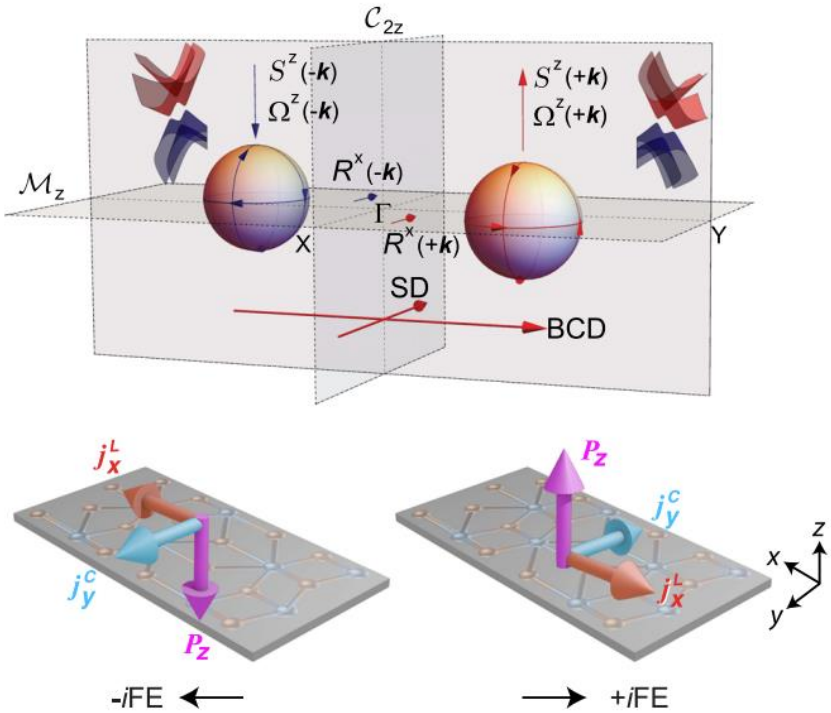
Computational material design for spintronics and functional materials



Moh. Adhib Ulil Absor, S.Si, M.Sc., Ph.D
KBK Fisika Material Fungsional, Departemen Fisika FMIPA UGM

Webinar tema skripsi dan tesis, Departemen Fisika, FMIPA UGM, 18 Maret 2022

Computational Spintronics and Functional Materials Research Group in UGM

https://fisika.fmipa.ugm.ac.id/kbk-fisika-material-fungsional/

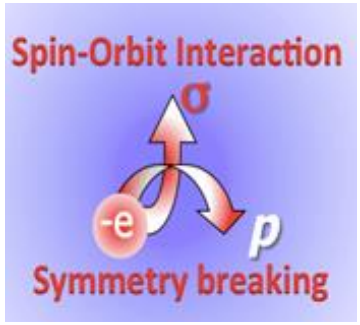
UNIVERSITAS GADJAH MADA

Main researchers:
1. Dr. M. Adhib Ulil Absor

Main Collaborator:
1. Prof. F. Ishii (NANOMARI, Kanazawa Univ., Japan);
2. Dr. N. Yamaguchi (NANOMARI, Kanazawa Univ. Japan);
3. Dr. Sholihun (UGM)
4. Dr. Iman Santoso (UGM)
5. Dr. Edi Suharyadi (UGM)
6. Prof. Harsojo (UGM)

Materials

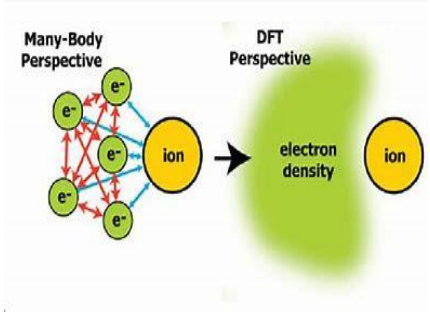
Coupling between degree of freedoms, Multifunctional:



- **2D multiferroic**
- **Defective systems**
- **Interface/surface**

Methods

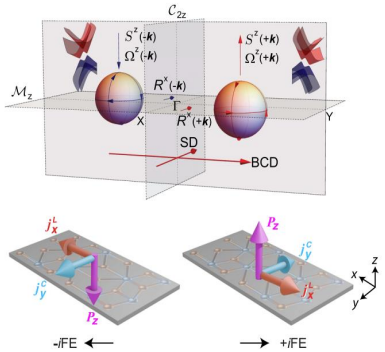
- **Density-functional theory**



- **Symmetry analysis**
- **Development of Hamiltonian models**

Physical properties

- **Electronic and spin-related properties**
- **Topological properties**



- **spin-valley physics**
- **Optical-Magnetic properties**

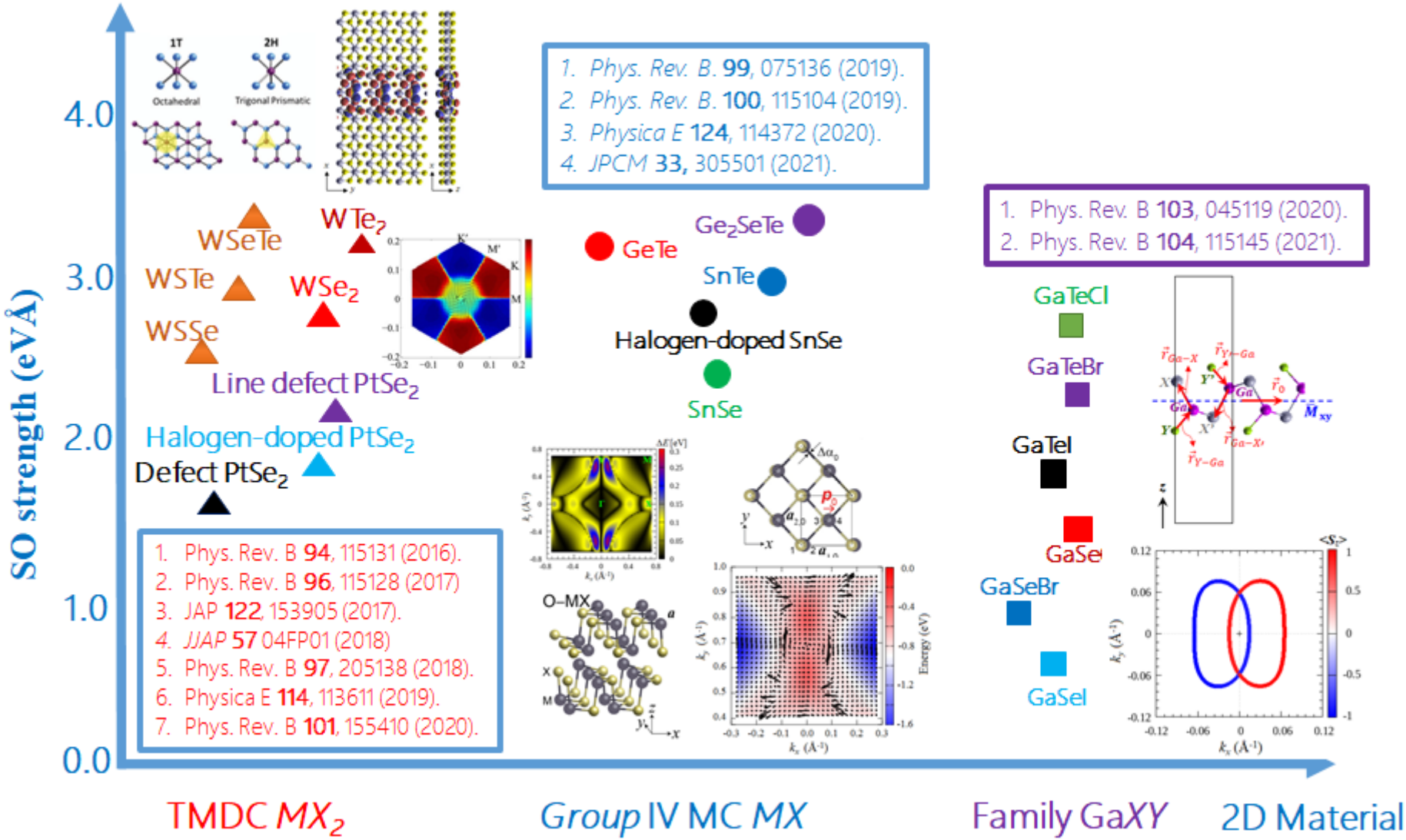
Alumni/ Former Students:

1. M. Dalilul F (Master)
2. M. Anshory (Master, PNS Dosen ITERA)
3. Siti Amalia (Master, granted Doctoral program LPDP in Japan)
4. M. Yusuf Affandi (Master, PNS Dosen ITERA)
5. Tin Subekti (Master)
6. Salsabila A. P. (Master DDP UGM-Kanazawa Univ, entering Doctoral Program (MEXT), Kanazawa Univ, japan)
7. Afrioni Romario (Master DDP UGM-Kanazawa Univ, PNS Dosen UNSRAT)
8. Berton Siahaan (Master DDP UGM-Kanazawa Univ, PNS Dosen UNSRAT)
9. Yusuf Faishol (Master)
10. M. Kharisma Amdri (Master)
11. Intan Masruroh (Master, Dosen UNSIQ)
12. AMM Indrawan (Master)
13. M. Yusrul Hanna (bachelor, Peneliti BRIN, entering Master program UI)
14. M Zuhdi Hendrawan (Bacelor, entering master program (MEXT) Kanazawa Univ, Japan.)
15. A. Alfian Pambudi (Bachelor)
16. Yediza YS Teweng (Bacelor, entering master program (MEXT) Kanazawa Univ, Japan.)
17. Hanif Y (Bacelor, entering 5 years Master-Doctor Program (MEXT), Tokyo Institute of Science and Technology, Japan)
18. Shifa Fauzia (Bacelor, entering Master program (MEXT) Kanazawa University)
19. Istiqomah (Bacelor, applying master LPDP)
20. Arief L (Bacelor, applying master LPDP)
21. Sastrawan N (Bacelor, applying master LPDP)

Students:

1. Harlina Ardiyanti (Doctor, Co-Promotor)
2. Dwi Nugraheni (Doctor, Colloborator)
3. Ahmad Zubair Alkahfi (Master, in collaboration with UNPAR, BRIN, University of Birmingham UK)
4. M. Khoirul Anwar (Bachelor)
5. M. Abud Fathul Ulum (Bachelor)

Our achievement : Prediction of 2D spintronics materials in UGM (2016-2021)



1. Phys. Rev. B. **99**, 075136 (2019).
2. Phys. Rev. B. **100**, 115104 (2019).
3. Physica E **124**, 114372 (2020).
4. JPCM **33**, 305501 (2021).

1. Phys. Rev. B **103**, 045119 (2020).
2. Phys. Rev. B **104**, 115145 (2021).

1. Phys. Rev. B **94**, 115131 (2016).
2. Phys. Rev. B **96**, 115128 (2017)
3. JAP **122**, 153905 (2017).
4. JJAP **57** 04FP01 (2018)
5. Phys. Rev. B **97**, 205138 (2018).
6. Physica E **114**, 113611 (2019).
7. Phys. Rev. B **101**, 155410 (2020).

