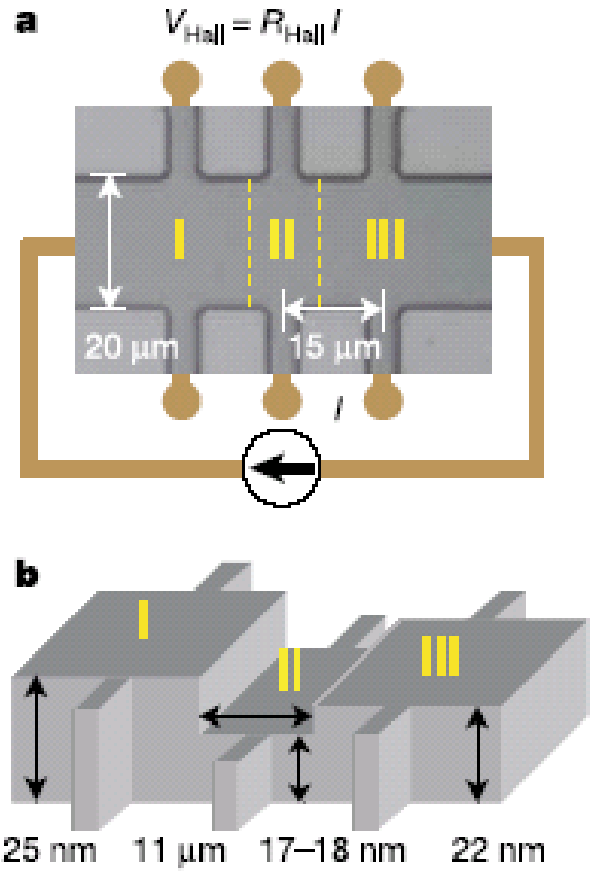
Current-induced domain-wall switching in a ferromagnetic semiconductor structure

