南方科技大学
SOUTHERN UNIVERSITY OF SCIENCE AND TECHNOLOGY

课程详述

COURSE SPECIFICATION

以下课程信息可能根据实际授课需要或在课程检讨之后产生变动。如对课程有任何疑问，请联系授课教师。

The course information as follows may be subject to change, either during the session because of unforeseen circumstances, or following review of the course at the end of the session. Queries about the course should be directed to the course instructor.

1.	**课程名称 Course Title**	研究型物理实验 Physics Laboratory IV
2.	**授课院系 Originating Department**	物理系 Department of Physics
3.	**课程编号 Course Code**	PHY301
4.	**课程学分 Credit Value**	3
5.	**课程类别 Course Type**	专业核心，Major Core
6.	**授课学期 Semester**	秋季 Fall
7.	**授课语言 Teaching Language**	中文 Chinese
8.	**授课教师、所属学系、联系方式（如属团队授课，请列明其他授课教师） Instructor(s), Affiliation& Contact （For team teaching, please list all instructors）**	曾孝奇，工程师，物理系 第一教学楼 332 室 Zengxq@sustech.edu.cn 0755-8801-8708 Zeng Xiaoqi, Engineer, Physics Department, Rm332,Teaching Building 1, Zengxq@sustech.edu.cn 0755-8801-8708 陈佶，工程师，物理系 第一教学楼 333 室 Chenj@sustech.edu.cn 0755-8801-8705 CHEN Ji, Engineer, Physics Department, Rm333,Teaching Building 1, Chenj@sustech.edu.cn 0755-8801-8705 杨珺，工程师，物理系 第一教学楼 333 室 yangj@sustech.edu.cn 0755-8801-8706 Yang Jun, Engineer, Physics Department, Rm333,Teaching Building 1, yangj@sustech.edu.cn

		0755-8801-8706 邵明珍，工程师，物理系 第一教学楼 334 室 Shaomz@sustech.edu.cn 0755-8801-8707 Shao mingzhen Engineer, Physics Department, Rm336,Teaching Building 1, Shaomz@sustech.edu.cn 0755-8801-8707 王才林，工程师，物理系 第一教学楼 335 室 Wangcl@sustech.edu.cn 0755-8801-8710 Wang Cailin, Engineer, Physics Department, Rm335,Teaching Building 1, wangcl@sustech.edu.cn 0755-8801-8710 张贤高，工程师，物理系 第一教学楼 337 室 Zhangxg@sustech.edu.cn 0755-8801-8782 Zhang Xiangao, Engineer, Physics Department, Rm337,Teaching Building 1, Zhangxg@sustech.edu.cn 0755-8801-8782 邓冬梅，工程师，物理系 第一教学楼 336 室 dengdm@sustech.edu.cn 0755-8801-8712 Deng dongmei Engineer, Physics Department, Rm336,Teaching Building 1, dengdm@sustech.edu.cn 0755-8801-8712 许婷婷，工程师，物理系 第一教学楼 336 室 xutt@sustech.edu.cn 0755-8801-8712 Xu Tingting Engineer, Physics Department, Rm336,Teaching Building 1, dengdm@sustech.edu.cn 0755-8801-8233 王晓峰，工程师，物理系 第一教学楼 337 室 Wangxf3@sustech.edu.cn 0755-8801-8782 Wang Xiaofeng, Engineer, Physics Department, Rm337,Teaching Building 1, Wangxf3@sustech.edu.cn 0755-8801-8230
9.	**实验员/助教、所属学系、联系方式** **Tutor/TA(s), Contact**	待公布 To be announced
10.	**选课人数限额(可不填)** **Maximum Enrolment**	

（Optional）					
11. 授课方式 Delivery Method	讲授 Lectures	习题/辅导/讨论 Tutorials	实验/实习 Lab/Practical	其它(请具体注明) Other（Please specify）	总学时 otal
学时数 Credit Hours			96		96
12. 先修课程、其它学习要求 Pre-requisites or Other Academic Requirements	大学物理 B 上（PHY103B）				
13. 后续课程、其它学习规划 Courses for which this course is a pre-requisite	无 NA				
14. 其它要求修读本课程的学系 Cross-listing Dept.					