Our achievement : Recent publications

Scopus

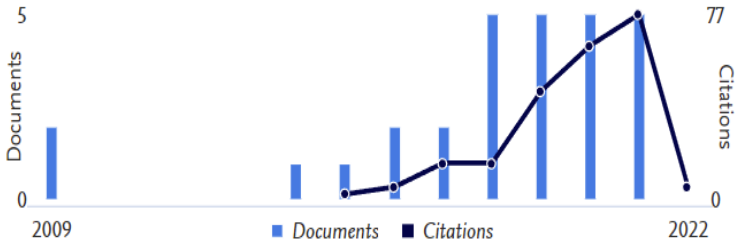
Metrics overview

28
Documents by author

228
Citations by *137* documents

9
h-index: View *h*-graph

Document & citation trends



Google Scholar

Moh. Adhib Ulil Absor

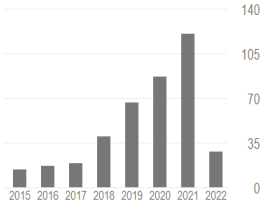
FOLLOWING

Associate Professor, Department of Physics, Gadjah Mada University
Verified email at ugm.ac.id
Spintronics and strongly ele...

TITLE	CITED BY	YEAR
Full-zone Persistent Spin Textures with Giant Spin Splitting in Two-dimensional Group IV-V Compounds M Absor, A Ulil, A Lukmantoro, I Santoso arXiv preprint arXiv:2202.02558		2022
Reversible spin textures with giant spin splitting in two-dimensional $GaXY$ ($X = Se$, Te; $Y = Cl$, Br, I) compounds for a persistent spin helix SA Sasmito, M Anshory, I Jihad, MAU Absor Physical Review B 104 (11), 115145	1	2021

Cited by VIEW ALL

	All	Since 2017
Citations	407	365
h-index	13	12
i10-index	18	16



PHYSICAL REVIEW B
covering condensed matter and materials physics

Highlights Recent Accepted Collections Authors Referees Search Press About

Reversible spin textures with giant spin splitting in two-dimensional $GaXY$ ($X = Se$, Te; $Y = Cl$, Br, I) compounds for a persistent spin helix

Siti Amalia Sasmito, Muhammad Anshory, Ibnu Jihad, and Moh. Adhib Ulil Absor
Phys. Rev. B **104**, 115145 – Published 22 September 2021

PHYSICAL REVIEW B
covering condensed matter and materials physics

Highlights Recent Accepted Collections Authors Referees Search Press About

Large band splitting with tunable spin polarization in the two-dimensional ferroelectric $GaXY$ family ($X = Se, Te$; $Y = Cl, Br, I$)

Moh. Adhib Ulil Absor and Fumiyuki Ishii
Phys. Rev. B **103**, 045119 – Published 19 January 2021

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Journal of Physics: Condensed Matter

PAPER

Highly persistent spin textures with giant tunable spin splitting in the two-dimensional germanium monochalcogenides

Moh. Adhib Ulil Absor[3,1], Yusuf Faishal[1], Muhammad Anshory[1], Iman Santoso[1], Sholihun [1], Harsojo [1] and Fumiyuki Ishii[2]
Published 11 June 2021 • © 2021 IOP Publishing Ltd
Journal of Physics: Condensed Matter, Volume 33, Number 30
Citation Moh. Adhib Ulil Absor *et al* 2021 *J. Phys.: Condens. Matter* **33** 305501