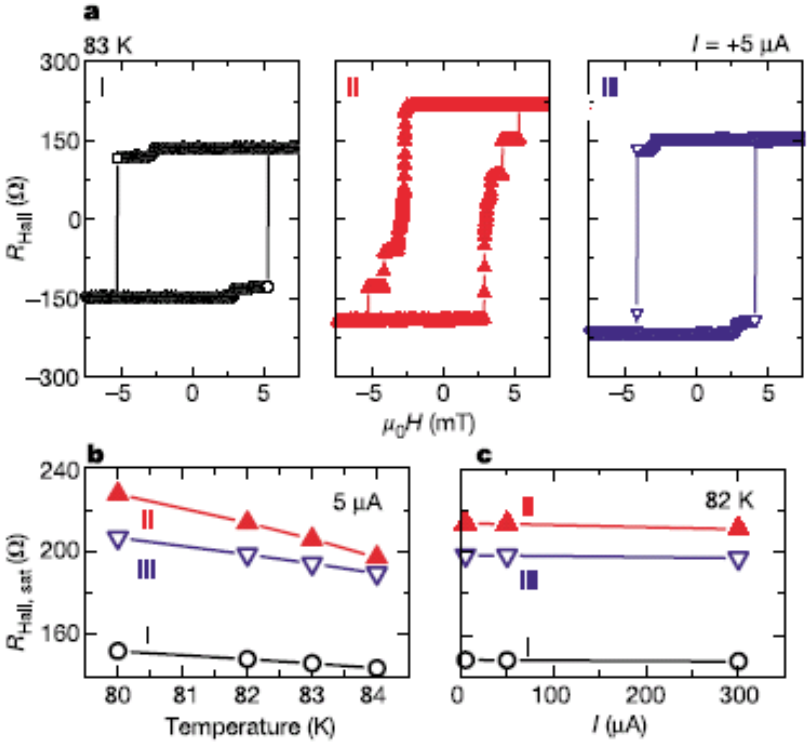
NATURE | VOL 428 | 1 APRIL 2004 |

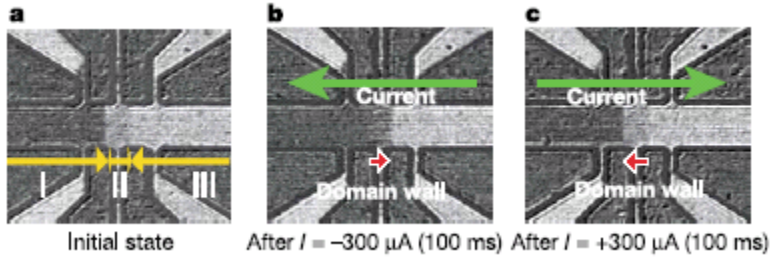
p539

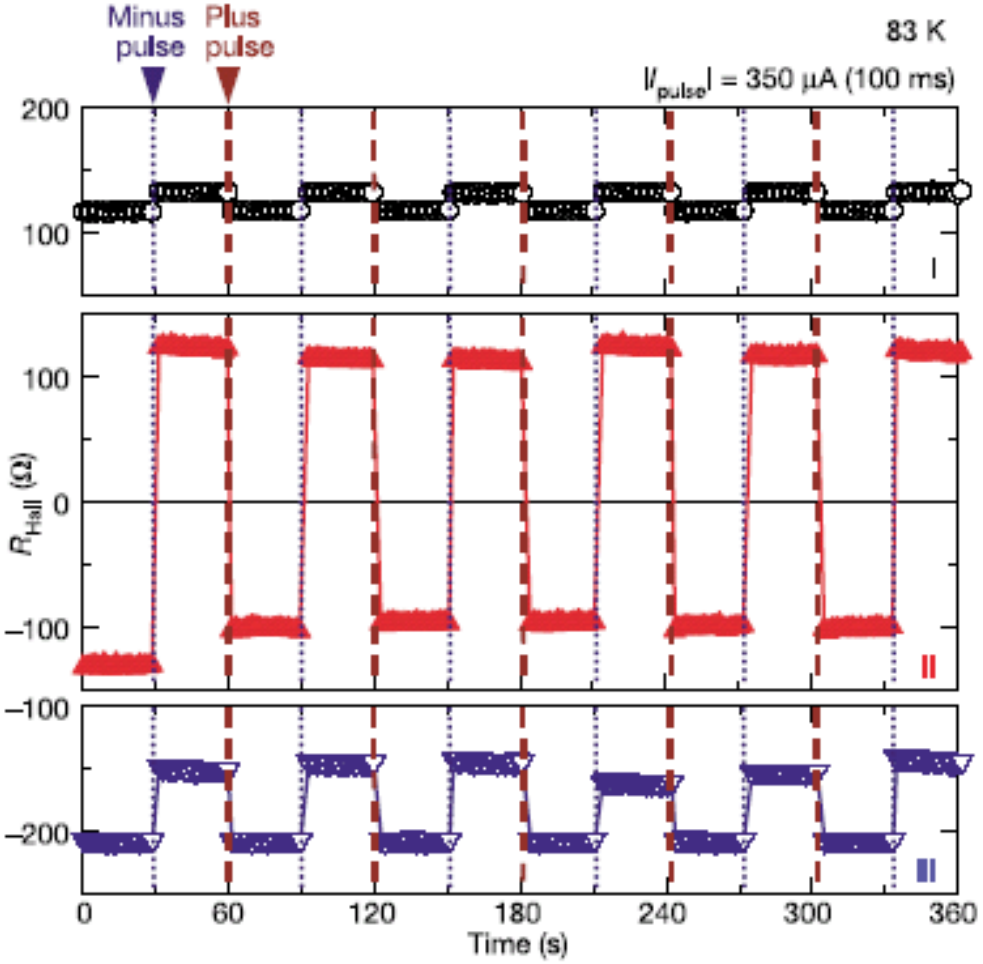
M. Yamanouchi[1], D. Chiba[1], F. Matsukura[1,2] & H. Ohno[1,2]

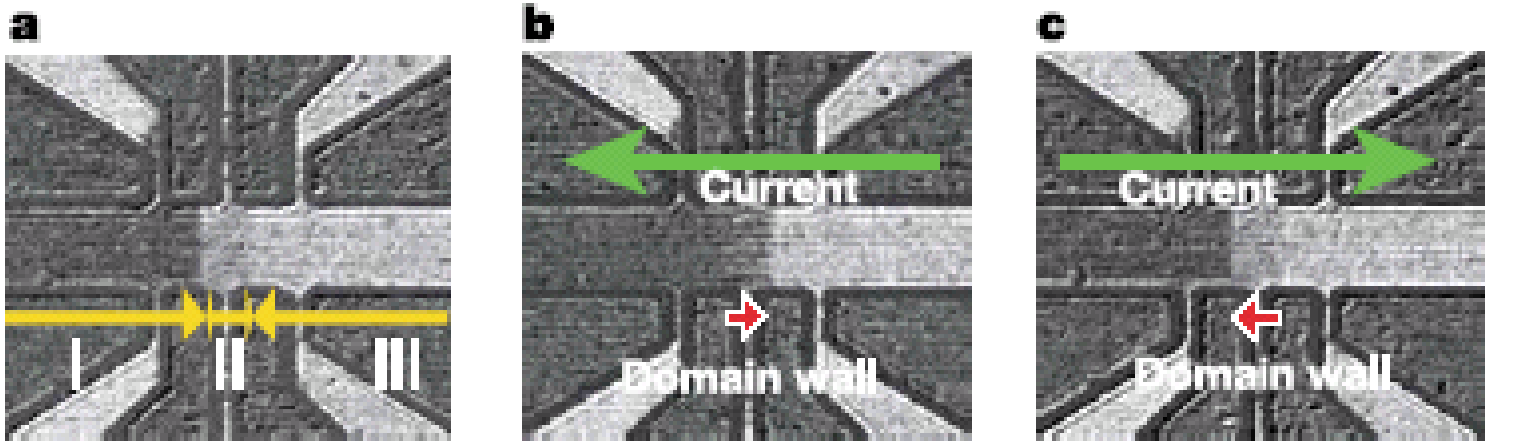
[1]*Laboratory for Nanoelectronics and Spintronics, Research Institute of Electrical Communication, Tohoku University, Katahira 2-1-1, Aoba-ku, Sendai 980-8577, Japan*
[2]*ERATO Semiconductor Spintronics Project, Japan Science and Technology Agency, Japan*




a
83 K
I = +5 μA
I
II
II
300
150
0
−150
−300
R_{Hall} (Ω)
−5
0
5
$\mu_0 H$ (mT)
b
5 μA
II
III
I
240
200
160
$R_{Hall, sat}$ (Ω)
80
81
82
83
84
Temperature (K)
c
82 K
I
II
I
0
100
200
300
I (μA)


a
b
c
I
II
III
Current
Domain wall
Current
Domain wall
Initial state
After I = −300 μA (100 ms)
After I = +300 μA (100 ms)