教学大纲及教学日历 SYLLABUS

15. 教学目标 Course Objectives

研究型实验课程涉及领域为现代物理技术与现代物理综合实验，包括原子分子光谱实验、脉冲核磁共振与核磁共振成像实验、光信息处理综合实验、光纤干涉与通讯综合实验、光的力学效应系列实验、扫描隧道显微实验、原子力显微实验、材料制备与性能测试实验等,涵盖着广阔的现代科技与研究领域。上课模式以开放型、科研小实践课题研究型为主。本课程是教学与科研相结合的课程，其目的是使教学与科研接轨，使学生了解科研的全过程、学习科研思想、科研方法、科研精神，进一步激发学生的学习兴趣、提高他们的自主学习能力、探究精神和创新能力，特别是提高他们理论与实际相结合的应用能力和实践能力。

Physics Laboratory IV includes experiments of the atom and molecule spectroscopy, pulse nuclear magnetic resonance (pNMR) and magnetic resonance imaging (MRI), interference and communication of optical fiber, optical tweezer, scanning tunneling microcopy (STM), atomic force microscopy (AFM), etc. The teaching schedule includes the process of open experiment elective via internet (8 labs of 10 weeks) and the research project of 5 weeks. This course is a combination of teaching and research, aiming to let students know the research process and learn the research thoughts, methods and spirit to stimulate the physics interests. It specially improves the application and practical ability of physics theory.

16. 预达学习成果 Learning Outcomes

1. 学生对研究型实验课程的内容、教学模式，特别是对教学与科研相结合的研究型实验科研小实践的课题充满兴趣和探究的热情。
2. 在研究型实验教学中，学生们自主学习、自主探究、自主创新能力实质性地得到提高。他们能够综合应用基础物理实验、综合物理实验、现代物理技术实验和研究型实验的知识、实验思想、实验方法等在课题小实践中，表现出很强的自主设计能力、应用能力、实践能力和创新能力。.

1. Students have exploring passions to the contents and teaching mode of this course, especially having lively interests in the research projects.
2. During the teaching process, the initiative, independent, innovative research capability of students has a remarkably enhancement. The students can apply the physics knowledge and technology into the research projects expertly, which gained from the former course (physics laboratory I,II,III). The research projects show the designing, practical and creative ability of students.

17. 课程内容及教学日历 （如授课语言以英文为主，则课程内容介绍可以用英文；如团队教学或模块教学，教学日历须注明主讲人）

Course Contents (in Parts/Chapters/Sections/Weeks. Please notify name of instructor for course section(s), if this is a team teaching or module course.)

教学周第一、二周：

绪论：一、现代物理综合实验思想与方法　　二．研究型实验课程教学要求　　**主讲人:邵明珍**

Week 1-2:

Introduction: 1. Experiment Thoughts and Methods of Modern Physics

2. Requirements of Physics Laboratory IV

教学周 第三周--第十周： 第三周熟悉实验及选课，四到十周学生利用选课系统在以下实验中任选并完 7 个实验

Week 3-10: Students select and finish 8 experiments by the Experiment Elective System via internet.

实验一、 白光全息实验　指导教师：杨珺

实验内容：1.搭建像面全息光路图；2.用氦氖激光器进行波前记录；3.用白光扩展光源波前再现，观察像面全息图的再现像；4.搭建一步彩虹全息光路图；5.用氦氖激光器进行波前记录；6.用白光扩展光源波前再现，观察一步彩虹全息图的再现像；7.比较像面全息图与一步彩虹全息图的异同。

Experiment 1 White light holography　Instructor：Yang Jun

Content： 1. Know the theory of white light reconstructing holograms. 2. Record and reconstruct image plane holograms and rainbow holograms. 3. Observe these holograms and compare image plane holograms with rainbow holograms.