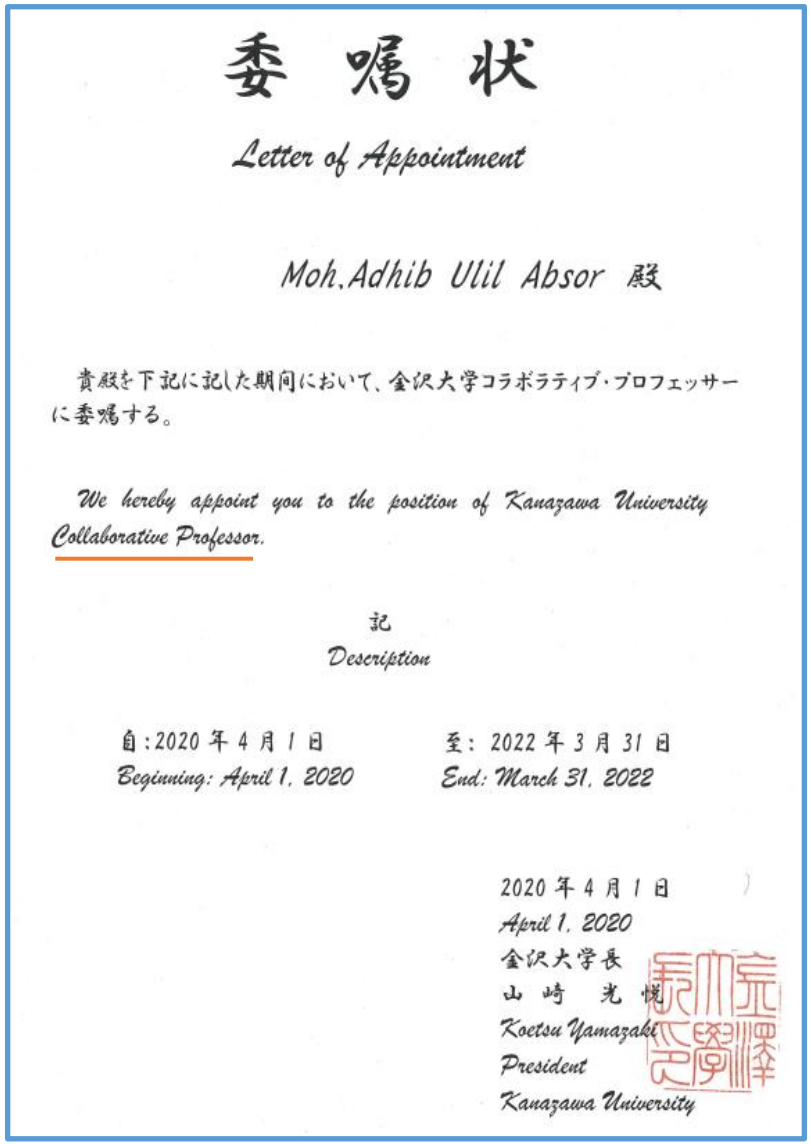
ELSEVIER

Physica E: Low-dimensional Systems and Nanostructures
Volume 124, October 2020, 114372

Strain-controlled spin-splitting in the persistent spin helix state of two-dimensional SnSe monolayer

Muhammad Anshory [a], Moh. Adhib Ulil Absor [b]
https://doi.org/10.1016/j.physe.2020.114372

Our achievement : National and International Recognitions



委 嘱 状

Letter of Appointment

Moh.Adhib Ulil Absor 殿

貴殿を下記に記した期間において、金沢大学コラボラティブ・プロフェッサーに委嘱する。

We hereby appoint you to the position of Kanazawa University Collaborative Professor.

記

Description

自：2020 年 4 月 1 日 Beginning: April 1, 2020

至：2022 年 3 月 31 日 End: March 31, 2022

2020 年 4 月 1 日
April 1, 2020
金沢大学長
山 崎 光 悦
Koetsu Yamazaki
President
Kanazawa University

Why spintronics?

- Spintronics → utilize and controll electron's spin including generation, manipulation, detection, and corresponding to their applications.

SPINTRONICS

Electrical control of spin-state
(no external magnetic fields)

Speed
(fast data reading and writing)

