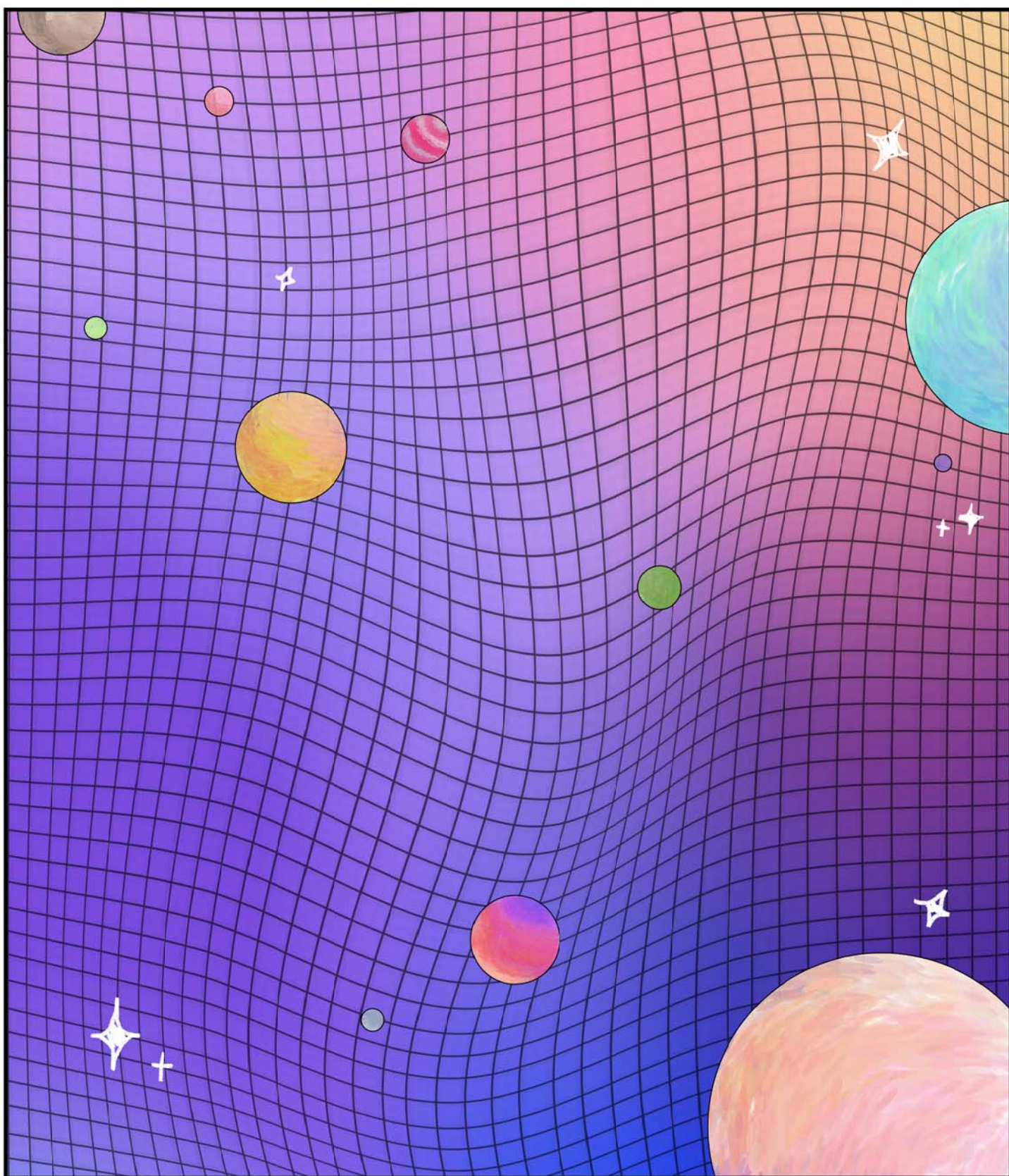


# 物理週 2021



## 系主任的話



物理是人類認識自然界最基本的能力，學習物理不僅是要了解真實世界的本質，更要了解現實世界是如何被改造的，才能對未來科技發展提出解方。感謝今年負責籌備「物理週-學術發表競賽」的同學與老師們，為淡江物理打造了一個嶄新的學術交流平台，讓我們有機會擴大研究視野，增進學術包容性，並幫助物理系變得更有活力和創造力。讓我們繼續努力，一同見證淡江物理系邁向偉大之路！

系主任

薛宏中



# 2021物理週-學術發表 日程表

11.29(一) ~ 12.03(五)

時間	星期一	星期二	星期三	星期四	時間	星期五
12:00   12:40	專題研究分享與競賽 @ 3F走廊		專題研究分享與競賽 @2F走廊		12:10   12:30	科普演講 @S215
12:40   13:00	科普演講 @S215				12:30   13:00	閉幕式 頒獎典禮 @S215

## 科普演講日程

日期	演講者	題目
11/29 (一)	李啟正老師	固態材料裡的世界：磁單極
11/30 (二)	潘璽安老師	公民天文學
12/01 (三)	莊程豪老師	在科學(Science)館內做科學(Science)-鋰電池研究中動態電化學反應
12/02 (四)	陳慳旭老師	認識基本作用力與物質結構
12/03 (五)	吳俊毅老師	量子，你在計什麼算

# 2021物理週-學術發表 注意事項

**11.29(一) ~ 12.03(五)**

注意事項：

1. 週一、週二海報位置在科學館三樓，週三、週四在二樓，請於11/25(四)21:00前依序號張貼完成。
2. 海報評分時間為每日12:00~12:40。
3. 每位參加海報競賽的同學，皆有紀念禮物一份，活動當週請記得與工作人員領取。
4. 得獎名單將於12/2(四)下午五點前公布於系辦門口，以及致信通知得獎人。
5. 閉幕式及頒獎典禮於12/3(五)12:30~13:00 S215舉行。
6. 12/3(五)13:00~16:00請自行移除海報，得獎海報系上保留。



# 2021 物理週-學術發表海報競賽 摘要目錄

共計35篇(研究所16篇、大學部19篇)

