

2017

ZHEJIANG UNIVERSITY  
**ACADEMIC  
ANNUAL REPORT**

2017

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ACADEMIC ANNUAL REPORT

2017

浙江大学  
学术年报

**History of winning remodels  
thalamo-PFC circuit to reinforce  
social dominance**

**Aluminum-Graphene Battery**

**Optical stabilization technology  
for Remote Sensing Satellite**

浙江大学学术年报

ZHEJIANG UNIVERSITY ACADEMIC ANNUAL REPORT

**胜利者效应改变丘脑-  
前额叶环路加强社会优势地位**

重复的胜利经历能够选择性地增强中缝背侧丘脑-前额叶皮层  
这一神经环路的突触连接，促使动物  
在之后的竞争中更具优势

**铝-石墨烯电池**

为研制兼具高能量密度、高功率密度、超长寿命、宽工作温度  
区间等性能的新型绿色环保储能体系打开了光明之窗

**卫星遥感光学稳定成像关键技术及应用**

卫星运动和颤振是制约高分辨率光学遥感成像质量的重要瓶颈之一，  
突破这一瓶颈，助推我国向该领域国际尖端水平的技术跨越



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## 前言

浙江大学是一所历史悠久、声誉卓著的高等学府，坐落于中国历史文化名城、风景旅游胜地杭州。在120余年的办学历程中，浙江大学始终以造就卓越人才、推动科技进步、服务社会发展、弘扬先进文化为己任，逐渐形成了以“求是创新”为校训的优良传统。经过百余年的砥砺奋进，其学科涵盖理学、工学、农学、医学、管理学、哲学、经济学、法学、教育学、文学、历史学、艺术学、等十二个门类；设有7个学部，36个专业学院（系），1个工程师学院，2个中外合作办学学院、7家附属医院，是一所特色鲜明、在海内外有较大影响的综合型、研究型、创新型大学。学校拥有紫金港、玉泉、西溪、华家池、之江、舟山、海宁等7个校区，占地面积5739978平方米，校舍总建筑面积2575983平方米。图书馆总藏书量708.4万余册。截至2017年底，浙江大学现有全日制在校学生53673人（其中：本科生24878人，硕士研究生18048人，博士研究生10747人），在校留学生（含非学历留学生）6843人（其中：攻读学位的留学生4116人）。

学术是大学的灵魂，是大学的生命之源，是大学的立身之本，因此，学术建设工作在大学显得尤为重要，是一所大学智慧、进步和声誉的基石。浙江大学坚持以学术建设为核心，大力推进学科建设、人才队伍、科学研究、人才培养、学术交流与合作以及学术制度等方面的建设工作，取得了长足的发展。

大学肩负着知识的创造、传承和积累，对客观事物本质和规律性的认识和探索的重任，营造校园追求真理、客观公正、民主包容的良好氛围，培育师生尊重学术、关注学术、了解学术、接近学术的校园文化，是师生们对学术永无止境的追求的源动力。

编辑《学术年报》的目的在于引发浙江大学广大师生、学界和社会公众对我校学术发展的关注和兴趣，旨在营造浓厚的学术氛围，加强学术交流。

《学术年报》在概括总结学校一年的学术建设工作的基础上，重点介绍通过浙江大学学术委员会委员、青年学者代表以及科学传播主流媒体代表等共同评选出的优秀学术成果，以及列表展示我校主要的研究成果。《学术年报》将汇集浙大人的学术贡献，记录浙江大学向一流奋力迈进的足印。

透过《学术年报》，可以看到浙大人怀着对真理的“求是”精神，求真创新，勇于探索，以专业知识、创新意识和慎思明辨的思维，努力做好学术研究，更好地服务国家和社会。

感谢大家对编辑出版本学术年报的支持和鼓励！



浙江大学学术委员会

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The Academic Annual Report 2017,  
Zhejiang University  
2017浙江大学学术年报

主办：浙江大学学术委员会  
协办：浙江大学青年教授联谊会  
主编：张 泽  
编辑：李浩然 朱敏洁

致谢：  
浙江大学科学技术研究院  
浙江大学社会科学院  
浙江大学外国语学院徐雪英、  
OSBORNE TIMOTHY JOHN、  
图书馆 徐建刚

设计：赵江辉设计事务所

ACZJU 浙江大学学术委员会  
THE ACADEMIC COMMITTEE OF ZHEJIANG UNIVERSITY



## 浙江大学2017年度学术建设总体概况



2017年是浙江大学学习贯彻党的十九大精神、实施“十三五”规划的重要一年，是推进综合改革的深化之年，是“双一流”建设的启程之年。学校紧紧围绕学校“双一流”建设方案、“十三五”发展规划和综合改革方案确定的总体目标与基本任务，深入实施“六高强校”战略，深入推进“五大体系”“五大布局”建设，并更加突出“高精尖”的导向，探索完善新时代建设中国特色世界一流大学的战略思路，各项事业持续呈现蓬勃发展的良好态势。

### 一、学科建设

人才队伍建设成效明显。坚持党管人才，成立党委教师工作部、师德建设工作领导小组和师德建设工作委员会，健全教师思想政治工作和师德建设机制。加强高层次人才和高水平团队培育，深入实施“学术大师汇聚计划”“百人计划”，加大管理服务、思政教育、实验技术等各类人才队伍建设力度，科学评价、人尽其才的人才队伍体系不断健全。完善博士后队伍建设体系，出台《浙江大学关于进一步加强博士后队伍建设的若干意

见》，启动实施“千名博士后计划”。继续优化人才年龄结构和学缘结构，出台《浙江大学外籍教师聘用暂行办法》，加快建设专兼结合的国际师资队伍。截至2017年12月，全校有教职工8657人（其中：专任教师3611人），教师中有中国科学院院士21人，中国工程院院士20人，文科资深教授9人，国家“千人计划”入选者（含青年项目）237人，教育部“长江学者奖励计划”入选者（含青年学者）101人，国家杰出青年科学基金获得者129人，国家优秀青年科学基金获得者109人，“万人计划”领军人才、青年拔尖人才63人，浙江省特级专家43人，高层次人才队伍规模位居全国高校前列。

学科整体实力迈上新台阶。进一步构建高峰凸显、生态和谐的一流学科体系，大力建设高峰学科、一流骨干基础学科，谋划推动顶尖学科、优势特色学科和会聚型学科建设，推动各学部、学院、学科开展畅想创新2030工作。根据ESI数据统计，学校18个学科进入世界学术机构前1%，7个学科进入ESI前100位，均居全国

高校第二；8个学科进入前1%，5个学科进入ESI前50位，均居全国高校第一。在全国第四轮学科评估中，学校有11个一级学科被评为A+，居全国高校第三；39个一级学科被评为A类，居全国高校第一；一级学科优秀率达63.93%，居全国高校第二。

## 二、人才培养

本科教育教学水平进一步提升。不断拓展教育教学大讨论成果，落实关于进一步深化教育教学改革的若干意见。完善“知识传授、能力培养、素质提升、人格塑造”四位一体的人才培养体系，积极实施连贯“通”“专”“跨”的通识教育，优化全过程、全方位、全员育人机制。以学生学习成效为导向，科学制定本科生培养方案。稳步推进各类课程建设，严把课程教学质量。促进教学模式创新，深化信息技术与教育教学融合。出台《浙江大学本科生第二、三、四课堂学分管理办法（试行）》等文件，进一步推进四个课堂实质性融通。继续开展海外教师主导全英文课程建设工作，共支持25个院系建设了57门全英文课程。

研究生培养改革深入推进。强化科教协同与国际合作，制定并实施新一轮研究生培养方案，完成课程体系梳理工作，启动研究生素养与能力培养型课程建设。推进专业学位改革和多学科交叉工作，各级学位评定委员会调整到位，增设工程师学院专业学位评定委员会和“医药+X”多学科交叉人才培养卓越中心学位评定委员会。进一步建设工程师学院，完善工程领域专业学位研究生教育，创新校企协同培养模式，有效开展与欧美著名工程院校的国际联合培养项目。成功入选教育部博士研究生教育综合改革试点高校，实施科教融合等博士生教育“十大行动计划”。