实验二、 θ 调制、卷积定理等傅里叶光学扩展实验　指导教师：陈佶

实验内容：1.搭建 θ 调制假彩色编码光路图，观察 θ 调制片的空间频谱，并进行空间滤波，成出彩色的像；2.利用空间频率不同两个光栅，观察两个函数卷积，理解卷积定理；3.利用 θ 调制空间伪彩色编码原理，设计并制作一个两种颜色以上的图案。

Experiment 2 Experiments of Θ modulation and pseudo-color coding based on Fourier Optics　Instructor：Yang Jun

Content：1. know the theory of Θ modulation and pseudo-color coding based on Fourier Optics. 2. Demonstrate the convolution theorem using two different gratings. 3. Design and make a pseudo-color image containing more than two different colors.

实验三、 光纤干涉传感实验　指导教师：曾孝奇

实验内容：1.搭建马赫-曾德光纤干涉仪；2.测量干涉仪的温度灵敏度；3.根据测定光纤温度灵敏度测量未知温度。

Experiment 3 The fiber-optic interferometer sensor　Instructor：Zeng Xiaoqi

Content: 1 build Mach - Zehnder fiber interferometer; 2 measure the temperature sensitivity of the interferometer; 3 measure the unknown temperature based on fiber optic temperature sensitivity.

实验四、 扫描隧道显微镜实验　指导教师：王晓峰

实验内容：1．学习和了解并掌握扫描探针显微镜的工作原理和仪器结构；2．观测和验证量子力学中的隧道效应以及原子间相互作用力；3．学习扫描探针显微镜的操作和调试过程，并以之来观测样品的表面形貌；

Experiment 4 Scanning Tunnelling Microscope Instructor: Zhang Xiangao

Content: 1 To learn and understand the working principle and structure of the scanning probe microscope; 2 to learn and understand the tunneling effect in quantum mechanics; 3 to learn the operation of the scanning probe microscope, and observe the surface morphology of the sample.

实验五、 原子力显微镜实验 指导教师：王晓峰

实验内容：1．学习和了解 AFM 的结构和原理。2．掌握 AFM 的操作和调试过程，并以之来观察样品表面的形貌。3．学习用计算机软件来处理原始数据图像。

Experiment 5 Atomic Force Microscope Instructor: Zhang Xiangao

Content: 1 To learn and understand the working principle and structure of AFM; 2 to learn the operation of AFM, and observe the surface morphology of the sample; 3 to learn how to process data images using software

实验六、 激光拉曼实验 指导教师：王才林

实验内容：1、理解激光拉曼的原理 2、熟悉并掌握光谱仪的原理及操作 3、正确调节外光路，使散射信号进入光谱仪 4、测量不同浓度苯掺杂 CCl4 的拉曼光谱

Experiment 6. Laser Raman spectra Instructor: Wang Cailin

Content: 1.Understanding the principle of Raman spectra 2.Master the operation of Raman spectrometer 3.Correctly adjust the scattering signal to the spectrometer 4.Measure the Raman spectra of carbon tetrachloride doped with benzene

实验七、 高温超导材料的导电性能及转变温度的测量 指导教师：王才林

实验内容：1、掌握利用传统固相反应法制备超导 YBa2Cu307-x 的方法和步骤 2、利用自制样品观察迈斯纳效应 3、掌握利用四探针法测量超导转变温度的方法

Experiment 7 The measurement of electrical conductivity and transition temperature of high-temperature superconductivity Instructor: Wang Cailin

Content: 1.Master the method of preparing superconductor YBa2Cu307-x by traditional solid-state reaction 2.Observe the Meisner effect via the home-made sample 3.Master the four-probe measurement of the transition temperature of superconductivity

实验八、 变温霍尔效应实验 指导教师：邓冬梅

实验内容：1、理解并掌握霍尔效应的基本原理 2、掌握霍尔电压的测量方法 3、通过测量材料的霍尔电压及电阻值计算出载流子浓度、迁移率和电导率随温度变化的趋势

Experiment 8 Experiments of temperature-dependent Hall Effect Instructors: Deng Dongmei

Content: Understand and master the basic principle of Hall Effect 2. Master the method for measuring the Hall voltage 3.Calculate the carrier density, mobility and conductivity by measuring the Hall voltage and resistance at different temperature, and analyze the changes of these quantities with temperature.