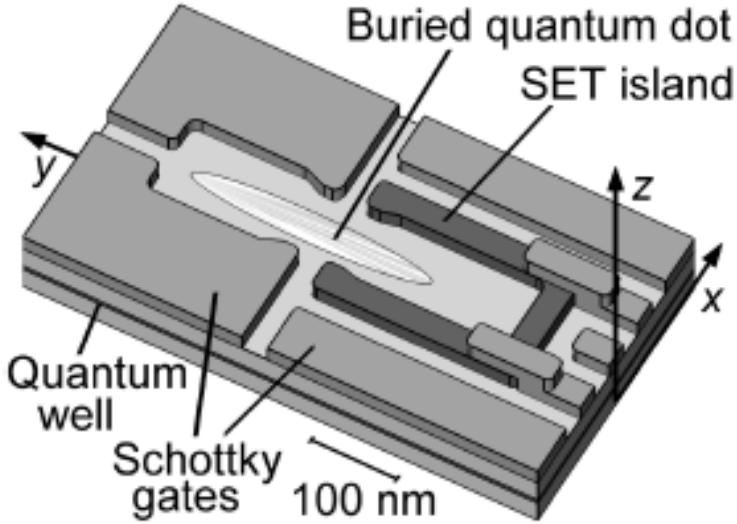

Minus pulse
Plus pulse
83 K
$|I_{pulse}|$ = 350 μA (100 ms)
200
100
I
100
0
−100
R_{Hall} (Ω)
II
−100
−200
II
0
60
120
180
240
300
360
Time (s)



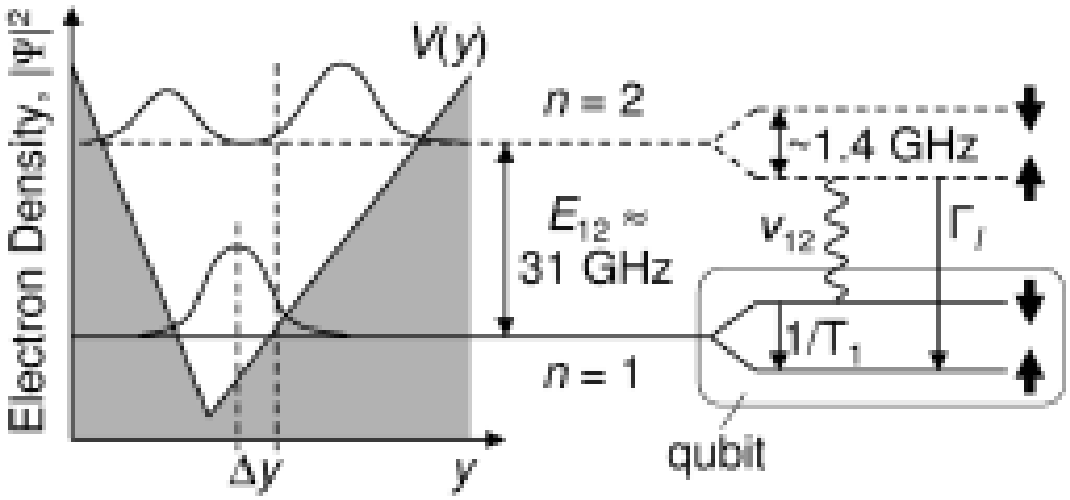
Initial state After I = −300 μA (100 ms) After I = +300 μA (100 ms)