招生和就业工作取得实效。创新多元招生模式，稳步提高生源质量，“三位一体”综合评价招生涉及面更广。接轨新高考改革，实现新模式下本科生招生录取工作的平稳落地。进一步扩大博士生招生“申请—审核”制范围，顺利实施全日制非全日制研究生统筹招生管理改革。2017年，学校在全国各省市提档线分数的考生名次得到进一步提升。2017届毕业生就业率稳居全国高

校前列，选调生录取、赴国防军工单位工作、赴西部地区就业的总人数同比增长27.46%。

创新创业教育品牌加快形成。进一步凝练创新创业教育特色，在本科专业培养方案中新增通识必修创新创业类，不断完善课程教学、培训、竞赛、实训、孵化和实践全链条推进的工作体系。加强创新创业实践平台建设，成立创新创业学院，成功入选国家双创示范基地，获首批“全国深化创新创业教育改革示范高校”“全国深化创新创业教育改革特色典型经验高校”等荣誉，IdeaBank创客空间被纳入国家级孵化器管理服务体系。2017年，我校学生在国际国内创新赛事中表现突出，荣获国际竞赛特等奖6项、一等奖45项，荣获全国竞赛特等奖8项、一等奖17项，包括第三届互联网+大学生创新创业大赛总冠军、中国青年互联网创业大赛总冠军等。

## 三、科研能力

2017年科研规模突破40亿元，实现在高位的持续增长。到校科研总经费40.17亿元（比2016年增加4.99亿元），其中纵向科研经费29.16亿元（占72.59%），横向科研经费11.01亿元（占27.41%）。

重大科研项目承载能力稳步提升。新增国家重点研发计划项目18项、国家重大专项课题11项；获批国家基金重大项目1项，国家基金重点项目19项。

科研基地布局不断完善，为学校科研发展提供了强大平台支撑。目前，学校已拥有国家级科研基地24个，其中国家重点实验室10个、国家工程技术研究中心4个、国家工程研究中心2个、国家（地方联合）工程实验室8个，拥有各类省部级基地136个，学校自主设立校设研究院13个、研究中心39个、研究所176个。积极发挥之江实验室的驱动作用，推动之江实验室挂牌成立并有序运行。“超重力离心模拟与实验装置”国家重大科技基础设施项目获得国家发展改革委正式批复，批复总投资20.3434亿元，这是在浙江省建设的首个国家重大科技基础设施项目。“16+X”科研联盟、协同创新中心建设稳步开展。

2934项，合同经费达140545万元，其中技术转让合同41项，合同经费3148万元。

## 五、哲学社会科学的发展

探索构筑开源的思想文化高地，完善文化传承创新的工作体系和平台，成立文化遗产学科发展联盟、艺术与考古图书馆、中华译学馆、马一浮书院等，《中国历代绘画大系》列入“国家重大出版工程”。启动《浙江大学史》编纂与研究项目，成立浙江大学校史研究中心，对学校的办学历史和发展历程进行系统梳理和科学总结。设立专项基金支持哲学社会科学的发展，重点引导教师潜心治学，不断扩大学术话语权，提高学术声誉。继续加大大学科交叉预研专项的培育力度，推进“大数据+”人文社会科学交叉创新团队建设。

制订智库成果认定办法，加强高端智库建设，区域协调发展研究中心入选第二批国家高端智库试点培育单位。深化与浙江省委宣传部共建传媒与国际文化学院、马克思主义学院工作，加强马克思主义理论研究和宣传教育。

2017年，文科全口径实到科研经费2.65亿元，继续保持全国前列水平；SSCI收录论文数540篇，同比增长44%；A&HCI收录论文数39篇，居全国高校第二；国家社科基金重点项目立项数居全国高校第一；《国家哲学社会科学成果文库》的成果入选数并列全国高校第一。

## 六、国际合作与交流

深入实施“海外一流学科伙伴提升计划”“世界顶尖大学战略合作计划”，推动与哈佛大学、耶鲁大学、芝加哥大学、斯坦福大学、牛津大学等世界顶尖大学的机制性合作，完善全球国际链接的合作网络。

持续优化国际联合学院（海宁国际校区）人才培养模式，发挥其优质教育资源的溢出效应。学生海外学习交流的规模与层次不断提升，本科毕业生海内外深造率达61.97%，其中毕业生进入世界百强名校继续深造近800人，占出国总人数的56.82%；本科生海外学习交流人数达3250人次，同比增长22.64%；研究生海外学习

## 四、学术影响力

科技论文质量持续提升。根据中信所2017年10月公布的数据，2016年度，我校科学引文索引扩展版（SCI）收录论文6231篇，2007—2016年48595篇论文被引用571022次，中国卓越科技论文收录4008篇，作为第一作者国际合著论文（据SCI统计）收录1489篇，以上数据均位居全国高校第一。根据2018年1月15日的统计，2017年我校被SCI收录第一单位论文影响因子10以上的208篇；三大期刊及子刊论文43篇：其中《科学》1篇、《细胞》1篇、《美国科学院院报》（PNAS）10篇，《自然》子刊25篇、《细胞》子刊6篇。

国家科技奖励取得历史性突破。2017年度我校作为第一完成单位获得国家科学技术奖共4项，其中李兰娟院士团队“以防控人感染H7N9禽流感为代表的新发传染病防治体系重大创新和技术突破”获得中国高校首个国家科技进步特等奖；高翔教授团队“燃煤机组超低排放关键技术研发与应用”获得我校历史上首个国家技术发明一等奖；严建华教授团队、陈耀武教授团队分别获得国家科技进步二等奖、国家技术发明二等奖1项；蔡天新教授获得国家科技进步二等奖（科普类）；作为参与单位获得国家科学技术奖一等奖3项，二等奖6项。边学成教授领衔的项目“高速铁路列车运行动力效应试验系统”荣获2017年度“中国高等学校十大科技进展”。我校作为第一完成单位获教育部高等学校科学研究优秀成果奖（科学技术）16项（一等奖8项、二等奖8项）；作为第一完成单位获浙江省科学技术奖一等奖13项。

科技成果转化成效明显。优化科技创新全链条布局，进一步完善成果转化激励政策与制度。完成工业技术转化研究院与国家大学科技园合署，着力提升国家大学科技园综合科技服务内涵，获得国家科技企业孵化器A类（优秀）评价和浙江省唯一的“全国大学生创业示范园”称号。全年获得中国三大专利授权2357件（其中发明专利1979件），发明专利授权数持续位居国内高校第一，通过PCT途径申请专利14件。新签横向技术合同

交流人数达2440人次，同比增长10.5%，其中博士生交流率达到72.77%。

加强全校国际化管理队伍建设，第一批国际化工作岗位人员已到岗并完成专项培训。进一步优化、完善海外工作机构建设，制订《海外工作机构建设提升方案》。进一步增强网络宣传、声誉评估和外事工作能力，打造高水平外文门户网站，积极拓展与海外媒体、驻外联络机构、海外合作高校等联络合作。携手斯坦福大学、芝加哥大学、耶鲁大学等世界名校举办系列学术交流活动，Nature主刊分8期刊载了学校7个学部科研成果。通过“海外名师大讲堂”、“诺奖大师中国校园行”、“学术大师专项”、“竺可桢杰出学者讲座”等项目，共邀请了57位海外知名专家来校举办公众讲座，其中15位诺贝尔奖获得者。

### 七、学术制度

完成学术委员会改选换届工作，组建新一届校学术委员会。在2016年改选换届前期工作的基础上，于2017年4月21日召开浙江大学学术委员会改选换届大会暨2017年第一次全体会议。会上校党委书记金德水、校长吴朝晖发表了重要讲话，并代表学校向新一届学术委员会委员颁发聘书；常务副校长宋永华在会上介绍了委员的组成情况，宣读了浙江大学党委文件。并在随后召开的2017年第一次全体会议选举产生了主任、副主任和秘书长；审议表决了《浙江大学学术委员会章程（修订）》，审议了《新一届学术委员会委员履职要求》、校学术委员会工作委员会的组建及主要职责等学术委员会规范运行的文件。

