BENJAMIN K CHANG

Understanding the **Physics** *in* **Materials**
by **Computations** *and* **Machine Learning**.

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EDUCATION

National Taiwan University (NTU), M.S. in **Physics** 09/2015-07/2017
Thesis: First-Principles Studies of Cubic Sb-Doped GeTe Compounds for Thermoelectric Applications
Graduated with **Dean's Award**

National Tsing Hua University (NTHU), B.S. in **Interdisciplinary Program of Sciences (IPCS)** 09/2011-06/2015
Fields of study: **Physics** and **Materials Science**, Minor in **Computer Science**
Graduate Ranking: **1**/27 (**top 3.7%**) || GPA: **3.94**/4.0 (**4.03**/4.3)

Coursera Certificates (Offered by Prof. Andrew Ng at Stanford University) 2017
Machine Learning & Deep Learning

PUBLICATIONS

1. Deniz P. Wong, Masoud Aminzare, Chin-Sheng Pang, Benjamin K. Chang, Hsiang-Ting Lien, Sun-Tang Chang, Chia-Hua Chien, Yang-Yuan Chen, Ming-Wen Chu, Yaw-Wen Yang, Wen-Pin Hsieh, Gerda Rogl, Peter Rogl, Mei-Yin Chou, Li-Chyong Chen, and Kuei-Hsien Chen. **Boosting zT above 2.5: Temperature-Induced Valence Band Convergence in GeTe-rich Ge-Sb-Te Thin Film.** Under review by *Nature Communications*.
2. Benjamin K. Chang and Mei-Yin Chou, **First-Principles Studies of Cubic Sb-Doped GeTe for Thermoelectric Applications.** Waiting for submission to *Physical Review B* after the first paper is published.

RELEVANT COURSES

Physics
Undergraduate (Average GPA: **4.0**/4.0 || **4.19**/4.3)

Quantum Mechanics (I) (A+)
Thermal and Statistical Physics (I) (A+)
Quantum Physics (I, II) (A+, A)
Electromagnetics (I, II) (A+, A+)
Theoretical Mechanics (I, II) (A+, A+)
Introduction to Elementary Particle Physics (II) (A+)
Applied Mathematics (I, II) (A, A-)

Graduate (Average GPA: **4.0**/4.0 || **4.14**/4.3)

Quantum Mechanics (I, II) (A, A+)
Statistical Physics(I) (A+)
Classical Electrodynamics (I) (A)
Classical Mechanics (A)
Topics on Theoretical Materials Physics (A+)

Computer Science
Undergraduate (Average GPA: **4.0**/4.0 || **4.16**/4.3)

Design and Analysis of Algorithms (A+)
Operating Systems (A)
Computer Architecture (A)
Data Structures (A+)
Logic Design (A)
Scientific Computing (A+)
Web Programming, Technologies, and Applications (A+)
Introduction to Programming (A+)
Linear Algebra (I, II) (A+, A)
Statistics (A)

Materials Science and Engineering
Undergraduate (Average GPA: **3.96**/4.0 || **4.00**/4.3)

Biomedical Materials (A-)
The Physical Properties of Materials (A+)
Ceramic Materials (A-)
Introduction to Crystal Structure and Diffraction Theories (A+)
Material Science and Engineering (I, II) (A+, A+)
Thermodynamics of Materials (I, II) (B+, A)

Machine Learning
Coursera (All Passed with **Certificates**)

Machine Learning
Neural Networks and Deep Learning
Structuring Machine Learning Projects
Improving Deep Neural Networks: Hyperparameter tuning, Regularization and Optimization
(All offered by Prof. Andrew Ng at Stanford University)

SKILLS AND TOOLS

First-Principles (*Ab-initio*) Computation VASP, Quantum Espresso, BandUP, BoltzTraP, Phonopy

Machine Learning & Deep Learning Tensorflow, Scikit-learn
Other Basic Languages and Tools Python, C/C++, Matlab, Shell Script, HTML5/CSS, Javascript, PHP, SQL, LabVIEW

RESEARCH EXPERIENCES

Institute of Atomic and Molecular Sciences (IAMS), Academia Sinica, Taipei 09/2015-present
Advisor: Prof. Mei-Yin Chou (Vice President of Academia Sinica)

Identifying Large Anharmonic Force Contants (LAFCs) of SnSe Using Machine Learning

- Collaborating with a Physics Ph.D. student at Georgia Institute of Technology.
- Applied a machine learning method called "Compressive Sensing".
- Trained the statistic learning model "LASSO" using nearly ten thousand atomic displacement data derived from DFT to identify the LAFCs up to the fourth order.
- The LAFCs are planned to be used for the analyses of unusual bonding and molecular dynamics calculations.