实验九、 光的力学效应系列实验 指导教师：张欢

实验内容：1、了解光的力学效应 2、对粒子进行横向及纵向的操作 3、通过对横向阱阈的测量计算出光镊对粒子的最大捕

获力

Experiment 9 Experiments on photomechanical effect Instructors: Deng Dongmei

Content: 1. Understanding the photomechanical effect 2. Manipulating the movement of micro-scale particles at transvers and longitudinal directions 3. Calculate the maximum trapping force by measuring the transverse well-field.

实验十、 常温变温下的吸收与发射光谱 指导教师：邓冬梅

实验内容：1、调节光路 2、熟练操作光谱仪、锁相放大器等测量系统 3、利用温控仪调节样品的温度并测量样品的吸收与发射光谱

Experiment 10 Temperature-dependent absorption and emission spectrums Instructors: Deng Dongmei

Content: 1. Optical path set-up. 2. Skilled manipulation of experimental systems. 3. Measuring the temperature-dependent absorption and emission spectrums

实验十一、 核磁共振成像实验 指导教师：邵明珍

实验内容：1、用油样品观察 FID 信号和 FID 傅里叶变换 2、用硬脉冲 FID 确定拉莫尔频率及 90° 和 180° 硬脉冲的脉宽 3、用自旋回波法测量油样品的横向弛豫时间和纵向弛豫时间 4、利用自旋回波序列测玉米的核磁共振成像

Experiment 11 Pulse nuclear magnetic resonance and magnetic resonance imaging Instructor: Shao Mingzhen

Content: 1. Observe the FID and FID Fourier transform signal by oil sample; 2. Decide Lamer frequency and the 90°,180° pulse width by pulse FID signal; 3. Measure the vertical and horizontal relaxation time of the oil sample; 4. Measure the MRI images of a corn grain .

实验十二、磁控溅射镀膜 指导教师：张贤高

实验内容:1 熟练掌握磁控溅射沉积技术的基本原理及应用；2 掌握分子泵的结构、性能，利用分子泵获得高真空；3 用磁控溅射方法，在微晶玻璃制备多层膜。

Experiment 12 Magnetron sputtering Instructor：Zhang Xiangao

Content：1. Understand the principle and applications of magnetron sputtering technique;2. Understand the construction, performance and applications of turbo pump and obtain high vacuum with turbo pump;3. deposit multilayers by magnetron sputtering method on microcrystalline glass substrates.

实验十三、液晶盒制备及性能测试 指导教师：曾孝奇

实验内容：
1. 制作一个 TN 型液晶盒；
2. 在偏光显微镜下，观察液晶盒表面取向及在电压作用下的结构变化；
3. 测试液晶盒的电光特性及视角特性。

Fabrication and Measurement of a Liquid Crystal Cell
Contents:
1. Make a twisted nematic type Liquid Crystal (LC) cell.
2. Using the polarization microscope, observe the surface rubbing direction of the LC cell and how the cell changes with voltage.
3. Measure the characteristics of the LC cell under the electro-optic effect (adjust the voltage and incident angle of light respectively).

实验十四、光纤拉制实验　　指导教师：曾孝奇

实验内容：
1. 理解光纤拉丝机的结构及工作原理；
2. 拉制一段 10 米长的光纤；
3. 观察光纤导光效果，测试其损耗。

Optical Fiber Drawing
Contents:
1. Understand the structure of an optical fiber drawing machine and how it works.
2. Draw an optical fiber of length 10 m.
3. Observe how the laser propagates in the fiber and measure the loss of fiber.

实验十五、点矩阵全息　　指导教师：邵明珍

实验内容：
1.了解点矩阵全息图的形成和应用
2.学习电动位移台的控制方法
3.实践并制作一张点矩阵全息图

Dot Matrix Holography
Contents:
1. Understanding the formation and application of dot matrix holograms
2. Learning the Control Method of Electric Displacement Platform
3. Practice and make a dot matrix hologram

实验十六、溶胶凝胶法制备纳米二氧化钛　　指导教师：徐婷婷

实验内容：
1. 了解溶胶凝胶法制备纳米颗粒的原理;
2.掌握溶胶凝胶法制备纳米二氧化钛的基本过程.