競賽日期	組別	序號	姓名	論文題目	指導教授
11/29(一)	研究所	1	賴君豪	Neutron Powder Diffraction Study of the Helimagnet YBaCuFeO <sub>5</sub> with B-site Disorder	杜昭宏
		2	朱文騰	A study on neutrino mass problem relating to Xenon1T anomaly	陳檉旭
		3	劉恩沛	Study of Structure and Magnetic Properties of Perovskite Pr(Mn <sub>x</sub> Cr <sub>1-x</sub> )O <sub>3</sub>	杜昭宏
		4	周宏宇	A Study of Determination on Neutrino mass hierarchy	陳檉旭
	大學部	5	楊承濤	Tunable Hetero-Nanojunction Barrier of Defect Trigger by Multiple Wavelength Light	葉炳宏
		6	謝文鈺	Study of the A-site substitution effect of the double-layered Fe-based perovskite AA'CFO <sub>5</sub>	杜昭宏
		7	蔡宜靜	結合機器學習與第一原理方法研究二維材料之聲子能譜	薛宏中
		9	歐陽依晴	Investigation the Charge Transport properties of Hetero-Nanojunction Gate of defect-rich nanofiber at Various Gas Environment	葉炳宏
11/30(二)	研究所	10	梁喻惠	Investigating The Magnetic Structure of Single Crystal YBaCuFeO <sub>5</sub> by Neutron and X-ray Scattering	杜昭宏
		11	李晉維	Observation of gap free Fermi state in Pr <sub>3</sub> Co <sub>4</sub> Sn <sub>13</sub> for possible charge density wave transition	彭維鋒
		12	黃暉智	The Bose-Einstein Condensate of Dark Matter in the Neutron star	陳檉旭
		13	黃柏翔	Searching for Dark Star in aLIGO O3 data	陳檉旭
	大學部	14	林子鈴	Short Wavelength Light Controllable Depletion Zone of Defect In Different Concentration Oxygen Gas Environment	葉炳宏
		15	胡正文	Charge transport mechanism of all-inorganic perovskite quantum dot resistive random-access memory	洪振湧
		16	游雅婷	The electric and magnetic properties of Co/GO interface	洪振湧
		17	林彰裕	半導體與金屬之光學性質-鑽石、矽與鈷	李啟正
		18	王柏雅	ALMA detections of [OIII] and [CII] emission lines from A1689-zD1 at z=7.13	秦一男
12/1(三)	研究所	19	熊家璿	A new way for stochastic gravitational wave background map making using maximum entropy method	劉國欽
		20	陳冠宏	X-ray Spectroscopic Study of Nanostructured Fe <sub>2</sub> TiO <sub>5</sub> /ZnO Heterostructure Interface for High Performance Photoelectrochemical	彭維鋒
		21	朱彥儒	Voltage controlled forming free unipolar resistive switching in AlO <sub>x</sub> - based magnetic tunnel junctions	洪振湧、林大欽
		22	許誌恩	Investigating many body effect and Raman spectrum in Graphene/h-BN heterostructure	薛宏中、李啟正
	大學部	23	吳冠宏	Defect Controlling Nano-Junction Gate Devices Trigger by Gas Molecular with Multiple Wavelength Light	葉炳宏
		24	曾浚翔	Tunneling magnetoresistance of AlO <sub>x</sub> magnetic tunnel junctions with resistive-switching characteristics	洪振湧
		25	宋冠穎	Study and Synthesis of 2D Alloys Material	杜昭宏
		26	許博翔	The effect of hydrogenation on the magnetic properties of Fe-Pd multilayers	洪振湧
		27	許家豪	Combustion synthesis of CuMn <sub>2</sub> O <sub>4</sub>	杜昭宏

## 2021 物理週-學術發表海報競賽 摘要目錄

共計35篇(研究所16篇、大學部19篇)

競賽日期	組別	序號	姓名	論文題目	指導教授
12/2(四)	研究所	28	林暉軒	Origin of the ferromagnetic transition in $\text{Co}_{2-x}\text{ZrSn}$ Heusler alloy Weyl semi-metal	彭維鋒
		29	陳婉婷	The Study of the B-site doping in double layered perovskite $\text{YBaMn}_{2-x}\text{Fe}_x\text{O}_5$	杜昭宏
		30	許明賢	The effect of hydrogenation on the magnetic properties of Fe-Pd multilayers	洪振湧
		31	林奕安	Band gap Shrinkage and Charge Transfer in Two-Dimensional Layered $\text{SnS}_2$ doped with Vanadium : First-principles study	薛宏中
	大學部	32	黃再興	多缺陷光感奈米纖維的製程與面膜上的應用	葉炳宏
		33	陳玫瑜	Effect of Oxygen Defect Structures on the Multiple Wavelength Light Sensing Properties of Defect-Rich Nanofiber Device	葉炳宏
		34	賴誼峰	Effects of Hydrogen Absorption on the Magneto-Transport Properties of Co-Pd Multilayers	洪振湧
		35	侯孟宏	Use NJA to Search for the Interior Solution of Kerr black hole	曹慶堂
		36	張智凱	Structural and magnetic studies of $(\text{Fe}_{1-x}\text{Mn}_x)_2\text{TeO}_6$	杜昭宏

# Neutron Powder Diffraction Study of the Helimagnet YBaCuFeO<sub>5</sub> with B-site Disorder

Chnu-Hao Lai (賴君豪)<sup>1</sup>, Yen-Chung Lai (賴彥仲)<sup>2</sup>, Chin-Wei Wang (王進威)<sup>2</sup>,  
Hung-Cheng Wu (吳紘丞)<sup>3</sup>, and Chao-Hung Du (杜昭宏)<sup>1\*</sup>

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## Abstract

Structural and magnetic properties of variety Cu/Fe ratio of the double perovskite YBa(Cu<sub>1-x</sub>Fe<sub>x</sub>)<sub>2</sub>O<sub>5</sub> were investigated by using neutron powder diffraction (NPD) and susceptibility measurements. The crystal structures of all the samples are formed in a space group of  $P4/mmm$  with in the  $x$  range between 0.45 and 0.55. Susceptibility measurements of YBaCuFeO<sub>5</sub> exhibited two antiferromagnetic transitions at  $T_{N1} \sim 450$  K and  $T_{N2} \sim 175$  K, accompanied with two distinct spin ordering. The refinement results show a commensurate (CM) phase with propagation vector  $Q_{C1} = (1/2 \ 1/2 \ 1/2)$ , between  $T_{N1}$  and  $T_{N2}$ , which as a collinear magnetic structure. Below  $T_{N2}$ , two satellites of incommensurate (ICM) phase were observed at around each commensurate peaks with  $Q_i = (1/2 \ 1/2 \ 1/2 \pm q)$ , indicating the appearance of helical magnetic structure. Furthermore, these observations revealed that  $T_{N2}$  is very sensitive to the concentration of iron, and explained the paradox of transition temperatures in the past reports. For  $x = 0.510$ , extra magnetic reflections emerge with a propagation vector  $Q_{C2} = (1/2 \ 1/2 \ 0)$ , suggesting the coexistence of two commensurate magnetic phases with propagation vectors of  $(1/2 \ 1/2 \ 1/2)$  and  $(1/2 \ 1/2 \ 0)$ , respectively.

**Keywords – Neutron Powder Diffraction, Rietveld Refinement, Incommensurate Phase.**

**A study on neutrino mass problem relating to Xenon1T anomaly**Wen-Teng Chu (朱文騰)<sup>1</sup>, Chian-Shu Chen (陳愷旭)<sup>1\*</sup><sup>1</sup>Department of physics, Tamkang University, New Taipei City, Taiwan  
[hoho26711@gmail.com](mailto:hoho26711@gmail.com)**Abstract**

XENON1T collaboration has reported an excess of electron recoil events last year over the background in the recoil energy in a range 1-7 keV, peaked around 2.4 keV. We apply the one-loop radiative seesaw model which was proposed by E.Ma in 2006 to provide an explanation for the Xenon1T anomaly. The model predicts a stable and long-lived dark matter candidate, which is an inner-doublet scalar field  $\eta$  with additional  $Z_2$ -parity odd. We found the property of nearly mass-degeneracy among the neutral component of  $\eta$  is consistent with XENON1T keV recoil events.