First-Principles Studies of Cubic Sb-Doped GeTe Compounds for Thermoelectric Applications (Master Thesis)

- Collaborated with the experimental group of Prof. Kuei-Hsien Chen (Director of IAMS) to study the high thermoelectric performance cubic Sb-doped GeTe (β-GST) films.
- Verified the applicability of the cubic GeTe (β-GT) rigid band model (RBM) to β-GST system by investigating β-GT supercells with various concentrations of defects.
- Used the state-of-the-art band-unfolding technique for qualitative analyses.
- Implemented a Python program was implemented for quantitative calculations of the root-mean-square deviations of supercell eigenvalues from that of primitive cell.
- Used Fermi surface visualizations and Boltzmann transport calculations to show that the high thermoelectric performance of β-GST originates from the decrease of Fermi level and the expansion of the phase space.
- Discovered the electron-donor role of the Si-substrate used in the experiments. Predicted that other substrates would not result in the β-GST films with the same good performance. Later confirmed by experiments.
- Earned the Dean's Award from the College of Science, NTU.
- Two papers on their way. Please refer to **PUBLICATIONS**.

Department of Physics, Fudan University, Shanghai 07/2013-08/2013
Supervisor: Prof. Jian Shen (Director of the Department)

Co-Alq$_3$-LSMO Film and Giant Magnetoresistance

- Took part in the preparation of Co-Alq$_3$-LSMO film using molecule beam epitaxy (MBE).
- Implemented a user-friendly monitor program by using LabVIEW.
- Earned the distinctive honor of Chun-Tsung Scholar based on my performance.
- This work was continued by the group and later published on *Nature Communications* **5**:4396 (2014).

HONORS AND AWARDS

Dean's Award, *College of Science, NTU* 08/2017
Awarded to graduate students outstanding in academic research.

Phi Tau Phi Honorary Membership, *NTHU Branch, Phi Tau Phi Scholastic Honor Society of the Republic of China* 06/2016
Awarded to top 1% undergraduate students annually.

College of Science Elite Student Award, *College of Science, NTHU* 04/2015
Awarded to 1 student in each year in each department in the College of Science annually.

Academic Achievement Award (2 times), *NTHU* 02/2013-01/2014
Awarded to top 5% students of each department, every semester.

Yu Kuo-Hua Scholarship, *Yu Kuo-Hua Foundation* 12/2013
Awarded to 2 students in the College of Science at NTHU annually.

Chun-Tsung Scholar, *Hui-Chun Chin and Tsung-Dao Lee Chinese Undergraduate Research Endowment (CURE)* 11/2013
Awarded to 2 undergraduate students outstanding in academic research from each of the 6 top universities of Republic of China and People's Republic of China (National Tsing Hua, Peking, Fudan, Shanghai Jiao Tong, Soochow, and Lanzhou University). Each of the recipients are invited to give a talk on the Chun-Tsung Annual Conference.

Dr. Chen Ke-Zhong Memorial Scholarship, *NTHU* 10/2013
Awarded to 1 student in the College of Science every semester.

Mr. Ma Shang-Keng Memorial Scholarship, *NTHU* 10/2013
Awarded to 2 students outstanding in "subjects in physics" annually.

Mr. Jiang Ying-Bin Memorial Scholarship, *NTHU* 10/2013
Awarded to 1 NTHU student outstanding in both academic performance and team activities annually.

Academic Exchange Scholarship to People's Republic of China, *NTHU* 07/2013-08/2013
Awarded to a small number of students with good academic performance annually.