Experiment：Synthesis of nano-TiO2 by sol-gel method Instructor: Xu Tingting
Content:
1. Learn and understand the principle of synthesis of nanoparticles by sol-gel method;
2. Master the basic process of preparation of nano-TiO2 by sol-gel method.

教学周第十一周—第十六周：四人一组分组自选探究性课题，教师指导完成实验并在最后一周进行成果展示和答辩。

Week 11-16: Research project for one group of 4 students. Presentation and defence at the last week.

探究性课题项目：

1. 碲化铋基热电器件的快速制备与性能测试　　主讲人：何佳清教授
2. 新型铁磁铁电二维材料的制备与封装　　主讲人：林君浩教授
3. 利用助溶剂方法生长新型量子材料单晶　　主讲人： 刘畅教授
4. 超快光谱研究二维半导体材料中载流子寿命　　主讲人： 戴俊峰教授
5. 石墨烯和 MoS2 层状材料机械剥离制备以及相关物性测量　　主讲人：张立源教授
6. 用 STM 研究金属、半金属及半导体材料的电子态密度　　主讲人:王克东教授
7. 超导磁悬浮力及转变温度的测量研究（设计方案、搭建实验系统研究超导悬浮力与距离之间的关系，并研究转变温度）　　主讲人：叶飞教授 何洪涛教授
8. sol-gel(溶胶-凝胶)法制备 Pb(Zr,Ti)O3 铁电薄膜　　主讲人：陈朗教授
9. 石墨烯的拉曼光谱研究（自制石墨烯）　　主讲人：黄明远教授
10. 含硼单晶金刚石的高温高压生长与制备　　主讲人：王善民教授
11. 超薄半导体薄膜的 X 射线衍射研究　　主讲人：王干教授
12. 量子神经网络与人工智能能量采集　　主讲人：Oscar Dahlsten

13. 拉曼光谱对物质的检测 主讲人：王才林
14. 拉曼光谱退偏度的研究及其应用 主讲人：王才林
15. 增强拉曼光谱的研究 主讲人：王才林
16. 脉冲核磁在水样品检测中的应用 主讲人：邵明珍
17. 脉冲核磁和核磁共振成像实验在油检测中的应用 主讲人：邵明珍
18. 核磁共振弛豫时间与溶液浓度关系的研究 主讲人：邵明珍
19. 巨磁阻材料、巨磁阻抗材料特性及其在弱磁场传感器的应用研究 主讲人：张贤高
20. 用 θ 调制技术制作 6 色光栅，研究提高光栅质量的途径。 主讲人：杨珺
21. 研究氮化镓薄膜的光吸收特性及其应用。 主讲人：邓冬梅
22. Mg 掺杂 ZnO 薄膜的压电及光谱特性研究 主讲人：王才林

研究用溶胶-凝胶方法制备样品及研究 Mg 掺杂浓度对 ZnO 薄膜的压电及光谱特性的影响。

23. 对光纤干涉式温度传感器的研究 主讲人：曾孝奇

搭建实验装置，研究光纤温度传感器的机制，测量光纤温度传感器的温度灵敏度。

24. 以光学玻璃为衬底镀适当厚度的银膜，用 STM 观察并测绘不同镀膜条件成膜后银粒子的颗粒度和镀银膜表面的平均粗糙度。 主讲人：张贤高

25.搭建实验装置用全息干涉法测量微小位移 主讲人：杨珺

26.用光的力学效应的原理，完成：ＳＵＳＴＣ与操作者姓名的字样。 主讲人：邓冬梅

Research Projects:

1. Fabrication and thermoelectric properties of Bi2Te3-based materials Instructor: He Jiaqing
2. Fabrication and packaging of novel two-dimensional ferromagnetic and ferroelectric materials Instructor：Lin Junhao
3. Studies of single crystal of quantum materials grown by flux method Instructor: Liu Chang
4. The study on carrier dynamics in 2D semiconductor materials by Ultrafast spectroscopy Instructor: Dai Junfeng
5. Preparation and Characteristics of two-dimensional layered material of graphene and MoS2 Instructor: Zhang Liyuan
6. State Density of Electrons in Metal, semi-metal and semiconductor material by STM Instructor: Wang Kedong
7. Studies on the magnetic suspending force and transition temperature of superconductor Instructor: Ye Fei, He Hongtao
8. Preparation of Pb(Zr,Ti)O3 thin film by sol-gel method Instructor: Chen Lang
9. Research on Raman Spectroscopy of graphene Instructor: Huang Mingyuan
10. Synthesis Boron-doped diamond single crystal Under High-Pressure and High temperature Instructor: Wang Shanmin
11. Studies on ultra-thin semiconductor films by XRD Instructor: Wang Gan
12. Quantum neural nets and AI Energy harvesting Instructor: Oscar Dahlsten
13. The detection of the material by Raman spectroscopy Instructor: Wang Cailin
14. The research and application of the depolarization of Raman spectroscopy Instructor: Wang Cailin
15. Study on enhanced Raman spectra Instructor: Wang Cailin
16. Applications of aqueous sample by pulse nuclear magnetic resonance Instructor: Shao Mingzhen
17. Applications of oil sample by pulse nuclear magnetic resonance Instructor: Shao Mingzhen

18. Studies on the relation of relaxation time and the solution concentration of NMR Instructor: Shao Mingzhen

19. The investigation on the properties of giant magneto resistive material and their application in magnetic sensors Instructor: Zhang Xiangao

20. Fabrication of a pseudo-color image containing 6 different colors and improving the image quality Instructor：Yang Jun

21. Investigation of the absorption and its applications of GaN thin film Instructor: Deng Dongmei

22. Study on the piezoelectric and spectral properties of ZnO film doped with Mg Instructor: Wang Cailin

23. Research on the temperature sensor of fiber interferometry Instructor: Zeng Xiaoqi

24. Depositing silver film with appropriate thickness on glass and observating the particle size and average roughness of silver film by using STM Instructor: Zhang Xiangao

25. Measurement of tiny displacement by holography interferometry Instructor：Yang Jun

26. Application of photomechanical effects: micro-scale particle arrangements. Content: Manipulating micro-scale particles to consist letter- SUSTECH and operator's name by using the optical tweezer. Instructors: Deng Dongmei

18. 教材及其它参考资料 Textbook and Supplementary Readings

教材：

现代物理技术与研究型实验 何佳清 霍剑青 主编 高等教育出版社

网络学习资源：

物理实验教学中心主页： http://172.18.6.16:8088/
大学物理实验选课系统： http://172.18.6.16:9200
大学物理实验预习系统： http:// 172.18.6.16:9202
大学物理实验仿真系统： http://172.18.6.16:8003
Online Resources:
Teaching Center of Physics Experiment: http://172.18.6.16:8088/
Physics Experiment Elective System : http://172.18.6.16:9200
Physics Experiment Preparation System: http:// 172.18.6.16:9202
Physics Experiment Simulation System : http://172.18.6.16:8003

课程评估 ASSESSMENT

19.

评估形式 Type of Assessment	评估时间 Time	占考试总成绩百分比 % of final score	违纪处罚 Penalty	备注 Notes
出勤 Attendance				
课堂表现 Class Performance				
小测验 Quiz				
课程项目 Projects		50%		包含论文（40%）、答辩（40%）表现(20%)三项分数 Including paper (40%), presentation(40%) and performance (20%)
平时作业				

Assignments				
期中考试 Mid-Term Test				
期末考试 Final Exam				
期末报告 Final Presentation				
平时实验 Experiments		50%		包含操作（50%）、报告（50%）两项分数 Including operation(50%) and report(50%

20. **记分方式 GRADING SYSTEM**

☑ A. 十三级等级制 **Letter Grading**
☐ B. 二级记分制（通过/不通过） **Pass/Fail Grading**

课程审批 REVIEW AND APPROVAL

21. **本课程设置已经过以下责任人/委员会审议通过**
This Course has been approved by the following person or committee of authority

物理系教学指导委员会
Education Instruction Committee of Physics department