**Keywords** –Xenon1T, neutrino mass mechanism, inelastic dark matter scattering



**Study of Structure and Magnetic Properties of Perovskite  $\text{Pr}(\text{Mn}_x\text{Cr}_{1-x})\text{O}_3$** En-Pei Liu (劉恩沛)<sup>1,3</sup>, Yu-Ting Tai(戴郁庭)<sup>2</sup>, Chao-Hung Du (杜昭宏)<sup>1\*</sup>, and Wei-Tin Chen (陳威廷)<sup>3\*</sup><sup>1</sup>Department of physics, Tamkang University, New Taipei City, Taiwan<sup>2</sup>Department of Chemical Engineering, National Cheng Kung University, Tainan City, Taiwan<sup>3</sup>Center for Condensed Matter Sciences, National Taiwan University, Taipei City, Taiwan[chd@gms.tku.edu.tw](mailto:chd@gms.tku.edu.tw)[weitinchen@ntu.edu.tw](mailto:weitinchen@ntu.edu.tw)**Abstract**

The perovskite oxide has a chemical formula  $\text{ABO}_3$  and has provided a playground for synthesizing the various functional materials, such as superconductors, thermoelectric materials, semiconductors, magnetic materials, multiferroics, and so on. Among these functional materials, the B-site atoms with oxygen form a B-O octahedra and play a key role for the occurrence of the interesting physical properties. In order to understanding the correlations between the B-site atoms and the magnetic phase transition, we study the B site doping effects by changing the ratio of B/B' with different elements of Mn and Cr. In this poster, we report the syntheses of a series of powder samples,  $\text{Pr}(\text{Mn,Cr})\text{O}_3$ , and the characterizations by x-ray powder diffraction. The magnetic property evolution of the solid solution was studied by magnetometer, and their magnetic structures were investigated with neutron powder diffraction.

***Keywords – perovskite, XRD, NPD, magnetic susceptibility***

**A Study of Determination on Neutrino mass hierarchy**Hong-Yu Chou (周宏宇)<sup>1</sup>, Chian-Shu Chen (陳樑旭)<sup>1\*</sup><sup>1</sup>Department of physics, Tamkang University, New Taipei City, Taiwan  
[608210034@mail.tku.edu.tw](mailto:608210034@mail.tku.edu.tw)**Abstract**

Neutrino oscillation has been confirmed as the resolution to the long-standing solar neutrino problem. The key is the so-called Mikheev-Smirnov-Wolfenstein effect which takes into account the interaction between neutrinos and matter during the propagation. The resonant transition probability among neutrino depends on parameters such as the number density of electron ( $n_e$ ), neutrino energies ( $E_\nu$ ) and mass differences of neutrinos ( $\Delta m_{ij}^2 \equiv m_i^2 - m_j^2$ ,  $i, j = 1, 2, 3$  refers to neutrino mass eigenstates). It was found the solar environment with the aid of mixing angle ( $\theta_{ij}$ ) determination, the sign of  $\Delta m_{21}^2$  can be confirmed. However, ambiguity remains for the ordering of  $\Delta m_{31}^2$ . In this project, we study the mass hierarchy (MH) problem by utilizing the matter effect of atmospheric neutrinos which pass through the core of Earth. We discuss the generic theoretical approach and then compare with the collecting data from IceCube and Super-K. The systematic, as well as statistical errors to pin down the MH, are investigated.

**Keywords** – *Neutrino oscillation, Neutrino mass hierarchy, MSW effect*

## **Tunable Hetero-Nanojunction Barrier of Defect Trigger by Multiple Wavelength Light**

Cheng-Hao Yang<sup>1\*</sup>, Chun-Yen Lai<sup>2</sup>, Ping-Hung Yeh<sup>3</sup>

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### **Abstract**

In this research , an electrospinning system and a high-temperature annealing system were used to prepare defect-rich polycrystalline SnO<sub>2</sub> nanofibers and polycrystalline TiO<sub>2</sub> nanofibers, using the oxygen defect structure as the reaction center to combine with water molecules. A hydrophobic glass substrate and a hydrophilic SiO<sub>2</sub> substrate were used to compare the adsorption reaction on the surface of the material. It is found from research that the hydrophilic SiO<sub>2</sub> substrate can greatly improve the performance of TiO<sub>2</sub> and become a multiple wavelength light sensor (365,465,520 nm). It has a good response to moisture,and it has the potential to become a good humidity sensor.



## Study of the A-site substitution effect of the double-layered Fe-based perovskite $AA'CFO_5$

Xie, Wen-Yu(謝文鈺)<sup>1\*</sup>, Liu, En-Pei(劉恩沛)<sup>1</sup>, Liang, Yu-Hui(梁喻惠)<sup>1</sup>, Du, Chao-Hung(杜昭宏)<sup>1</sup>

<sup>1</sup>Department of physics, Tamkang University, New Taipei City, Taiwan  
[phys@mail.tku.edu.tw](mailto:phys@mail.tku.edu.tw)

### Abstract

The double-layered perovskite  $YBaCuFeO_5$  (YBCFO) can be denoted as an oxygen-deficient double perovskite and consists of an alternative arrangement of Cu-O and Fe-O octahedra along c-axis in a unit cell. YBCFO shows a very rich phase diagram including the double-helical spin ordering, and magnetic soliton lattice. The coupling between the Cu-O and Fe-O layers is suspected to be responsible for the formation of such a rich phase diagram. In order to control the coupling strength between the Cu-O and Fe-O layers, we synthesize a series of powder samples by replacing the A-site atoms with different elements such as La, Pr, Sr, and Ca. The synthesized powder samples are characterized to be a single phase by using in-house x-ray powder diffraction.

## 結合機器學習與第一原理方法研究二維材料之聲子能譜

Yi-Ching Tsai (蔡宜靜)<sup>1\*</sup>, Hung-Chung Hsueh (薛宏中)<sup>1</sup>

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### 摘要

透過第一原理計算聲子性質，可以描述晶體中原子集體振動的行為。然而相較總能與能帶結構等基態性質，聲子計算往往需要更高的計算成本與精確度，因此延續本實驗室過去所提出的重新分配力常數方法，在降低計算成本的同時維持一定的精準度。至於力常數的權重可調參數  $d$ ，將會透過深度學習方法來找出。然而深度學習有著「過擬合」的致命問題，為了預防過擬合的發生，最基本的方式就是從一個「小模型」開始。因此我們會先從相對少的層數與參數進行訓練，作為此研究的起步。

此外，本研究著重於二維層狀結構材料，它的厚度被限制在奈米尺度，或甚至只有單一原子大小（如石墨烯、六方氮化硼等），使材料具有特殊的柔軟度、透明度、光學特性與高載子遷移率等；其輕量低耗能且可使元件微小化等的優勢，將在電子學、光學、量子資訊以及半導體等領域上，具有極大的應用潛力。