Student Award, *Department of IPCS, NTHU* 11/2012
Awarded to outstanding students in the Department of IPCS annually.

TEACHING EXPERIENCES

Teaching Assistant, Classical Mechanics (Graduate Course), *Department of Physics, NTU* 09/2016-01/2017
Instructor: Prof. Kazuo Hosomichi
Marking homework, answering online questions and offering office hours, all in English. 34 students.

Teaching Assistant, Quantum Physics (Undergraduate Course), *Department of Physics, NTU* 09/2016-01/2017
Instructor: Prof. Yeong-Chuan Kao
Following course, producing the first version of lecture notes, answering after-class questions. About 100 students.

Teacher of NTHU Belize Educational Volunteer Service Group, *Cayo District, Belize* 07/2014-08/2014
Taught basic computer concepts in English with the help of simple Spanish dialogs. More than 150 Belizean children between 6-15 years old.

Dean's Honorable Peer Tutor, *NTHU* 09/2013-06/2014
Offered after-class guidance of selected subjects in mathematics, physics, materials science, and computer science for any NTHU students who made an appointment online, in both Chinese and English.

POSTERS

First-Principles Studies of Cubic Sb-Doped GeTe for Thermoelectric Applications, 10/2017
The 20th Asian Workshop on First-Principles Electronic Structure Calculations, Nanjing, China
Presented master's work.

First-Principles Studies of Cubic Sb-Doped GeTe for Thermoelectric Applications, 09/2017
IAMS-Yokohoma City Univeristy Autumn Workshop, IAMS, Taipei, Taiwan
Presented master's work.

TALKS

Introduction to Machine Learning, *IAMS Theory Groups Joint Meeting* 07/2017
Gave a pedagogical talk in English on the current development of machine learning. About 20 attendants.

Electron Localization Function, *IAMS Theory Groups Joint Meeting* 08/2016
Gave a pedagogical talk in English on the development of electron localization function. About 20 attendants.

Low Thermal Conductivity Thermoelectric Materials, *IAMS Theory Groups Joint Meeting* 05/2016
Gave a pedagogical talk in English on modern approaches of reducing thermal conductivity of thermoelectric materials, including anharmonicity, cage-like structures, phonon gap production, and lone-pair electrons. About 20 attendants.

Co-Alq_3-LSMO Film and Giant Magnetoresistance, *Chun-Tsung Annual Conference, Beijing* 11/2013
Reviewed the formulation of thermal transport, including Born-Oppenheimer approximation, anharmonic interactions, Boltzmann equation, and the formula for thermal conductivity.

TERM PROJECTS

Thermal Transport Theory 2016

Reviewed the formulation of thermal transport, including Born-Oppenheimer approximation, anharmonic interactions, Boltzmann equation, and the formula for thermal conductivity.

WORK EXPERIENCES

Research Assistant, *IAMS, Academia Sinica* 02/2016-present
Teaching Assistant, Classical Mechanics, *Department of Physics, NTU* 09/2016-01/2017
Teaching Assistant, Quantum Physics, *Department of Physics, NTU* 09/2016-01/2017

LEADERSHIP AND TEAMWORK EXPERIENCES

Programmer and Strategy Designer, *FDT Global College Student Investment Competition* 03/2016-06/2016
Collaborated with 4 other teammates from different fields. Used Python to implement foreign exchange transaction strategies on the platform provided by Financial Data Technologies (FDT) Ltd.

Chief of the Web and Information Division, *NTHU Graduate Student Association* 09/2014-06/2015
Led division members in designing and creating the association website.

Representative Speaker on Taiwanese Economy, *Exchange Workshop of Economics, Tsinghua University, Beijing* 07/2014
Represented NTHU group to give a talk about education industry's impact on Taiwanese economy at the exchange workshop held by the departments of Economics of Tsinghua University (Beijing) and NTHU.

Fundraiser and Member of the Media Division, *NTHU Belize Educational Volunteer Service Group* 11/2013-10/2014
Produced promotion videos, gave fundraising presentations, gained sponsorship at various charity bazaars, eventually, with colleagues, gathered over 33,000 USD and 40 computer sets in a few months.

-Updated 2017.11.3