Spin Readout and Initialization in a Semiconductor Quantum Dot

Mark Friesen,* Charles Tahan, Robert Joynt, and M. A. Eriksson



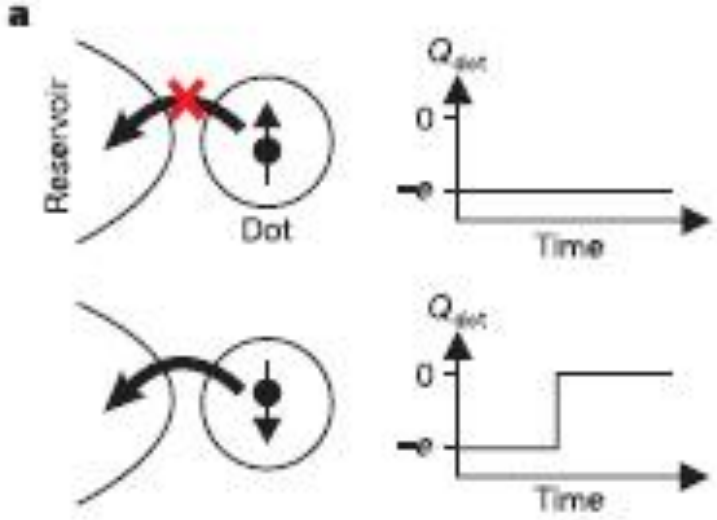
Physical Review Letters 92, 037901

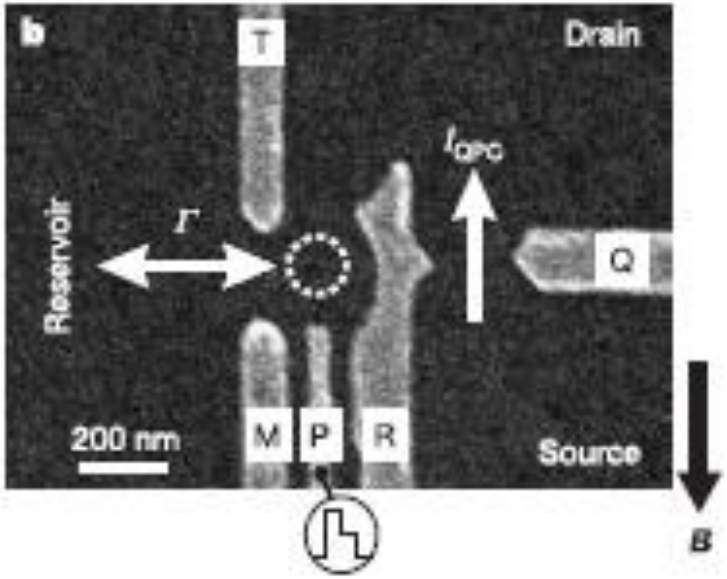


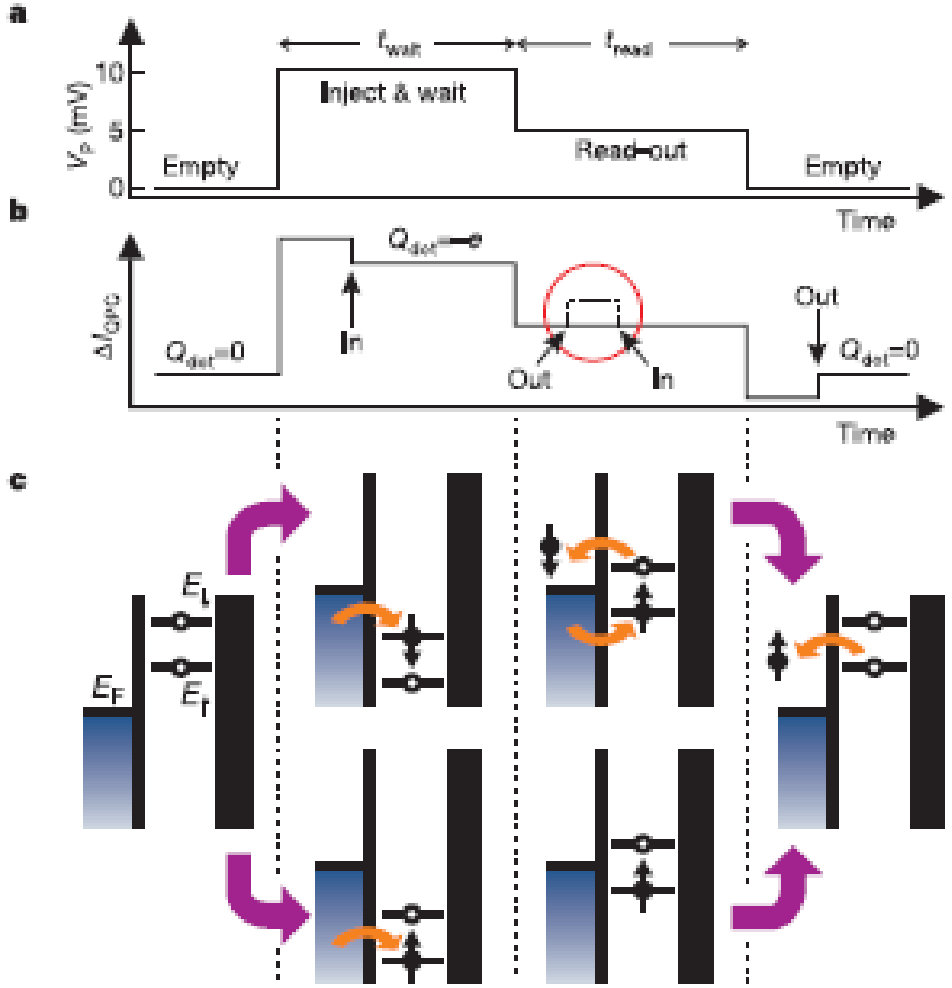
Single-shot read-out of an individual electron spin in a quantum dot