**Keywords** - 第一原理、聲子計算、機器學習、深度學習、二維材料

**Investigation the Charge Transport properties of Hetero-Nanojunction Gate of defect-rich nanofiber at Various Gas Environment**

Yi-Ching Ou Yang(歐陽依晴)<sup>1</sup>, Chun-Yen Lai(賴俊言)<sup>2</sup>, Guan-Hong Wu(吳冠宏)<sup>1</sup>,

Ping-Hung Yeh(葉炳宏)<sup>1\*</sup>

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**Abstract**

For giant enhancement of the sensing property. We investigated the defect-rich SnO<sub>2</sub> heterojunction nanofiber device, which can be fabricated by the electrospinning system and annealing process between 300 °C to 800 °C. According to defect engineering and grain size effect, the width of depletion not only can be created by defect structure but also served as a heterojunction gate to control the current generation rate. Furthermore, we also obtain the photo current with the multiple wavelengths (365 nm, 520 nm) LED light illuminated and gas sensing (NO, CO) by using the electrical measurement system. These results indicated that defect-rich SnO<sub>2</sub> nano-heterojunction sensing devices can be a good sensor in our daily lives.

**Keywords** : Hetero-junction, SnO<sub>2</sub>, Nanofiber



# Investigating The Magnetic Structure of Single Crystal YBaCuFeO<sub>5</sub> by Neutron and X-ray Scattering

Yu-Hui Liang(梁喻惠)<sup>1\*</sup>, Chun-Hao Lai(賴君豪)<sup>1</sup>, Chin-Wei Wang(王進威)<sup>2</sup>, Shin-ichiro Yano<sup>2</sup>, Kirrily C Rule<sup>3</sup>,  
Daisuke Okuyama<sup>4</sup>, Yen-Chung Lai(賴彥仲)<sup>5</sup>, and Chao-Hung Du<sup>1</sup>

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## Abstract

Multiferroics has been extensively studied because it plays as an important platform for studying the cross-coupling between the different electronic degrees of freedom in the crystal space, such as spin, orbital, charge, and lattice. Using magnetization we observed that single-crystal YBaCuFeO<sub>5</sub> (YBCFO), which grows by modified floating zone method, exhibits two antiferromagnetic transitions at  $T_{N1} \sim 455$  K and  $T_{N2} \sim 175$  K. Below  $T_{N2}$  the magnetic structure transforms from commensurate into an ab-spin spiral magnetic structure with a propagation vector of  $(h/2 \ k/2 \ l/2 \pm \delta)$  and the  $\delta$  is depending on temperature. In addition, from field-dependent AC susceptibility measurement we found an unusual domain structure behavior. In order to establish the mechanism, using elastic neutron scattering. The results indicate that strong magnetic coupling between different magnetic phases due to the strong interactions between Fe and Cu spins and YBCFO forms more domains with decreasing field or temperature. By using resonant x-ray scattering to confirm the mechanisms of the magnetic structure. We speculate that the spiral magnetic structure at low temperature is a double helix, composed of Fe/Cu, and form new helix structures with decreasing field or temperature.

**Keywords** – Magnetic Structure, Elastic Neutron Scattering, Resonant Elastic X-ray Scattering

## Observation of gap free Fermi state in $\text{Pr}_3\text{Co}_4\text{Sn}_{13}$ for possible charge density wave transition

Chin-Wei Li (李晉維)<sup>1</sup>, Hsiao-Tsu Wang (王孝祖)<sup>1</sup>, Abhijeet Shelke<sup>1</sup>, Wei-Xuan Lin (林暉軒)<sup>1</sup>, Kuan-Hung Chen (陳冠宏)<sup>1</sup>, Yu-Hui Liang (梁喻惠)<sup>1</sup>, Sheng-Chia Lu (呂晟嘉)<sup>1</sup>, Chao-Hung Du (杜昭宏)<sup>1</sup>, Chin-Shan Lue (呂欽山)<sup>2</sup> & Way-Faung Pong (彭維鋒)<sup>1</sup>

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[405220285@gms.tku.edu.tw](mailto:405220285@gms.tku.edu.tw) [wfpong@mail.tku.edu.tw](mailto:wfpong@mail.tku.edu.tw)

### Abstract

The local electronic and atomic structure in strongly correlated  $\text{Pr}_3\text{Co}_4\text{Sn}_{13}$  system is studied in this work for possible speculated charge density wave transition ( $T_{\text{CDW}}$ ) using synchrotron X-ray spectroscopic and X-ray diffraction techniques. The indistinct structural transformation in cubic phase to the superlattice variant at  $T_{\text{CDW}} \sim 115$  K has been affirmed from temperature dependent X-ray diffraction measurement. Even though, temperature dependent Co  $L_{3,2}$ -edge X-ray absorption near edge structure (XANES) measurements across the  $T_{\text{CDW}}$  temperature gives nearly identical spectral feature, and does not follow any small/larger shift at the leading edge for  $T > T_{\text{CDW}}$  or  $T < T_{\text{CDW}}$  suggest that this sample does not following Bardeen–Cooper–Schrieffer (BCS) gap and maintaining trigonal prismatic coordination of Co atoms to Sn atoms. This is further evidenced from valence band-photoemission spectroscopy (VB-PES) measurements. It is observed that VB-PES of  $\text{Pr}_3\text{Co}_4\text{Sn}_{13}$  for  $T > T_{\text{CDW}}$  and for  $T < T_{\text{CDW}}$  also does not show any subtle change in the binding energy position at the Fermi level unlike the other well reported  $\text{Ce}_3\text{Co}_4\text{Sn}_{13}$  system accompanied with absence of charge density wave gap across  $T_{\text{CDW}}$ . Additionally, the Co valence state also does not attribute the remarkable change in the oxidation state across the  $T_{\text{CDW}}$  observed from Co  $K$ -edge XANES. Therefore, in this study we paid our attention to find out the order of charge density wave transition by realizing disordered atomic sites in above  $\text{Pr}_3\text{Co}_4\text{Sn}_{13}$  correlated system by studying the local electronic structure.

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**Keywords:** Charge density wave, Correlated system, Electronic structure, Gap free Fermi state,

# The Bose-Einstein Condensate of Dark Matter in the Neutron star

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## Abstract

Neutron star (NS) is an ideal place to capture the interstellar dark matter (DM) due to its strong gravity and high baryonic density. We study the effects of self-interacting DM which is captured by NS and thermalize with the core. By adjusting the parameters of DM such as mass, number density, DM-nucleon cross section  $\sigma_{xn}$  and DM-DM cross section  $\sigma_{xx}$ , we investigate the possibility of the captured DM particles to reach the collapse condition of black hole (BH) in NS core. In particular, for the case of DM is a bosonic particle, the Bose-Einstein Condensate (BEC) might play a role during accumulation. We simulate the cooling processes of NS and the thermalization condition with DM. We discuss the number evolution of DM according to the interplay among thermalization and BEC.