Low-energy consumption

Nonvolatile data storage

SPIN-ORBITRONICS

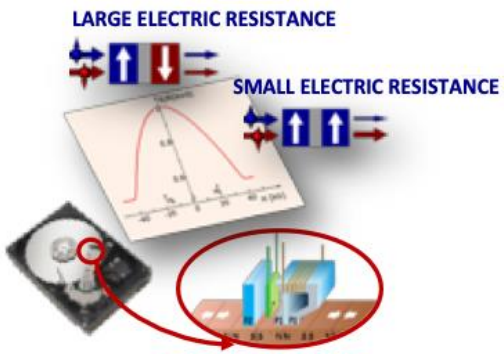
OPTO-SPINTRONICS

SPIN-CALORITRONICS

MATERIALS RESEARCH

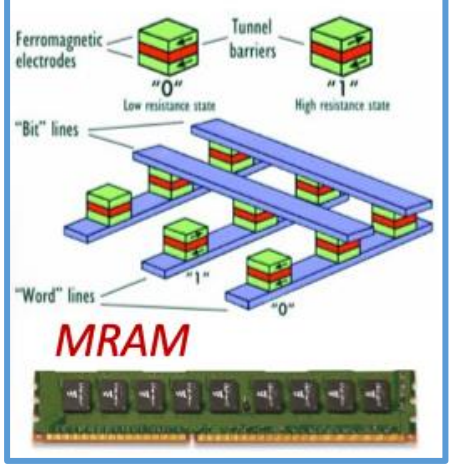
FUNDAMENTAL PHYSICS AND MATERIALS RESEARCH FOR NEW GENERATION OF ELECTRONIC DEVICES

GIANT MAGNETORESISTANCE



HDD READ HEAD

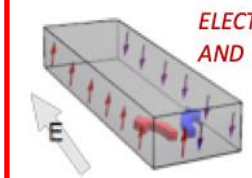
SPIN VALVES AND SPIN TRANSFER TORQUE

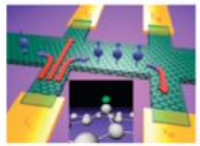


MRAM

SPIN-ORBIT DRIVEN PHENOMENA

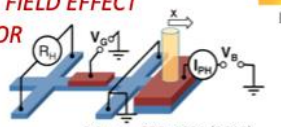
ELECTRICAL GENERATION AND DETECTION OF SPIN CURRENTS





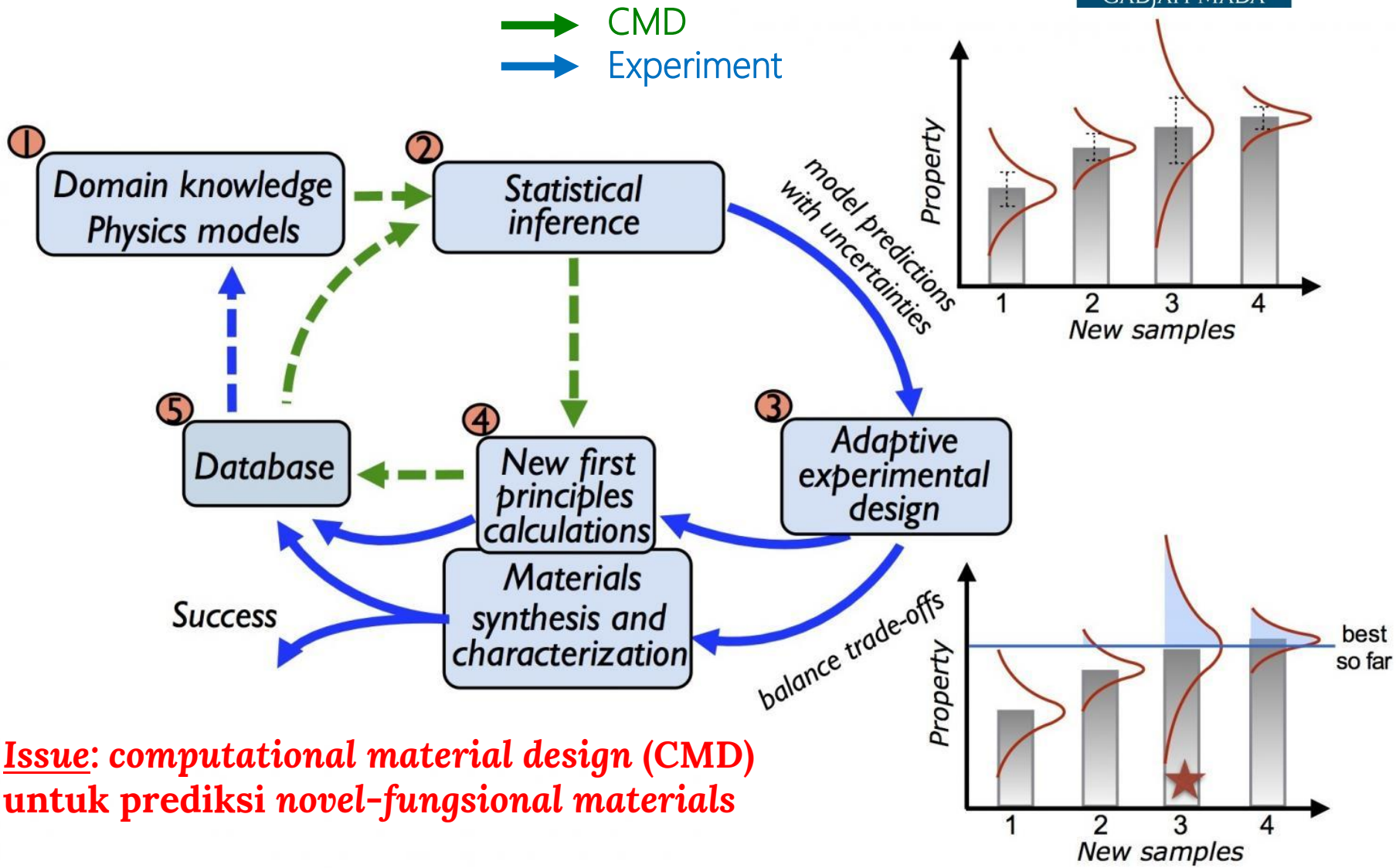
Nature Physics 9, 284 (2013)