J. M. Elzerman, R. Hanson, L. H. Willems van Beveren, B. Witkamp, L. M. K. Vandersypen & L. P. Kouwenhoven

Nature V430, p431



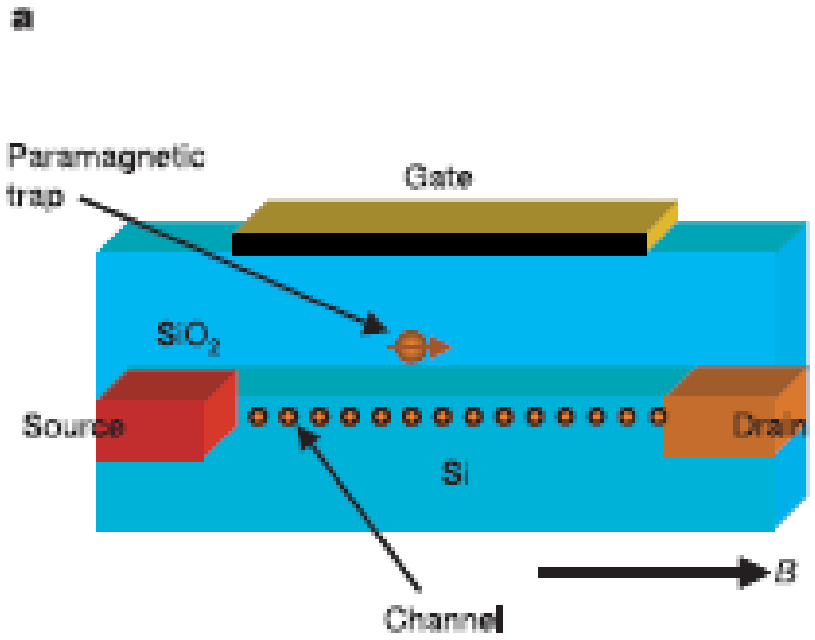


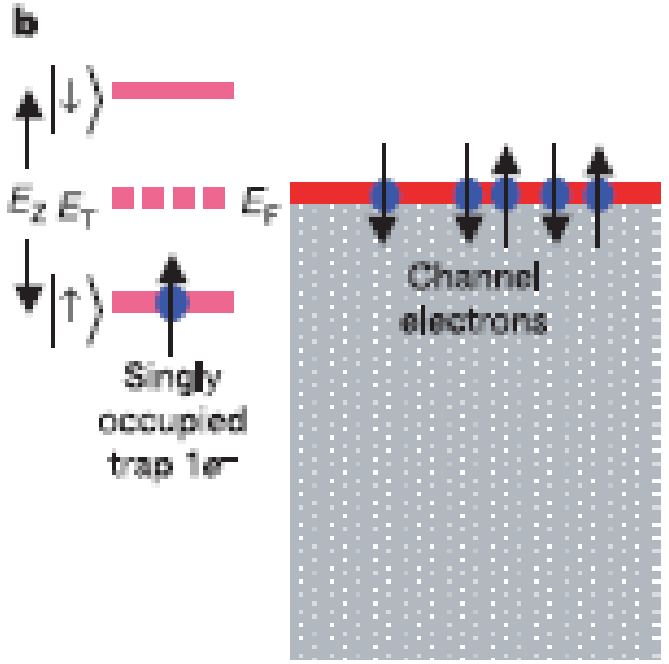


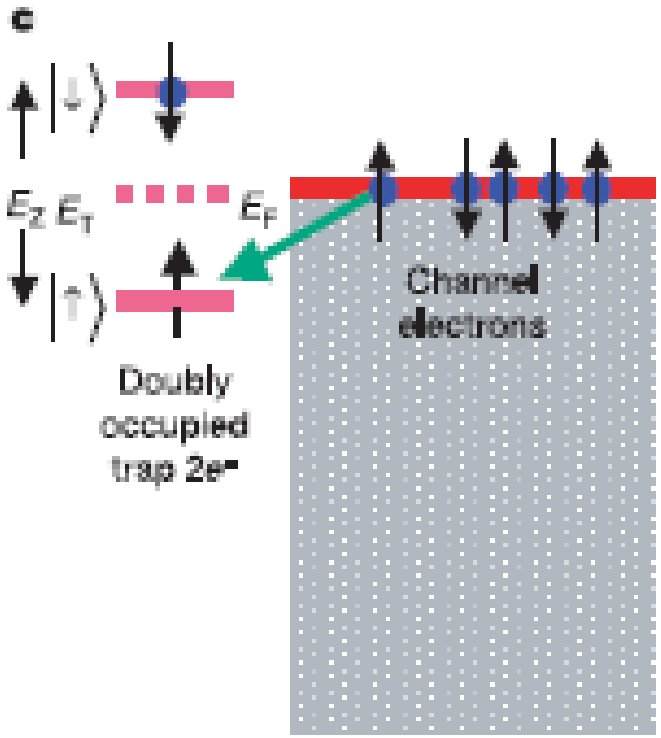
Electrical detection of the spin resonance of a single electron in a silicon field-effect transistor