**Keywords** –*self-interacting dark matter, neutron star temperature, Bose-Einstein condensate, black hole*



## Searching for Dark Star in aLIGO O3 data

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### Abstract

Gravitational wave (GW) plays an important role in discovering the universe. Unlike the electromagnetic signals which are easily disturbed during the propagations, GW preserves most information in its production such as masses, spins of stars in binary systems. Although the GW signals of binary black hole (BBH) and binary neutron star (BNS) mergers were firstly detected by advanced LIGO-VIRGO GW detectors in the O1 and O2 observation Runs, some puzzles such as mass gap events challenge the standard formation and distribution of compact stellar objects. Theoretical possibility of the compact star may be composed by dark matter (DM) was proposed in literature, if the mechanism exists, the abundance of dark star (DS) would not be ignored. In this research we adopt the assumption of DM as a fundamental scalar particle, the DS is called a boson star (BS). The main distinct features of BS lie in its compactness and tidal deformation, and these parameters would implement in GW waveforms. We take a Bayesian approach by introducing a tidal parameter in waveform model, and we utilize PyCBC (A Python-based parameter estimation toolkit for compact binary coalescence signals.) to analyze the aLIGO-VIRGO O3 data. We provide a Bayesian inference on the potential BS events.

**Keywords** – Gravitational-Wave , Advanced LIGO, PYCBC

## Short Wavelength Light Controllable Depletion Zone of Defect In Different Concentration Oxygen Gas Environment

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### Abstract

In this research work, the defect-rich SnO<sub>2</sub> nanofiber, which has plenty of oxygen defects can be fabricated by using an electrospinning system and annealing process at 600 °C. Besides, the defect-rich of nanofiber on the surface and interface can be a reaction center with oxygen gas and short wavelength light detection. Furthermore, our device can be a multifunctional sensor, which operates with different relative humidity in the N<sub>2</sub> environment (0% O<sub>2</sub>) and rich-oxygen environment (20% O<sub>2</sub>), respectively. This defect-rich SnO<sub>2</sub> nanofiber device also can be a short wavelength light (465 nm) detectors. These results indicated that defect-rich SnO<sub>2</sub> nanofiber sensor device can be a moisture meter and oxygen gas sensor in our daily life.

**Keywords**-SnO<sub>2</sub> nanofiber, multifunctional sensor, gas sensor

## Charge transport mechanism of all-inorganic perovskite quantum dot resistive random-access memory

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### Abstract

本研究利用全無機鈣鈦礦量子點製作非揮發性電阻式隨機記憶體，結構為 Ag/PMMA/CsPbBr<sub>3</sub>/ITO。實驗上利用改變 PMMA 濃度的方式進行旋塗，並使用掃描式電子顯微鏡 (Scanning Electron Microscope, SEM)、原子力顯微鏡 (Atomic Force Microscope, AFM) 進行鈣鈦礦量子點的品質確認；並以電性量測的方式觀察 I-V 特性曲線，觀察到不同濃度下會有正、負 SET 的情況發生，推測為厚度導致內部傳輸機制不同，藉由 SEM 顯面圖去看厚度對於濃度的影響，其中，電荷傳輸主要由兩個方式進行傳遞，溴空位通道以及銀導電絲通道，結果發現在厚度為 110nm 時為溴空位主導的傳輸機制，70nm 為銀導電絲為主，溴空位通道為輔的傳輸機制。藉由探討不同厚度下的傳輸機制，更能瞭解利用電離的方式操控鹵素離子，進行界面改性，造成不同的物理性質。

**Keywords** —all-inorganic perovskite quantum dot, resistive random-access memory  
Ion transmission mechanism, Resistive switching

## The electric and magnetic properties of Co/GO interface

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### Abstract

本研究探討氧化石墨烯(Graphene oxide ,GO)與磁性金屬鈷 Co 的介面影響。實驗上會藉由電性量測確認電流-電壓特性曲線，也會利用磁光克爾效應(Magneto-optic Kerr effect ,MOKE)量測樣品在不同狀態下的磁性變化。並嘗試透過偏壓調控氧離子遷移，針對 GO 不同的憶阻狀態、電子傳輸機制與介面磁性進行定性研究。

**Keywords** - Magnetic optical Kerr effect, Resistive-switching, Oxygen migration

## 半導體與金屬之光學性質-鑽石、矽與鈷

王偕峻、林彰裕、王哲豪、李啟正

### 摘要

利用第一原理計算，我們可將不同的元素組合成不同的結構，並探討每個結構的穩定性。從材料的能帶結構中，我們可了解各個材料的光學性質。例如，什麼顏色的光會被材料所吸收。我們先探討鑽石、矽與鈷最穩定的結構為何。再利用所算出來的能帶結構，解釋了為何可見光可以穿透鑽石，但無法穿透鈷，且矽也有它獨特的顏色。同時我們也將解釋為何鈷可導電，但是矽與鑽石無法導電。

## ALMA detections of [OIII] and [CII] emission lines from A1689-zD1 at $z=7.13$

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### Abstract

A1689-zD1 is one of the most distant galaxies, discovered with the aid of gravitational lensing, providing us with an important opportunity to study galaxy formation in the very early Universe. In this study, we report the detection of [CII]158 $\mu$ m and [OIII]88 $\mu$ m emission lines of A1689-zD1 in the ALMA Bands 6 and 8. The observed  $L_{[\text{OIII}]} / L_{[\text{CII}]}$  is  $2.17 \pm 0.14$ , higher than most of the local galaxies, but consistent with other  $z \sim 7$  galaxies. The high spatial resolution of ALMA data provided us with a precious opportunity to investigate spatial variation of  $L_{[\text{OIII}]} / L_{[\text{CII}]}$ . In contrast to the average value of 2.17, we find a much higher  $L_{[\text{OIII}]} / L_{[\text{CII}]}$  of  $\sim 7$  at the center of the galaxy. This spatial variation of  $L_{[\text{OIII}]} / L_{[\text{CII}]}$  was seldom reported for other high- $z$  galaxies. It is also interesting that the peak of the ratio does not coincide with optical peaks. Possible physical reasons include a central AGN, shock heating from merging, and starburst. Our moderate-spatial resolution data also reveals an additional redshifted part in the northwestern part of the galaxy, aside from the observed optical northeastern and southwestern clumps shown previously in HST images. Such complex structure might suggest that the A1689-zD1 is a merging galaxy, with the redshifted northern part as ejected materials; or that the redshifted material comes from the third, more obscured region of the galaxy.

**Keywords** – galaxies: high-redshift, galaxies: kinematics and dynamics, submillimeter: galaxies, radio lines: galaxies



## **A new way for stochastic gravitational wave background map making using maximum entropy method**

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### **Abstract**

Maximum Entropy Method (MEM) is widely used in the image deconvolution in radio astronomy. However, this method has never been used in gravitational wave map making process. In this work, we use MEM to reconstruct the sky map of Stochastic Gravitational Wave Background (SGWB). Using simulations, we expect that the MEM is useful to study the anisotropies of SGWB with the network of gravitational wave observatories that includes Advance LIGO, Advance Virgo and KAGRA.