建立学术发布机制。启动校学术委员会网站的改版工作，增设“学术发布”栏目，通过科普化讲述、图像及视频等形式，动态展示浙江大学重要学术进展。“学术发布”每周发布一次，并推送浙大主页“科学封面”栏目。

《浙江大学学术不端行为查处细则（试行）》正式发文。《浙江大学学术不端行为查处细则（试行）》（浙大发〔2017〕32号）共7章33条，规定了我校处理学术

不端行为的工作机制、学术不端行为的类型、学术不端行为的受理、调查、认定、处理、复议与监督等内容。

今后一段时期，既是浙江大学进入中国特色世界一流大学行列的关键期，也是乘势而上迈向世界一流大学前列的重要机遇期。我们要以全面立德树人为根本，以全面聚焦一流为主线，以全面深化改革为动力，以全面开放合作为途径，以全面优化支撑为保障，加快提高学校的核心竞争力、文化影响力、战略执行力、资源保障力，推动学校整体办学水平跃上新台阶。

# 2017年度浙江大学 学术进展

THE ACADEMIC COMMITTEE OF ZHEJIANG UNIVERSITY

浙江大学学术委员会

諸位在校，有兩個問題  
應該自己問問：第一，到浙  
大來做什麼？第二，將來  
畢業後做什麼樣的人？  
——竺可桢



2017年度浙江大学学术进展

# 胜利者效应改变丘脑-前额叶环路加强社会优势地位

★★★★★ (入选年度十大学术进展)

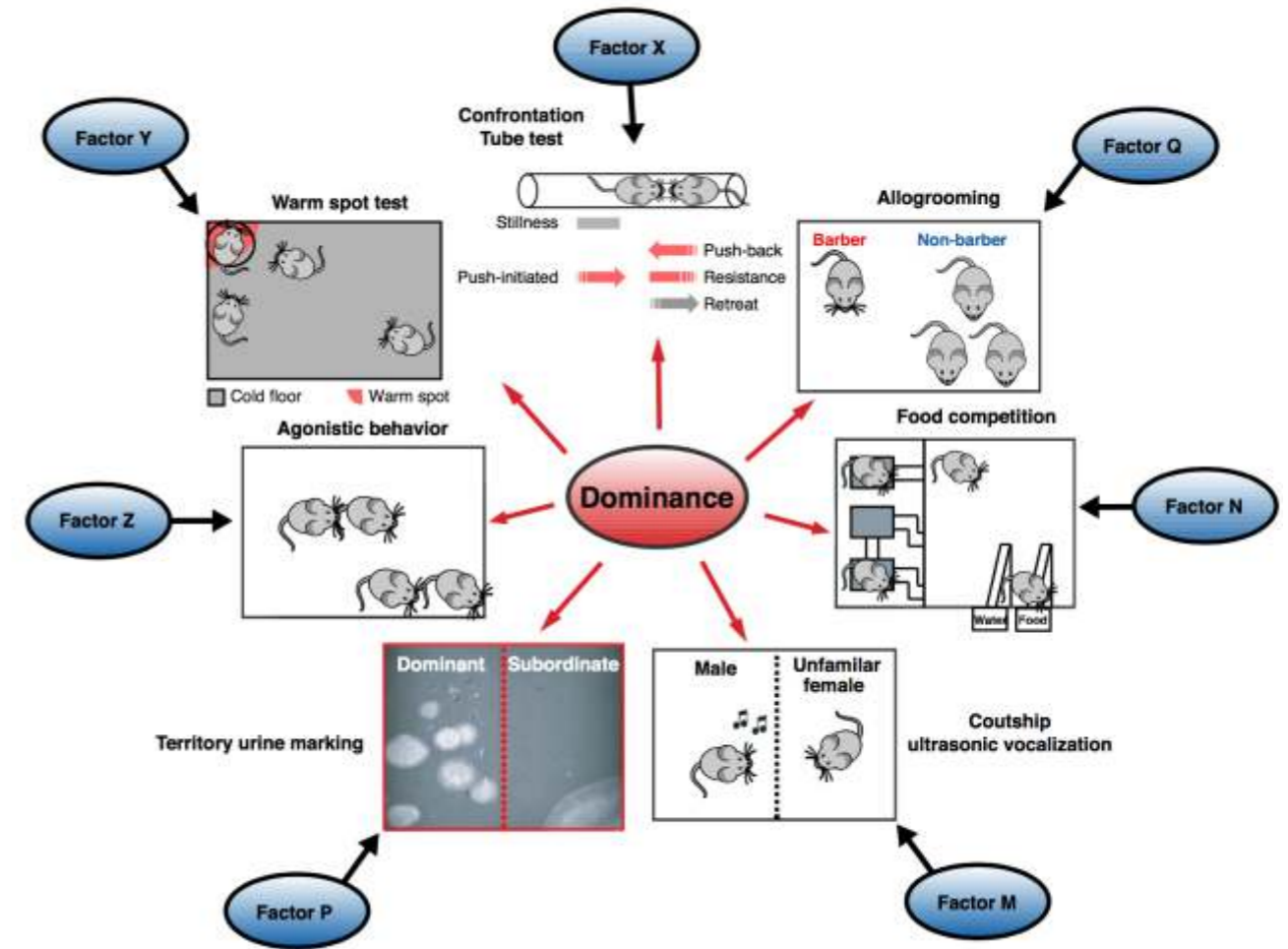
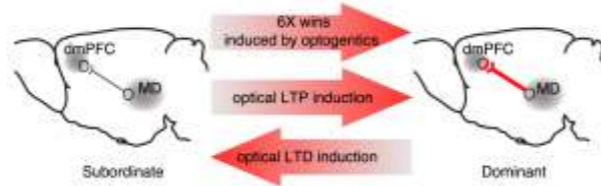
胡海岚团队首次破解哺乳动物大脑中“胜利者效应”的脑科学机制，报导了重复的胜利经历能够选择性地增强中缝背侧丘脑-前额叶皮层这一神经环路的突触连接，促使动物在之后的竞争中更具优势。

项目负责人：胡海岚

社会等级是动物社会的基本组织方式。对群体而言，稳定的等级结构可以减少族群内不必要的激烈冲突和能量浪费，有利于促进社会的和谐；对个体而言，社会等级对其生存繁衍和种群的进化都起着至关重要的作用。而在行为学研究中，动物的等级状态广泛影响这动物的激素水平、争斗、交配等等。然而人们对决定社会等级地位的神经环路机制却几乎一无所知。



浙江大学胡海岚研究组首次建立测量动物社会等级的行为学范式——钻管测验。该范式具有结果明确且可量化的优势，且被证明具有良好的稳定性、可传递性，且其结果与其它多种社会等级测试的结果具有高度相关性。课题组在2011年首次揭示内侧前额叶（mPFC）的突触强度对社会等级行为的决定作用，从与社会认知相关的mPFC入手，分析比较高、低等级小鼠的神经元活性，发现社会等级地位和小鼠mPFC神经元活动强度正相关。这一系列结果首次确立了mPFC和社会等级有关的神经活动的因果关系（Wang et al., Science,



2011)。以上成果以独立通讯作者于2011年9月在Science发表。同期Science将此工作列为首页亮点，美国的Discover杂志、法国世界报等也对该工作进行了专文报道。

随后在2017年，课题组首次揭示“胜利者效应”脑机制（Zhou et al., Science, 2017）。胜利者效应，即先前的获胜经历会增加个体之后获胜的可能性，是社会层级形成的重要机制。它与社会的和谐发展、种群的生存繁衍息息相关。浙大胡海岚团队在《科学》杂志以研究长文形式，报导了重复的胜利经