M. Xiao[1], I. Martin[2], E. Yablonovitch[3] & H. W. Jiang[1]

Nature V430, 435





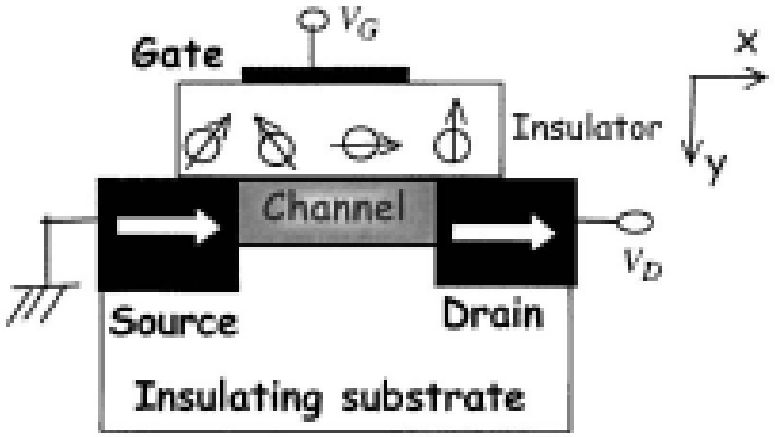


Proposal for a "spin capacitor"

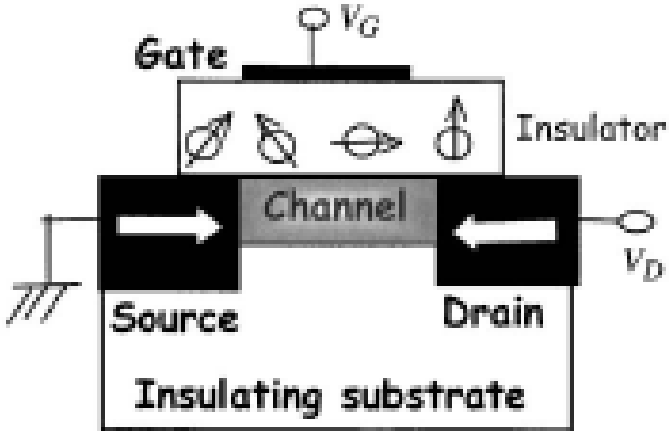
Applied Physics Letters 87, 013115

Supriyo Datta[a)]