***Keywords – SGWB***

## **X-ray Spectroscopic Study of Nanostructured Fe<sub>2</sub>TiO<sub>5</sub>/ZnO Heterostructure Interface for High Performance Photoelectrochemical Application**

Kuan-Hung Chen, Abhijeet Ravsaheb Shelke, Hsiao-Tsu Wang, Chin-Wei Li, Wei-Xuan Lin, Shu-Ang Teng, Tai-Chen Wu, Wu-Gee Wei and Way-Faung Pong

### **Abstract**

Fabrication of highly ordered heterostructure interfaces plays a key role in development of efficient photoanodes for photoelectrochemical (PEC) applications. Herein we have designed and fabricated nanostructured Fe<sub>2</sub>TiO<sub>5</sub>/ZnO heterojunction interfaces with nanorods (NR) and nano dendrite (ND) microstructure for the separation and utilization of photogenerated charge carriers. The local electronic and atomic structure were investigated by synchrotron-based X-ray spectroscopic techniques under illumination of visible light and under the dark operating conditions to understand the improved PEC performance of nanostructured Fe<sub>2</sub>TiO<sub>5</sub>/ZnO heterostructure interface. Observed maximum spectral difference of O *K*-edge X-ray absorption near edge structure (XANES) for ND heterostructure interface under the illumination of visible light is due to availability of maximum positive charges at the electrode for the PEC reaction. Furthermore, additional unoccupied density of states in NR and/or ND heterostructure interfaces compare to bare ZnO samples in O *K*-edge XANES suggest that formation of additional hybridized state potentially promoted by interfacial *d*-orbital charge transfer across Ti - Zn. This modification of the local electronic structure at the interface of Fe<sub>2</sub>TiO<sub>5</sub>/ZnO heterostructure enhance the efficiency of PEC performance by absorption of maximum visible light by lowering the electron hole recombination. Therefore, formation of additional hybridized state across the interface leaded reorganization of the local electronic structure, more preferentially for the ND heterostructure interfaces accompanying more interfacial charge transfer during the PEC reaction.

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**Keywords:** Heterostructure, Interface, Photoelectrochemical, charge transfer, X-ray spectroscopy

## Voltage controlled forming free unipolar resistive switching in $\text{AlO}_x$ -based magnetic tunnel junctions

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We fabricate an aluminum oxide magnetic tunnel junction (MTJ) that exhibit the resistive switching (RS) and tunneling magnetoresistance (TMR) properties. By investigating the set and reset process with compliance current ( $I_{CC}$ ) at the same polarity, the device shows a typical I-V characteristics of unipolar RS. A metallic I-V curve and lower MR ratio are observed at the low resistance state (LRS). However, a non-linear I-V characteristic and higher MR ratio are shown at high resistance state (HRS). With the MR measurement in an out-of-plane rotation of magnetic field, the decrease of the MR ratio is not obvious in LRS. It implies that the conduction mechanism is not associated with the ferromagnetic filament formed by electrodes. Based on the I-V characteristics of the device, the conduction mechanism and Joule heating effect are included to discuss the RS and TMR properties.

**Keywords:** magnetic tunnel junction, unipolar resistive switching, tunneling magnetoresistance

# Investigating many body effect and Raman spectrum in Graphene/h-BN heterostructure

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## Abstract

Angle-resolved photoemission spectroscopy (ARPES) and Raman spectrum are powerful tools for investigating the electron structure and structure details of nanoscale materials. In advanced, first-principles calculation can provide a theoretical analysis for experimental observations. In this work, we perform quasi-particle band structure calculations in the GW approximation and layer-dependent Raman spectrum of Graphene/h-BN heterostructure. Furthermore, the stacking dependence band structure have also been investigated. Our results show that the GW corrected band structures of Graphene/h-BN heterostructure are in very good agreement with recent ARPES measurements, which suggest that many-body effects in 2D materials are indeed essential.

**Keywords –** *First-principles calculation, GW approximation`*

## **Defect Controlling Nano-Junction Gate Devices Trigger by Gas Molecular with Multiple Wavelength Light**

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In this research work, defect-rich poly-crystalline SnO<sub>2</sub> nanofiber, which has plenty of oxygen defects by the electrospinning system and high-temperature annealing process. Besides, according to defect engineering, plenty of depletion areas can be created at the nano interface, which became a nano junction gate to well control the bend structure and electrical transport property between the grain-boundary. Furthermore, the oxygen defect structure also can be a reaction center to binding with water molecules and detecting multiple wavelength lights in different humidity environments. We also obtain the Raman spectrum of oxygen vacancies with different humidity environments by using the in-situ Raman spectrum system. Hence, a defect-rich SnO<sub>2</sub> nanofiber photocatalytic sensing device can be achieved. This device provided many advantages. First, the device can be operated in a low and high humidity environment (3%-75%) to enhance the sensing property. Second, the high photocatalytic property with multiple wavelength light (365 nm, 465 nm, and 520 nm). Defect-rich SnO<sub>2</sub> nanofiber photocatalytic sensing device has good potential for commercialization and use as toxic gas and photon sensor in the high humidity environment.

## Tunneling magnetoresistance of AlO<sub>x</sub> magnetic tunnel junctions with resistive-switching characteristics

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### Abstract

本研究探討 AlO<sub>x</sub> 磁穿隧接面 (Magnetic tunnel junctions, MTJs) 結構的自旋傳輸機制以及偏壓對氧化層的影響。透過磁光柯爾效應 (Magnetic optical Kerr effect, MOKE) 實驗針對接面、上層與下層鐵磁層的磁滯行為進行觀測。我們發現磁光訊號在外加磁場變化下的磁矩有平行和反平行的翻轉過程，結果表示因為上下層矯頑場的不同導致接面出現階梯式的磁滯曲線。此外我們利用電性量測方式，透過偏壓調控氧空缺的分布後可以觀察到高低電阻態並且磁阻訊號也會產生變化，代表氧空缺的遷移能影響自旋電子傳輸與穿隧之間的物理機制。

**Keywords** – Magnetic tunnel junctions, Magnetic optical Kerr effect, Magnetic hysteresis curve, Tunneling magnetoresistance, Resistive-switching, Oxygen migration



## Study and Synthesis of 2D Alloys Material

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### Abstract

Heusler compounds are magnetic intermetallics with face-centered cubic (FCC) crystal structure and a composition of XYZ (half-Heuslers) or X<sub>2</sub>YZ (full-Heuslers), where X and Y are transition metals and Z is in the p-block. In this post, we start from XZ, which X is iron, Z is tellurium. After FeTe alloy is successful, adding Y, which would be manganese. After FeMnTe is successful, adding different proportion of Fe and Mn. The FeTe sample are prepared by grinding uniformly the mixture of iron powder and tellurium powder respectively, and pressing it as a ingot. The FeTe ingot is in a vacuum-sealed silica-glass tube then sintering in furnace at 600°C for 24 hours. This post shows the technique to seal vacuum-silica-glass tube for sintering alloys and X-ray powder diffraction patterns of the samples which is FeTe alloys.