历能够选择性地增强中缝背侧丘脑-前额叶皮层这一神经环路的突触连接，促使动物在之后的竞争中更具优势。这是首次破解哺乳动物大脑中“胜利者效应”的脑科学机制，也是该团队在研究社会层级行为脑机制这一系列方向的第二篇《科学》论文。这一发现为研究社会竞争行为和社会层级的形成与维持开辟了全新的思路和研究方法，也为神经经济学、社会行为学等研究提供了崭新的靶点脑区。同时将对教育方法的改革提供重要的理论依据，并为研究社会行为相关的疾病奠定了理论框架。



2017年度浙江大学学术进展

# 铝-石墨烯电池

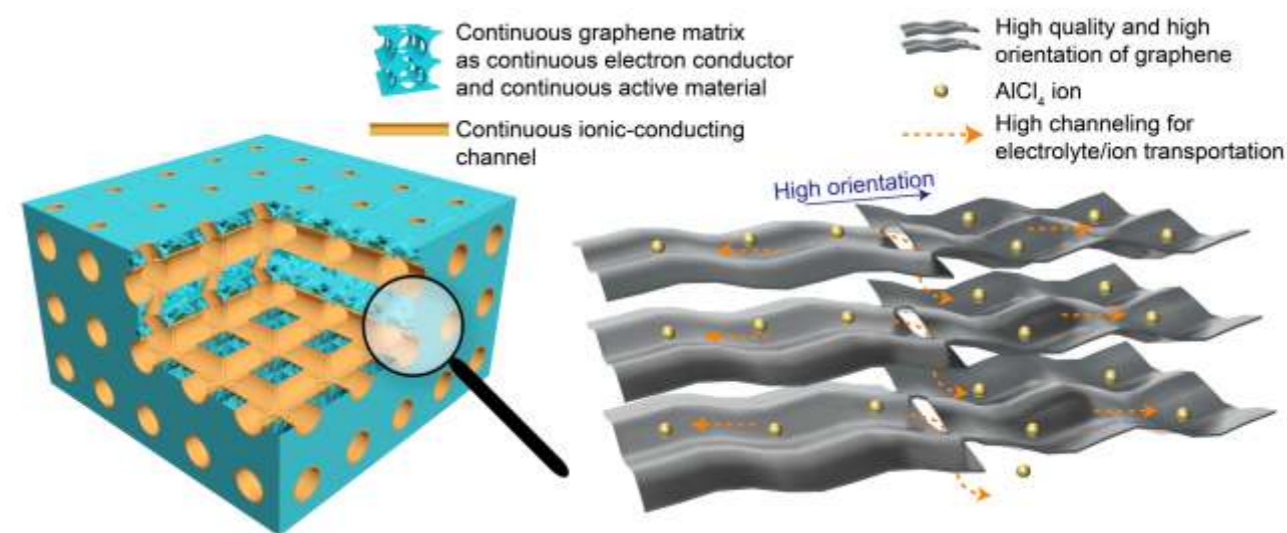
★★★★★ (入选年度十大学术进展)

提出铝-石墨烯超级电池概念，构建石墨烯宏观组装膜高性能正极，创立“三高三连续”和“无缺陷”正极设计原则，发现负极枝晶现象及抑制机理，为铝离子电池的科研和应用奠定了基础。

项目负责人：高超

太阳能、风能等清洁可再生能源存在不稳定、间歇性等问题，需要与储能电池配合使用。现有的电池储能系统存在诸多问题，迫切需要发展高丰度原料、高性能电极、高安全电池新体系。长循环寿命铝离子电池是新近发展起来的以金属铝为负极的新型储能系统，具有负极比容量高、资源丰富、安全绿色等优势，发展空间广阔。目前铝离子电池面临的主要问题在于正极材料的电化学性能不足、电池工作机理不明等，导致电池的整体性能仍无法匹敌传统的高能量密度锂离子电池和高功率密度的超级电容器。为此，该项目团队一直努力寻找高性能正极材料，探明电池工作机理。经过五年的研究，构建出全新的石墨烯宏观组装膜正极材料，研制出铝-石墨烯超级电池，为铝离子电池的科学发展和工业化应用奠定坚实基础。

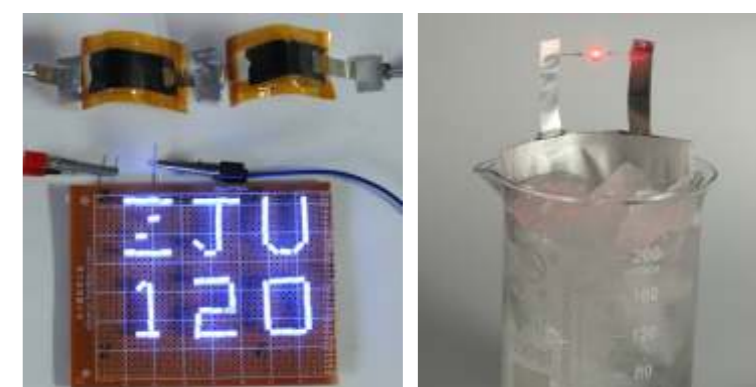
项目的主要特色是完全脱离传统的锂电池体系，构建新型铝电池体系，以金属铝为负极、石墨烯为正极、离子液体为电解质、玻纤为隔膜，具有六大“超”级优势：1)超长循环寿命，可使用数十万次，是传统电池的100-1000倍；2)超快充电，可实现分秒充电，充电速度是传统电池的10-100倍；3)超宽使用温度范围，-40-120摄



氏度全天候工作；4)超级安全，不燃烧、不爆炸；5)超低价格，金属铝为负极，丰富廉价；6)超广应用，储能、动力、电子产品、军事装备等均可用。除此之外项目有以下几个创新点：

1) 提出铝-石墨烯超级电池概念，之前报道的铝离子电池以石墨为正极，性能一般，本项目以石墨烯组装膜为正极，首次构建出以石墨烯为全正极活性物质的电极，因此可以称为真正意义上的“石墨烯电池”；同时电池寿命和倍率性能超出传统锂离子电池的1-3个数量级，结合了电池和超级电容器的优势，是真正意义的超级电池；

2) 创立正极材料的“三高三连续”设计原则（三高：高质量石墨烯、高取向组装结构、高孔隙率；三连续：连续的电子传输正极材料、连续的离子传输通道、连续的活性物质）和“无缺陷”设计原则（材料的缺陷越少，电极及电池的性能越好），为正极材料的设计提供了科学指导原则；



3) 发现了金属铝负极枝晶现象及抑制机理，之前的报道错误地认为负极没有枝晶，掩盖了真相，我们的发现揭开了铝离子电池长寿命的秘密。

随着科技不断发展，电网、未来城市及建筑供电系统、便携式电子器件和电动车辆对储能电池的需求量激增，开发更高能量密度、资源储量丰富的新型二次电池迫在眉睫。铝-石墨烯超级电池的成功实现，为推进其科学研究和实际应用铺平了道路，为研制兼具高能量密度、高功率密度、超长寿命、宽工作温度区间等性能的新型绿色环保储能体系打开了光明之窗。