SPIN HALL FIELD EFFECT TRANSISTOR



Science 330, 1801 (2010)

Development of new materials: From modelling to realization

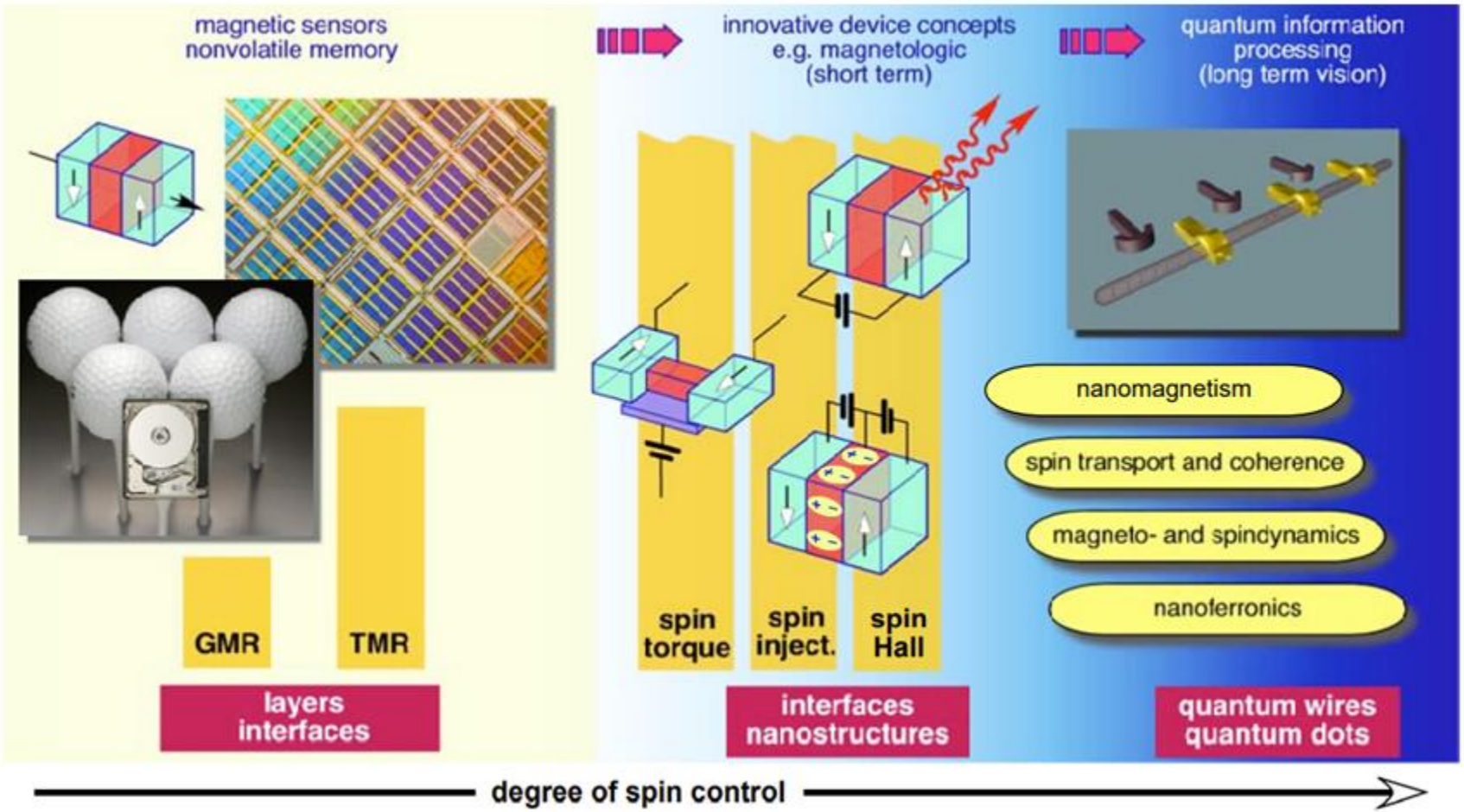


Issue*: computational material design (CMD) untuk prediksi *novel-fungsional materials

Recent trend inSpintronics

Past

Presence



Call for student:

UNIVERSITAS GADJAH MADA

- Research Topics:
  Computational Material design for Spintronics and Spin Energy Conversion:
  a. Non-trivial spin textures in non-centrosymmetric 2D ferroelectric materials.
  b. Spin Hall effect in 2D materials with strong ferroelectricity and spin-orbit coupling
  c. Spin-valley coupling in 2D material heterobilayer

- Funding:
  a. Hibah Penelitian Dasar 2022, KEMDIKBUD-DIKTI (Granted)
  b. Hibah Penelitian Dasar Unggulan Perguruan Tinggi 2022, KEMDIKBUD-DIKTI (Under review 2022).
  c. Program Rekognisi Tugas Akhir (RTA) 2022, DTLIT-UGM (Submitted)
  d. Grants-in-Aid for Scientific Research (Grant No. 16K04875) from JSPS and Grant-in-Aid for Scientific Research on Innovative Areas Discrete Geometric Analysis for Materials Design (Grant No. 18H04481) from MEXT Japan → in collaboration with Nanomaterial Research Institute, Kanazawa University (Ishii Lab)