**Keywords** – Heusler compound, Fe, Te, seal silica-glass tube, alloy

## The effect of hydrogenation on the magnetic properties of Fe-Pd multilayers

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### Abstract

本研究根據鈰(Pd)具有靈敏的吸氫氣(H<sub>2</sub>)能力，探討在氫化效應(Hydrogenation)下 [Pd(1nm)/Fe(1nm)]<sub>20</sub> 多層膜的磁性特徵。實驗上利用磁光柯爾效應(Magnetic Optical Kerr Effect, MOKE)量測磁光訊號，我們觀察到隨著曝氫壓力上升，磁矯頑場下降一定程度後會達到穩定，其意味著鈰對氫原子的吸附已趨於飽和，此外我們分析在大氣與氫氣環境下的磁滯曲線(Magnetic hysteresis loop)，結果磁矯頑場有明顯的下降，差距最大到 4.9 Oe，磁異向性也有所改變，磁易軸旋轉大約 10 度，該結果表明氫化後，鈰可能膨脹並與鐵介面產生交互作用。本實驗說明鈰對氫氣的確是很敏感，並且能有效利用氫化鈰的結構變化控制多層膜磁性特徵。

**Keywords:** Hydrogenation, Magnetic Optical Kerr Effect, Magnetic hysteresis loop, Coercivity, Square, Magnetic anisotropy, Magnetic easy axis.

**Combustion synthesis of  $\text{CuMn}_2\text{O}_4$** Chia-Hao Hsu<sup>1</sup> (許家豪), Chao-Hung Du<sup>1</sup> (杜昭宏)<sup>1</sup>Department of physics, Tamkang University, New Taipei City, Taiwan  
[408220407@o365.tku.edu.tw](mailto:408220407@o365.tku.edu.tw)**Abstract**

The crystal structure of spinel was determined independently by Bragg and Nishikawa. The majority of spinel compounds belong to the space group  $\text{Fd}\bar{3}\text{m}$ . This cell consists of two molecular  $\text{AB}_2\text{X}_4$  units. This time, using  $\text{CuO}$  and  $\text{Mn}_2\text{O}_3$  powders synthesized the  $\text{CuMn}_2\text{O}_4$ . According to the XRD patterns, the single crystal phase of spinel can be obtained for calcination at  $800^\circ\text{C}$  and  $900^\circ\text{C}$ . However, at  $1000^\circ\text{C}$ , the spinel decomposed into  $\text{MnO}$  and  $\text{CuO}$  compounds.

**Keywords** –  $\text{CuMn}_2\text{O}_4$ , spinel

## Origin of the ferromagnetic transition in $\text{Co}_{2-x}\text{ZrSn}$ Heusler alloy

### Weyl semi-metal

Wei-Xuan Lin(林暉軒)<sup>1\*</sup>, Anirudha Ghosh<sup>1</sup>, Hsiao-Tsu Wang (王孝祖)<sup>1</sup>, Kuan-Hung Chen (陳冠宏)<sup>1</sup>, Yu-Hui Liang (梁喻惠)<sup>1</sup>, Chao-hung Du (杜昭宏)<sup>1</sup>, Shang-Hsien Hsieh (謝尚憲)<sup>1,2</sup>, Chia-Nung Kuo (郭家農)<sup>3</sup>, Chin-Shan Lue (呂欽山)<sup>3</sup>, Hong-Ji Lin (林宏基)<sup>2</sup>, Jyh-Fu Lee (李志甫)<sup>3</sup>, Way-Faung Pong (彭維鋒)<sup>1</sup>

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### Abstract

The Heusler alloy single crystal of  $\text{ZrCo}_{1.6}\text{Sn}$  has been predicted to be a topological Weyl semimetal with the time reversal symmetry breaking by the ferromagnetism. This investigation aims to understand the electronic and local atomic structure by using temperature-dependent X-ray linear dichroism (XLD), X-ray magnetic dichroism (XMCD) and Extended x-ray absorption fine structure (EXAFS) spectra. Magnetization and resistivity measurements respectively reveal paramagnetic-to-ferromagnetic ( $T_c$ ) and insulator-to-metal ( $T_{\text{IM}}$ ) transitions near  $\sim 170$  K. The XMCD of Co  $L_{3,2}$  edge exhibits the ferromagnetic behavior. Analysis of the extended x-ray absorption fine structure spectra at Sn  $K$ -edge also show an increase in static disorder due to out-of-plane local lattice distortion (LLD), below  $\sim 170$  K, for the incident x-ray polarization parallel to the out-of-plane direction of the sample ( $\mathbf{E} \parallel [222]$ ). However, similar measurements along the in-plane ( $\mathbf{E} \perp [222]$ ) direction show the in-plane LLD at/below 190 K. This coincides with the temperature ( $T_h \sim 190$  K) at which the preferential hole occupancy in the Co  $3d$  in-plane orbital states begins to increase. Therefore, it is evident that the in-plane lattice-orbital correlation at/below 190 K triggers out-of-plane LLD, and subsequently paramagnetic-to-ferromagnetic transition due to possible spin-lattice-orbital coupling below 170 K. A finite temperature difference between  $T_{\text{IM}}$  and  $T_h$  indicates that the breakdown of time reversal symmetry near 170 K is responsible for the semi-metallic behavior.

**Keywords** -Topological material, Heusler alloy, X-ray Absorption

## The Study of the B-site doping in double layered perovskite $\text{YBaMn}_{2-x}\text{Fe}_x\text{O}_5$

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### Abstract

We reported the synthesis and magnetics change in  $\text{YBaMn}_{2-x}\text{Fe}_x\text{O}_5$  ( $\text{YBM}_{2-x}\text{F}_x\text{O}$ ). The sample is in the hypoxic double-layer perovskite structure  $\text{YBaMn}_2\text{O}_5$  ( $\text{YBMO}$ ), and the structure changes of the sample were observed after doping with iron in B-site. This sample was synthesized by solid-state reaction method, and a series of single-phase samples were synthesized. Then perform XRD detection through refine, it can be determined that the space group of the sample is  $P4/nmm$ . After measuring the magnetic properties, it can be found that as the proportion of iron mixed in is different, the magnetic pole has a great change.

## **The influence of H<sub>2</sub> absorption on the magneto-transport properties of Fe-Pd multilayers**

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In this study, we demonstrate that the anisotropic magnetoresistance (AMR) effect of the Fe/Pd multilayer was observably affected by the hydrogen absorption. By measuring the angular dependence of AMR in a current-in-plane (CIP) configuration in different environments of the hydrogen pressure, we found that the resistance reduced with increasing hydrogen pressure and that AMR ratio varied significantly with magnetization vector rotating. The phase transition (from  $\alpha$  phase to  $\beta$  phase) of Pd exposure to hydrogen gas, as demonstrated by the previous studies, could lead to the lattice expansion which corresponds to the change in resistance and AMR ratio of Fe/Pd multilayer.



# Band gap Shrinkage and Charge Transfer in Two-Dimensional Layered SnS<sub>2</sub> doped with Vanadium : First-principles study

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## Abstract

Tin disulfide (SnS<sub>2</sub>) has recently emerged as a 2D layered metal sulfide with various applications such as visible light photocatalysis in CO<sub>2</sub> reduction and water splitting, *etc.* Due to its promising potential on applications, the detail knowledge of atomic or volumetric doping of the layered SnS<sub>2</sub> is therefore essential.