2017年度浙江大学学术进展

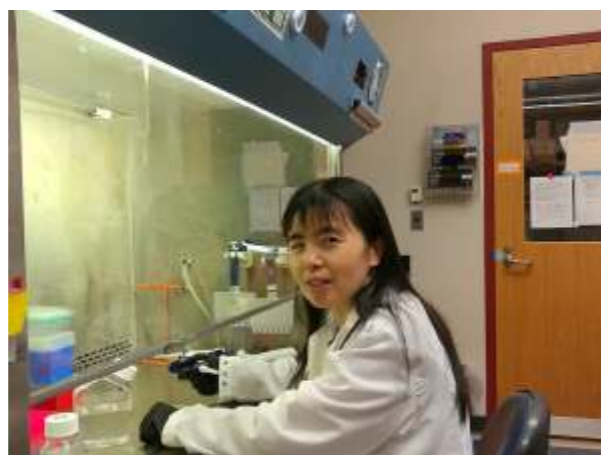
## 世界首批用于异种器官移植的安全猪研发

★★★★★ 〈入选年度十大学术进展〉

猪因诸多原因适合作为人类器官移植的供体。牛冬与合作者研发出世界首批内源逆转录病毒灭活猪，解决了异种移植存在的安全问题，为开展安全有效的异种移植提供了新希望。

项目负责人：牛冬

据不完全统计，全世界每年大约有200多万人需要器官移植，但是器官捐献的数量远远低于需要的人群，因此异种器官移植被认为具有较大的应用前景。猪被认为是最佳的异种器官来源供体，首先是猪的器官大小和功能与人类近似，且猪本身就是人类的肉用动物，不存在动物福利及保护等伦理问题，同时易于大规模养殖。然而，有两个因素阻止了猪器官的临床应用，即猪内源逆转录病毒（porcine endogenous retroviruses, PERVs）的跨种转染风险及物种间的免疫排斥。猪PERVs是所有猪种中均存在的一种 $\gamma$ 逆转录病毒，可以通过遗传传给后代。如果直接将猪的器官移植给人体，可能会导致新型疾病的传播，对人类产生潜在的健康风险。我校动物科学学院牛冬副教授与美国eGenesis公司、云南农大及哈佛大学合作，发现PERVs可以从野生型猪细胞转染给人细胞，同时人细胞中也可以传递该病毒，因此在异种器官移植中有必要对猪PERVs进行灭活。牛冬等首先确定了巴马猪细胞中PERVs的拷贝数为



25个，并用CRISPR基因编辑技术及经过各种筛选后选出的提高细胞存活力的药物得到了PERVs 所有25个拷贝全部灭活的细胞系，并用该细胞系进行核移植，生产出了世界首批PERVs全部灭活的克隆猪，且从出生至今已一年多的所有克隆猪均没有PERVs的重新感染。

该成果于2017年9月22日以封面文章发表于国际顶级权威杂志《Science》上，是世界上首次报道的可用于异种器官移植的安全供体猪，我校牛冬副教授为该论文的领头第一作者。在该猪的基础上进行免疫相关基因编辑，最终可提供用于人类移植的异种器官。该成果消除了病毒

跨种感染的风险，突破了异种移植停滞十几年之久的困境，为开展安全有效的异种器官移植提供了新希望。

该项目成果的发表引起了器官移植行业的轰动，使猪用于人类异种器官移植的供体成为了可能。该成果发表后，世界各大著名媒体（包括《Time》，《BBC》，《New York Times》，《Forbes》，《Fortune》，《Newsweek》，《CBS News》，《CNN》等一百多家媒体）及国内媒体（包括《人民日报》、《新华社》、《凤凰号》、《知识分子》等）均对此进行了报道。



2017年度浙江大学学术进展

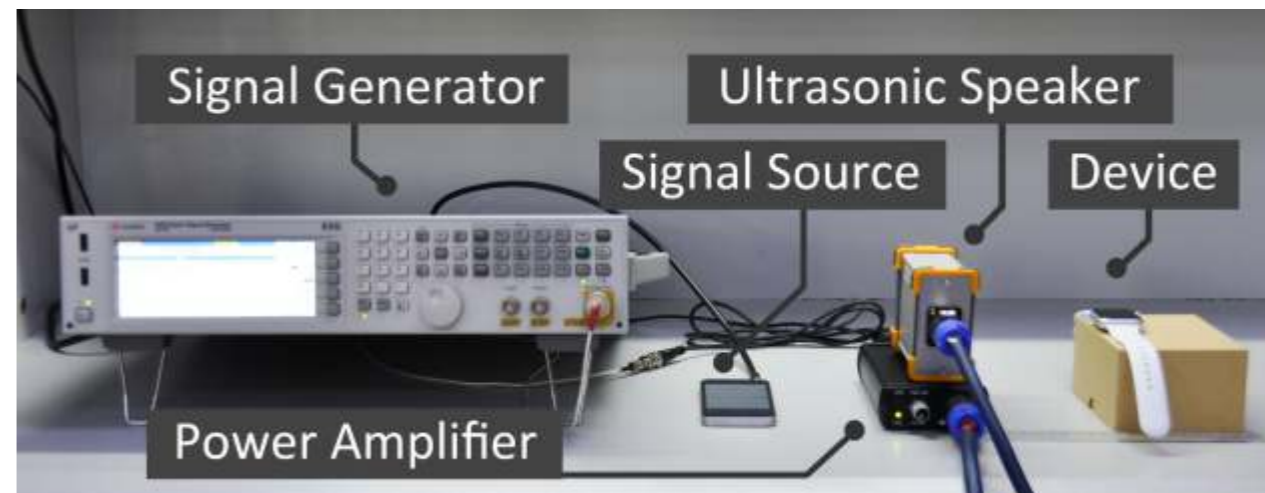
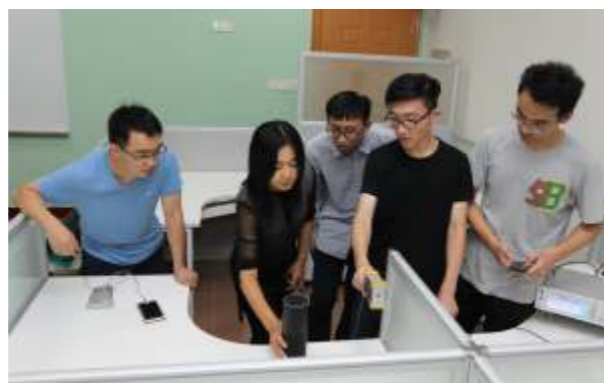
# “海豚音攻击”基于麦克风非线性作用的硬件漏洞发现与防护

★★★★★ (入选年度十大学术进展)

针对智能设备的麦克风传感器，首次发现了由于硬件耦合带来的系统漏洞，并给出了相应的防护和解决方案。在语音系统日益普遍的今天，DolphinAttack作为一个启发性和标志性的成果，在物联网安全领域具有重要意义。

项目负责人：徐文渊

语音助手系统让人通过最自然的语音输入方式和现代计算系统交互，它已经在手机、电脑、音箱、智能家居、汽车等智能设备上得到了广泛应用。作为一种便捷的重要人机交互方式，可以预见语音助手将在越来越多的设备系统中运用，为保护这些带有语音助手功能的系统，语音助手本身的安全性至关重要。该项研究针对语音助手系统进行安全分析，研究发现并对安全问题进行防护。其中研究成果包括两方面，(1)立足于语音助手依赖的声音传感器(麦克风)，首次发现了



Model	Model	OS/Ver	SR System	Attack Range	Actio	Modulation Parameters	Max Dist. (m)
						f (kHz) f <sub>1</sub> (Hz) f <sub>2</sub> (Hz)	Range Actio
Apple	iPhone 4s	iOS 9.3.5	Siri	✓	✓	20-42 [17.9]	2.97 173 1.0
Apple	iPhone 5s	iOS 10.0.2	Siri	✓	✓	24.1-30.2 [27.1] [28.1]	3.00 7.0 0.0
Apple	iPhone SE	iOS 10.0.1	Siri	✓	✓	22-29 [24]	2.475 58 25
Apple	iPhone SE 2	iOS 10.0.1	Chrome	✓	N/A	22-29 [24]	2.375 10 N/A
Apple	iPhone 6s	iOS 10.0.1	Siri	✓	✓	23-29 [27.5] [28.5]	2.405 10 24
Apple	iPhone 6s Plus	iOS 10.0.1	Siri	✓	✓	20 [20]	2.00 5 10
Apple	iPhone 7 Plus	iOS 10.0.1	Siri	✓	✓	21-24 [23]	2.300 18 10
Apple	watch	watchOS 3.0	Siri	✓	✓	20-27 [22.5]	2.35 11 100
Apple	Pad mini 4	iOS 10.0.1	Siri	✓	✓	22-30 [24]	2.200 91.9 30.5
Apple	MacBook	macOS Sierra	Siri	✓	N/A	20-23 [21.5] [22.5]	2.500 10 N/A
LG	Nexus 5X	Android 7.1.1	Google Now	✓	✓	30 [30]	2.00 5 11
Lenovo	Nexus 7	Android 6.0.1	Google Now	✓	✓	24-30 [24.1]	2.35 10 17
Samsung	Galaxy S6 edge	Android 6.0.1	S Voice	✓	✓	20-30 [24]	2.175 30.1 30.2
Huawei	Honor 7	Android 6.0	HVoice	✓	✓	20-27 [24]	2.175 13 10
Lenovo	ThinkPad E470	Windows 10	Cortana	✓	✓	23.9-29 [24]	2.10 10 8
Asus	EeePC	Windows 10	Alexa	✓	✓	23-24 [23.5] [24]	2.300 10 15
Asus	US	N/A	N/A	✓	N/A	23-29 [23]	2.00 10 N/A

<sup>1</sup> f<sub>1</sub> is the carrier wave frequency that exhibits highest bandwidth amplitude after demodulation.  
<sup>2</sup> Another iPhone SE with identical hardware spec.  
<sup>3</sup> Experimental with the best-top microphones on the device.