TUT WURI HANDAYANI

KANAZAWA UNIVERSITY nanomaterials research institute

文部科学省 MINISTRY OF EDUCATION, CULTURE, SPORTS, SCIENCE AND TECHNOLOGY-JAPAN

JSPS 独立行政法人 日本学術振興会 Japan Society for the Promotion of Science

Call for student:

UNIVERSITAS GADJAH MADA

- Computational Facilities:
  a. High speck computer facilities in Laboratorium Fisika Material Elektronika dan Instrumentasi, Departemen Fisika, FMIPA, UGM.
  b. High Performance computing system (HPC) LIPI, BRIN.
  c. Supercomputer facilities at RIIT Kyushu University → in collaboration with Nanomaterial Research Institute, Kanazawa University (Ishii Lab)
  d. Main Code/softwere: OpenMX, Quantum Expresso, Wannier90, Alamode, Phonopy, and Standard Numerical Program/Library

- Number of Students needed:
  a. One (1) Doctoral Students
  b. Three (3) master Students
  c. Two (2) Bacelor Students

Contact: Moh. Adhib Ulil Absor, S.Si, M.Sc., Ph.D.
Office: Lab Fismatel, Gd. Fisika Lantai 3, Sekip Utara BLS 21, Yogyakarta 55821
Email: adib@ugm.ac.id; Phone: 087738072516

Thank you for your attentions