In this work, we used first-principles calculations to simulate electronic and atomic structures of V-doped layered SnS<sub>2</sub>. The theoretical simulation can not only help us to optimize the position of doping Vanadium, but also to analyze the doping effects on its electronic structure with the advantage of tuning band-gap in layered compounds. By optimizing the position of V-doped layered SnS<sub>2</sub> and analyzing the electronic structure, it turns out that doping Vanadium gives rise to a band-gap shrinkage and possible charge transfer which plays a key role to enhance photocatalytic efficiency of this quasi-2D systems. Indeed, our calculations agree closely with the X-ray spectroscopy findings recently <sup>[1]</sup> and the comparison will also be discussed.

**Keywords** – First-principles calculation, band-gap shrinkage, charge transfer, V-doped layered SnS<sub>2</sub>

[1] The related work has been accepted for publishing in Small recently.

## 多缺陷光感奈米纖維的製程與面膜上的應用

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### Abstract

面膜是現代人對臉部保濕最常用的方式之一,根據玻尿酸、尿囊素、甘油、膠原蛋白等高分子聚合物對於肌膚的表皮層與真皮層具有保濕、鎖水及抗皺等功效。根據缺陷工程,由於奈米纖維表面具有奈米等級的高缺陷晶粒能與不同波段的光源反應產生不同強度的光電流。因此,本實驗為了增強精準保濕提升保水性並達到微電流光拉提效果,本實驗室開發了具多缺陷結構的金屬氧化物奈米光感微電流奈米纖維。當奈米纖維透過玻尿酸、尿囊素、甘油、膠原蛋白等高分子聚合物進行塗層後,我們不只能提供貼合度高、調理肌膚、吸收效果、透氣保濕,更可透過奈米纖維產生的微電流提高皮膚細胞修復的速度、抗皺與緊實能力。我們更利用自行設計的臨場拉曼(Raman)與電流特性分析系統進行各種成分分析,研究奈米纖維面膜的優勢。搭配玻尿酸、尿囊素、甘油、膠原蛋白等高分子聚合物來達到更佳保濕的功效。經由實驗證實,多缺陷結構的金屬氧化物奈米光感微電流奈米纖維確實可以成為新一代的奈米纖維面膜。

**Keywords – 保養品、奈米纖維、面膜**

## Effect of Oxygen Defect Structures on the Multiple Wavelength Light Sensing Properties of Defect-Rich Nanofiber Device

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### Abstract

In this research work, we investigated a defect-rich SnO<sub>2</sub> nanofiber, which can be multiple wavelengths (580 to 365 nm) LED light detector due to the plenty of oxygen defect structures at the nano-interface of grain. These different defect structures can be fabricated and tuned by the electrospinning system and annealing process with different oxygen environments (0 to 40%). According to defect engineering, oxygen defects at the nano-interface of grain not only can be the generation-combination centers to reaction with different wavelength light. Hence, a multifunctional defect-rich sensor device can be achieved. The detection ability, which can be analyzed by the electrical measurements system we designed. The fast response time and high generation rate indicated that the multifunctional defect-rich SnO<sub>2</sub> nanofiber can be served as a photon-sensing device in our daily lives.

**Keywords** – oxygen defect ,nanofiber

# Effects of Hydrogen Absorption on the Magneto-Transport Properties of Co-Pd Multilayers

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In this study, we report on the magneto-transport properties of the [Co/Pd]<sub>20</sub> multilayers in a hydrogen gas atmosphere. We measure the hysteresis curve using magneto-optical Kerr effect (MOKE) and anisotropic magnetoresistance (AMR) at various hydrogen pressure. The magnetic anisotropy of the sample tends to be the in-plane direction. Hydrogen absorption induces a resistance reduction, and interestingly, the variation of the MR ratio with increasing hydrogen pressure exhibits Ruderman-Kittel-Kasuya-Yosida (RKKY)-like behavior. Previous studies have demonstrated that when exposes Pd thin film to hydrogen gas atmosphere, hydrogen absorption will contribute to a volume expansion of the Pd.<sup>[1-2]</sup> The RKKY-like behavior of MR variation in our study could be due to the modification of the distance between two ferromagnetic layers with increasing hydrogen pressure.

## Reference:

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**Keywords:** Hydrogen absorption, magneto-optic Kerr effect (MOKE), anisotropic magnetoresistance (AMR), Ruderman-Kittel-Kasuya-Yosida (RKKY)

## Use NJA to Search for the Interior Solution of Kerr black hole

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### Abstract

Black holes are an existence permitted by the theory of relativity. In addition to having singularities and event horizons, black holes are also very compact. By solving the geodesic equation, we know that external observers cannot access the information inside the black hole. It is very curious how this mysterious entity is formed and what material it is composed of.

After Karl Schwarzschild obtained the Schwarzschild metric, its internal solution was quickly solved. But for the Kerr metric, the internal solution has not been easy to find. Because the Kerr metric is an axially symmetric metric, it has non-zero non-diagonal terms. Compared with a metric without non-diagonal terms, the complexity of the calculation is greatly increased by having these terms. However, in 1965, E. T. Newman and A. I. Janis found a method called the Newman–Janis algorithm (NJA), which is capable of using spherically symmetric metrics to generate axially symmetric ones. This provides us with a new way to find the interior solution of the Kerr metric. In our work, we look for the interior solution of the Kerr metric, and study the transformation of the material and junction conditions under the NJA.

**Keywords** – NJA, Kerr black hole, Junction conditions

## Structural and magnetic studies of $(\text{Fe}_{1-x}\text{Mn}_x)_2\text{TeO}_6$

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### Abstract

Both  $\text{Fe}_2\text{TeO}_6$  and  $\text{Mn}_2\text{TeO}_6$  have been known to have the inverse trirutile structure, but they possess the different crystal structures at room temperature, i.e.,  $\text{Fe}_2\text{TeO}_6$  is tetragonal with a space group ( $P4_2/mnm$ ) and  $\text{Mn}_2\text{TeO}_6$  is monoclinic phase ( $P2_1/c$ ). Since  $\text{Fe}^{3+}$  and  $\text{Mn}^{3+}$  have almost same ionic size, attempt is therefore made to investigate the doping effect and the physical properties by mixing the transition metal ions Mn and Fe. We have successfully synthesized a series of powder samples of  $(\text{Fe}_{1-x}\text{Mn}_x)_2\text{TeO}_6$ ,  $0 \leq x \leq 1$ , and they are first characterized to be good quality by x-ray powder diffraction. The refined diffraction data show the linear dependence of the lattice parameter with the concentrations of Mn. In addition, The magnetization measurements show at  $(\text{Fe}_{0.1}\text{Mn}_{0.9})_2\text{TeO}_6$  &  $\text{Mn}_2\text{TeO}_6$  found the first-order transition occurring.

**Keywords** – x-ray powder diffraction 、 inverse trirutile structure 、 magnetism