复出语音信号有效。此时，语音助手识别到该有效语音指令，并控制智能设备执行恶意操作。

针对这一硬件漏洞，该成果首次提出基于硬件和基于软件的防御方案。其中，基于硬件的防御方案是重新设计麦克风，通过抑制麦克风的高频响应，使得麦克风无法“听”到人类无法听的高频声音，避免了无声指令耦合进麦克风电路的可能。在软件上，通过分析正常语音和通过海豚音攻击产生的语音，发现两者在较高频段的信号有较大差异。基于此发现，该成果提出了基于机器学习的防御无声指令控制语音助手的方法，并达到理想的效果，因此，各大生产厂商只需要更新智能设备的系统就可以解决这个安全隐患。

由于硬件耦合带来的系统漏洞，并利用此漏洞在20多种智能设备上实施了“海豚音攻击”，该攻击可通过人耳不可听的方式实现有声语音指令的注入，从而以隐秘的方式控制智能设备拨打电话、发送信息、访问网页、购物等，威胁用户安全和隐私。(2)该研究成果同时包括相应的硬件和软件层面防护方案，通过麦克风硬件改进和基于SVM的分类器对攻击进行防护和检测，可提高语音交互方式的安全性。

该成果发现在麦克风中广泛存在非线性作用。非线性作用是指信号在通过设备时，输入与输出表现出非线性关系，这一现象主要源于硬件设备本身。通过利用这一现象，该成果成功将语音指令以人耳听不到的频率发送给智能设备，通过麦克风的非线性解调后，恢



2017年度浙江大学学术进展

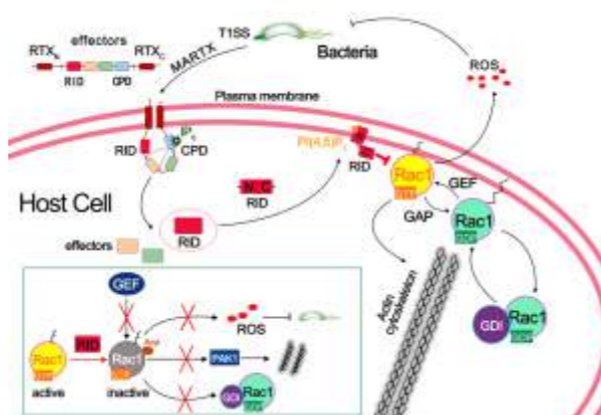
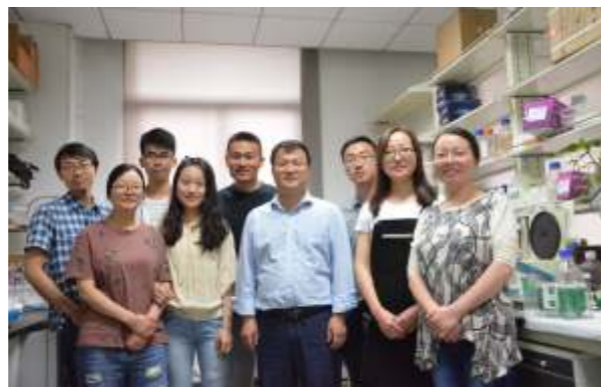
# 病原菌调节宿主信号通路的全新分子机制

★★★★★ (入选年度十大学术进展)

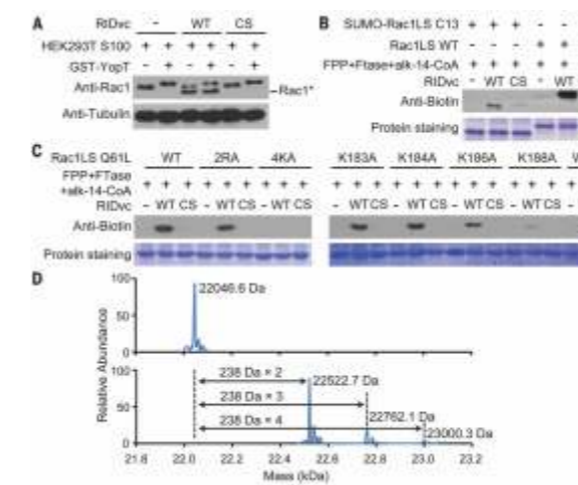
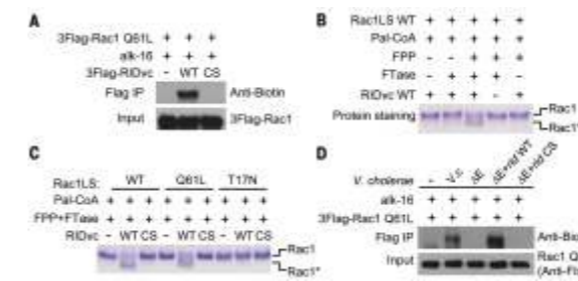
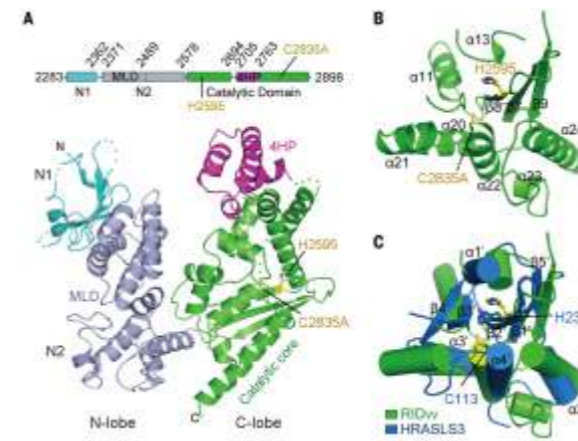
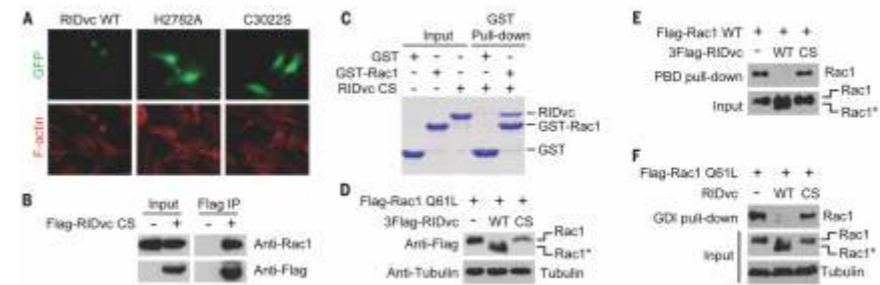
这项研究揭示了一种病原菌失活宿主关键信号分子Rho家族小G蛋白功能的全新作用机制，国际上首次鉴定催化赖氨酸长链脂肪酰基化的酶类，首次发现Rho家族小G蛋白的多碱性区域在细胞信号转导中的重要作用。