(a) Device with ferromagnetic contacts in 'P' configuration

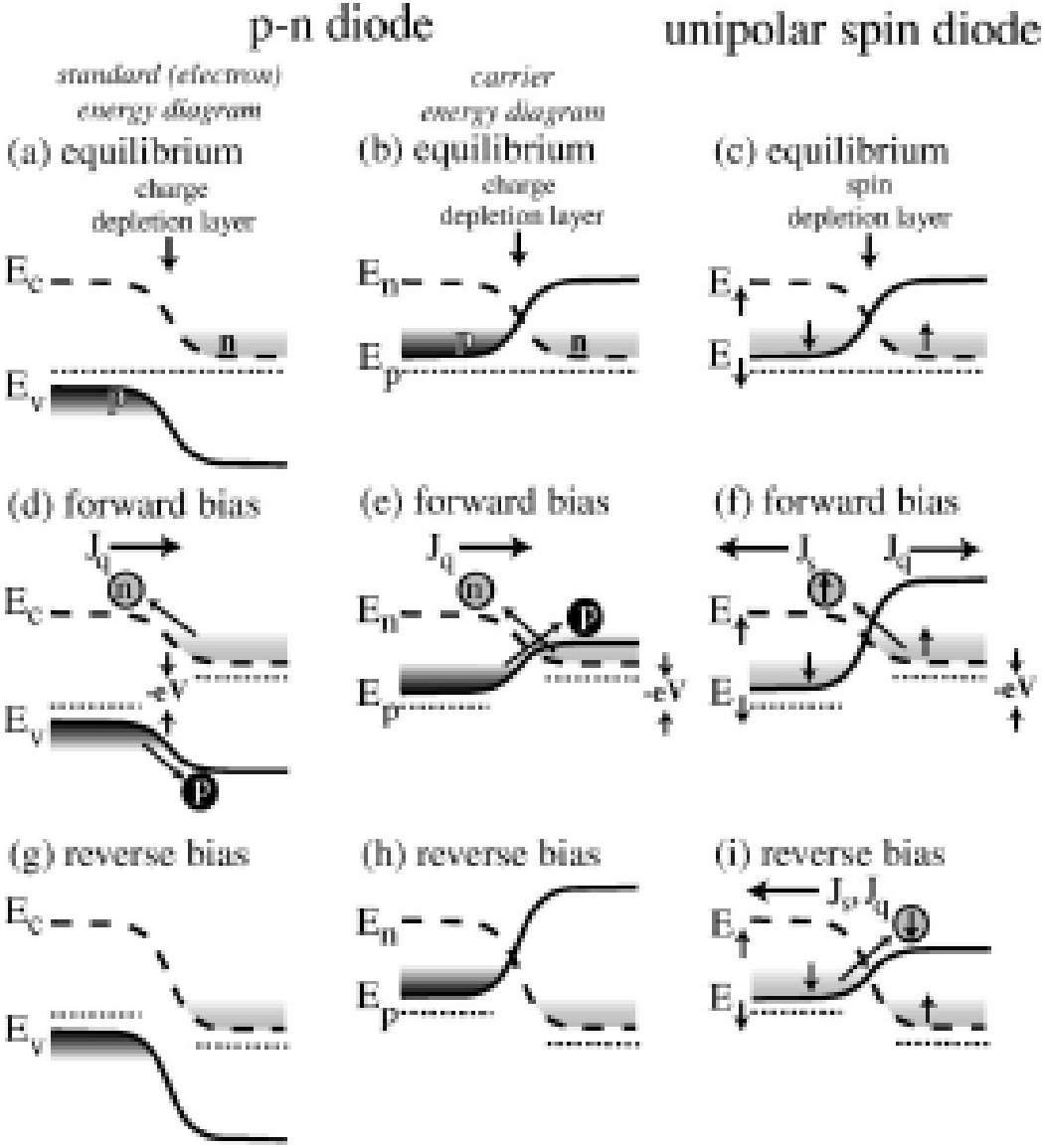


(b) Proposed device with contacts in 'A' configuration



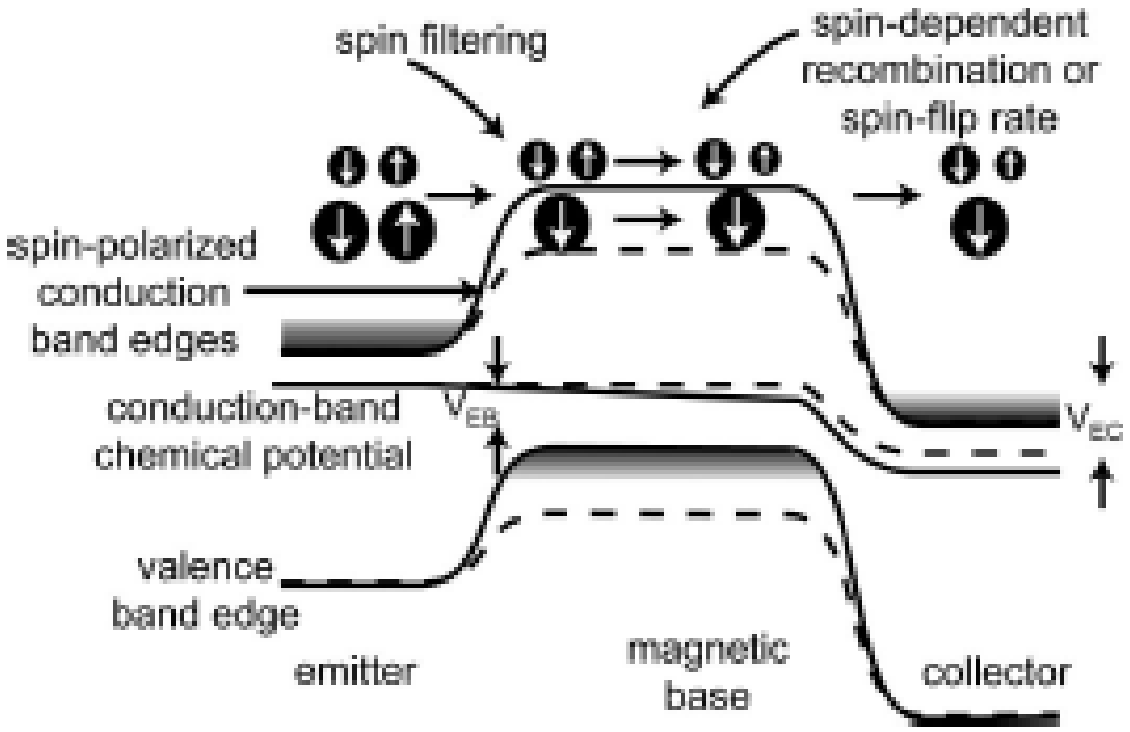
Unipolar spin diodes and transistors

M.E. Flatte and G. Vignale
Applied Physics Letters V78, 1273



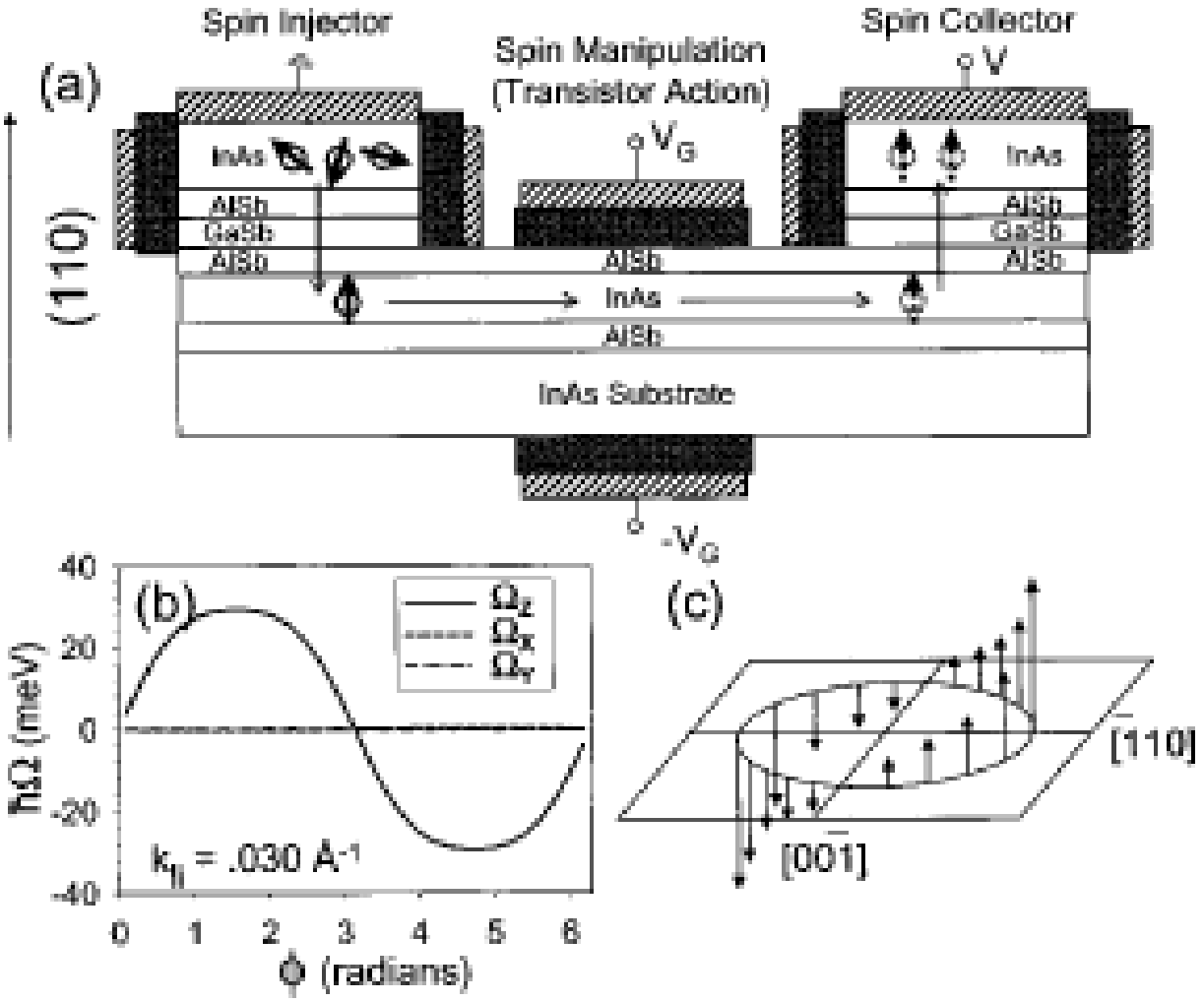
Theory of semiconductor magnetic bipolar transistors

M.E. Flatte et al., Applied Physics Letters V82, p4740