项目负责人：朱永群

MARTX毒素是一类具有4000-5000个氨基酸残基的大毒素家族，广泛存在于包括霍乱弧菌、创伤弧菌等众多病原细菌中，其N端和C端具有独特的RTX重复序列结构域，中间区域具有多个效应因子结构域，其中RID是MARTX毒素家族中非常保守的一个效应因子结构域。MARTX毒素通过N端和C端的RTX结构域，插入宿主细胞质膜上，然后通过真核细胞特有的IP6分子激活半胱氨酸蛋白酶结构域，切割并释放毒素中间的效应因子结构域，到宿主细胞胞质中。这些释放的效应因子作用于宿主关键信号分子，调节宿主信号通路。MARTX毒素保守的RID效应因子能够破坏宿主肌动蛋白细胞骨架，引起宿主细胞变圆，然而RID的作用机制还不清楚。



朱永群实验室发现RID能特异地识别和修饰宿主关键信号分子Rho家族小G蛋白Rac1，导致Rac1在SDS-PAGE胶中向下迁移，细胞内结合GTP的活性形式Rac1大量减少，修饰后的Rac1不能被宿主Rho GDI结合，从而导致所有被RID修饰的Rac1全部滞留在细胞膜上，打断了Rac1从细胞膜到细胞质中的循环。RID是一



个具有“U”形结构的分子，其N端能特异地结合细胞质膜特有成份PI(4,5)P2，C端是一个反置木瓜蛋白酶折叠模式的酶学结构域，和人类脂肪酰基转移酶HRASLS3结构具有很大的相似性。RID能以棕榈酰辅酶A等长链脂肪酰辅酶A为配体，利用脂肪酰基转移酶活性，在体内和体外有效地修饰Rac1的C端多碱性区域的赖氨酸残基。重要的是，被RID修饰后的Rac1既不能被宿主的上游激活蛋白GEF分子激活，也不能激活信号通路下游信号分子激酶PAK1，导致Rac1的功能彻底丧失。RID还能修饰Rac1同家族的Rac2和Rac3，但因为不能与该家族其他成员结合，RID对其他家族成员小G蛋白的活性很弱。在细菌感染过程中，RID能有效地抑制由Rac1调节的宿主免疫吞噬作用、细胞迁移和抗菌氧自由基的产生，并在小鼠感染中RID对创伤弧菌的致病性至关重要。

这项研究揭示了一种调节宿主关键信号分子Rho家族小G蛋白功能的全新方式，国际上首次鉴定催化赖氨酸长链脂肪酰基化的酶类，国际上首次发现Rho家族小G蛋白的多碱性区域在细胞信号转导中的重要作用。由于具有MARTX毒素的霍乱弧菌和创伤弧菌对人类健康构成了重大威胁，该研究对深入认识相关疾病的发生具有重要意义，对研发针对创伤弧菌等新型抗菌药物具有潜在的应用价值。

该成果于2017年10月27日发表在Science杂志上，获得了Science和Nature Chemical Biology等杂志的专文评述，获得中国科学报头版、科学网、知识分子、BioArt、浙江新闻、浙江24小时等大量媒体广泛报道。



2017年度浙江大学学术进展

# 卫星遥感光学稳定成像关键技术及应用

★★★★★ (入选年度十大学术进展)

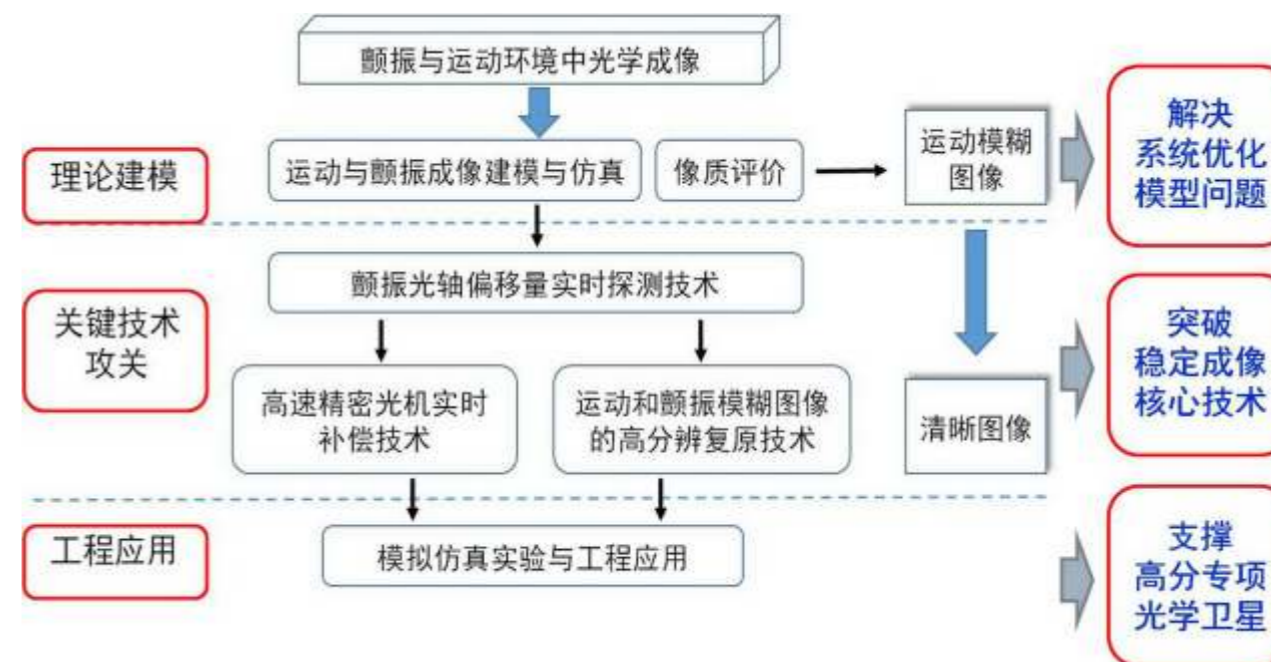
卫星运动和颤振是制约高分辨率光学遥感成像质量的重要瓶颈之一。徐之海教授团队经过12年的技术攻关，突破了这一瓶颈，助推了我国向该领域国际尖端水平的技术跨越。

项目负责人：徐之海

高分辨率对地观测系统是国家重大科技专项之一，随着我国高分辨率光学卫星的分辨率越来越高，卫星运动和颤振成为制约光学成像质量的重要技术瓶颈。徐之海团队瞄准这一瓶颈技术，开展了历时12年的艰苦技术攻关和推广应用，取得了突破性进展，实现了向该领域国际尖端水平的技术跨越，为我国高分辨率卫星光学遥感技术发展提供了重要的技术支撑。该项成果2017年被授予国防技术发明一等奖。



研究团队深入开展了高分辨率光学遥感运动与颤振成像理论建模与仿真、运动矢量高精度实时探测与光



机补偿、颤振与运动模糊图像软件复原方面的研究。主要技术创新与发明点为：

1. 建立了卫星颤振对成像质量影响的理论模型，研制了国内首个光学遥感卫星颤振成像仿真软件，解决了从平台颤振参数到光学遥感成像质量退化的量化映射关系问题，为分析卫星颤振对成像质量的影响提供了重要理论基础和技术手段。
2. 发明了基于支持向量机参数自适应和针对推扫积分成像的高精度颤振探测技术，解决了像移探测的实时性难题，为遥感光学卫星运动与颤振图像的软硬件补偿提供了准确的测试数据。
3. 发明了基于运动预测闭环控制、光轴复合稳定控制等多种光机稳像方法，解决了从像移探测到补偿执行的时间滞后难题，提高了闭环稳像系统的实时性和准确性，从光机硬件上实现了高精度光学稳定成像。
4. 发明了基于运动模糊核提取和TDI积分成像机理的颤振模糊图像复原方法，有针对性地构建反卷积运算因子，解决了盲恢复图像处理中的物理盲目性和TDI成像模糊核的空间不一致性等难题，有效提升了遥感复原图像的质量。