Nonmagnetic semiconductor spin transistor

K.C. Hall et al., APL V 83, p2937



A magnetic-field-effect transistor and spin transport

R.N. Gurzhi et al., APL V 83, p4577

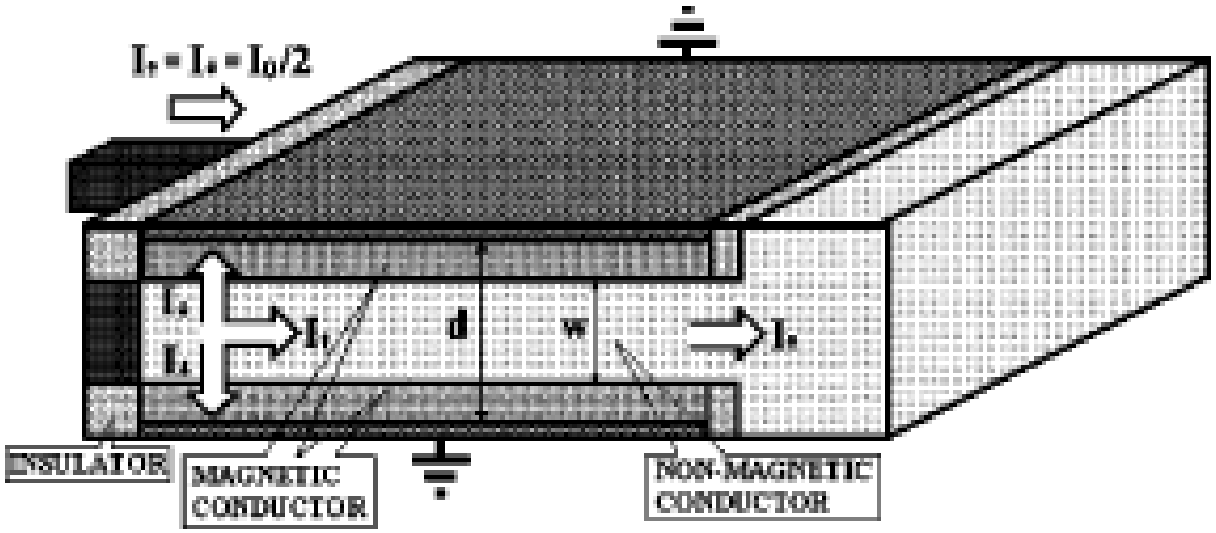


FIG. 1. A schematic of the spin guide. w is the width of the NM channel and d is the distance between the grounded magnetic contacts.

What is “Spin”?

How to manipulate spin?

How can we use “spin” to fabricate useful devices?