在研究中共取得25项知识产权，其中发明专利授权15项，取得软件著作权登记10项；发表SCI收录论文29篇、EI收录论文62篇。相关论文被美国、法国、比利时和国内同行专家在国内外文章（含Optics Express、SIAM Journal on Imaging Sciences等国际顶级光学期刊）中他引200余次——标志该项目理论研究进入同领域国际前沿。成果鉴定委员会的评价是：……整体技术达到国际先进，在高分辨率卫星遥感颤振模糊图像复原处理方面居国际领先。

研究成果已经在中国空间技术研究院及其所属北京空间飞行器总体设计部、508所、东方红卫星公司、钱学森实验室，上海卫星工程研究所等国家航天主力单位中推广应用，并在我国最高分辨率军用光学卫星等工程型号的应用中取得了很好的效果，在嫦娥五号飞行试验器的应用中，改善了运动模糊影响，获得了迄今为止我国月面分辨率最高的可用图像。

该成果对提升我国高分辨率卫星光学遥感系统的成像能力和成像质量具有重要价值和意义，已经取得非常显著的军事和社会效益。



2017年度浙江大学学术进展

# 国内首款拥有完全自主知识产权的60 GHz锁相环芯片

★★★★★ (入选年度十大学术进展)

曾几何时，芯片已超过石油成为我国进口额最大的商品。尤其是高端芯片，其设计与制造技术一直被国外垄断。如今浙大人做出了第一款国内自行设计和制造的60 GHz锁相环高端芯片。

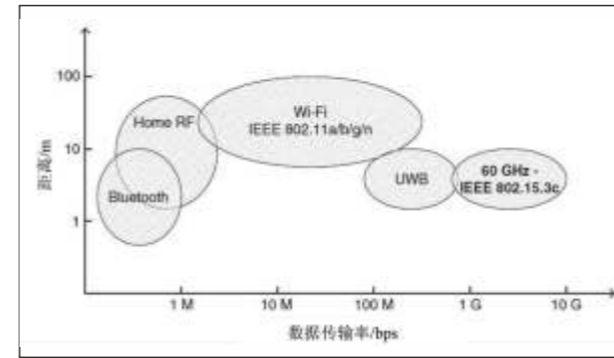
项目负责人：韩雁

在过去的半个世纪以来，整个人类社会的生活方式已经被无线通信技术的急速发展所彻底改变。但蓝牙、室内RF、WiFi、UWB协议所能提供的数据传输率都小于1Gbps，使得这些技术的发展已经被自身所固有的瓶颈所限制。因此进入21世纪以来，60 GHz的无线通信频段被免费向公众开放，相关领域的技术也成为了人们研究的热点。比如在无人驾驶的自适应巡航系统中，60 GHz以上的雷达成为关键组件；在军事保密通信方面，因为60 GHz具有高衰减峰，远距离或定向范围之外就有极大衰减，因而不被敌方截获。

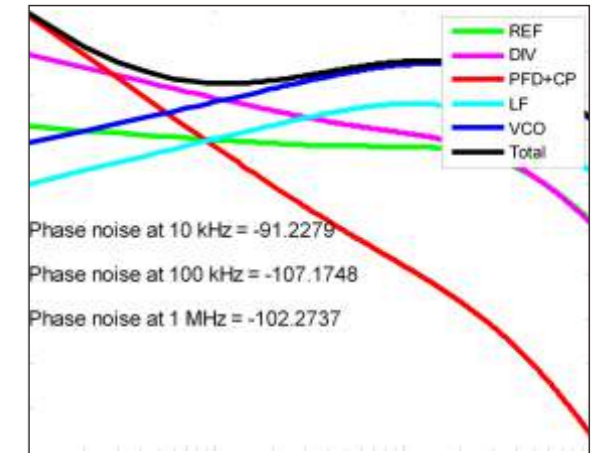
在60 GHz无线通信技术中，无线收发机是其硬件载体，而锁相环是无线收发机中的关键模块，其性能影响且决定着整个收发机的信号带宽和信噪比等指标。本项目基于国内设计和国内制造，实现了首款具有完全自主知识产权的国产化60 GHz锁相环高端芯片，浙大人打破了国内高端芯片只能依赖进口或国外加工的魔咒，实现了零的突破，也实现了《国家中长期科技发展纲要》确定的16个重大科技专项中的01专项——“核高基（核心器件、高端芯片与基础软件）”的努力目标。



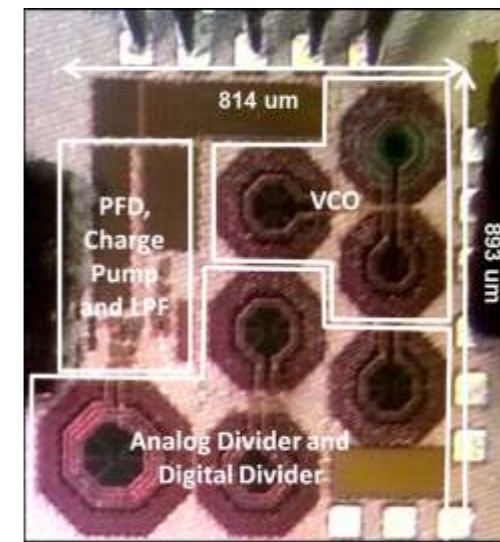
团队成员在全国研究生集成电路专业赛一等奖颁奖仪式上



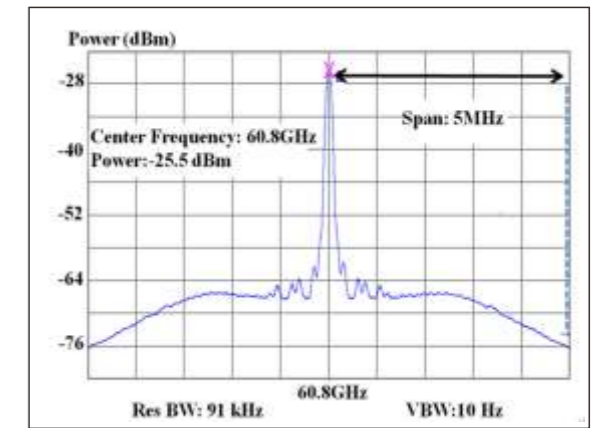
目前各可用通信频段的数据传输率



60 GHz锁相环的相位噪声仿真曲线



40 nm CMOS工艺的60 GHz锁相环版图设计



60 GHz锁相环的测试曲线

高端芯片国产化的难度主要在于两个方面：一个是设计方面，一个是制造方面。在设计方面，由于我们基础薄弱，与先进国家一直存在着较大的技术差距，国际顶级期刊与会议上发表的射频芯片的性能指标已经非常先进；在制造方面，国内射频芯片生产线缺乏完备的工艺库，使得芯片设计人员纷纷选择国外的生产线加工自己设计的芯片，这样更不利于国内生产厂家积累经验、提升完善自己的工艺流水线水平，而这反过来又进一步使得设计人员更不愿意依靠国内生产线设计高端芯片，进入恶性循环。高端芯片的国产化始终流于形式与口号之中。如若发生战争封锁，则高端芯片的制造仍将受制于人。所以芯片国产化须以“工艺为基础，设计为龙头”，两头并进才能拥有真正意义上的自主知识产权。

为此，本项目不但克服了芯片设计方面的重重困难，还解决了国内半导体集成电路制造厂商缺乏60 GHz相应工艺库的问题，使得原本只有20 GHz模型库的中芯国际公司，成为大陆第一家具备了生产制造60

GHz射频芯片的能力。今后国内射频芯片设计工程师，不必寻找和依赖国外的生产线完成自己的设计，真正实现高端芯片设计、制造的国产化梦想。

本项目由浙大微电子学院的韩雁教授带领博士生周赛等团队成员，花费4年多心血，在国内最先进的40 nm CMOS工艺线上完成的。由于在缺乏设计库的情况下研究难度太大，其他老师也曾认为不太可能实现，几乎两度放弃。但最终还是坚持到了胜利的这一天！



2017年度浙江大学学术进展

# 核酸天然免疫识别的细胞微环境控制及干预研究

★★★★★ (入选年度十大学术进展)

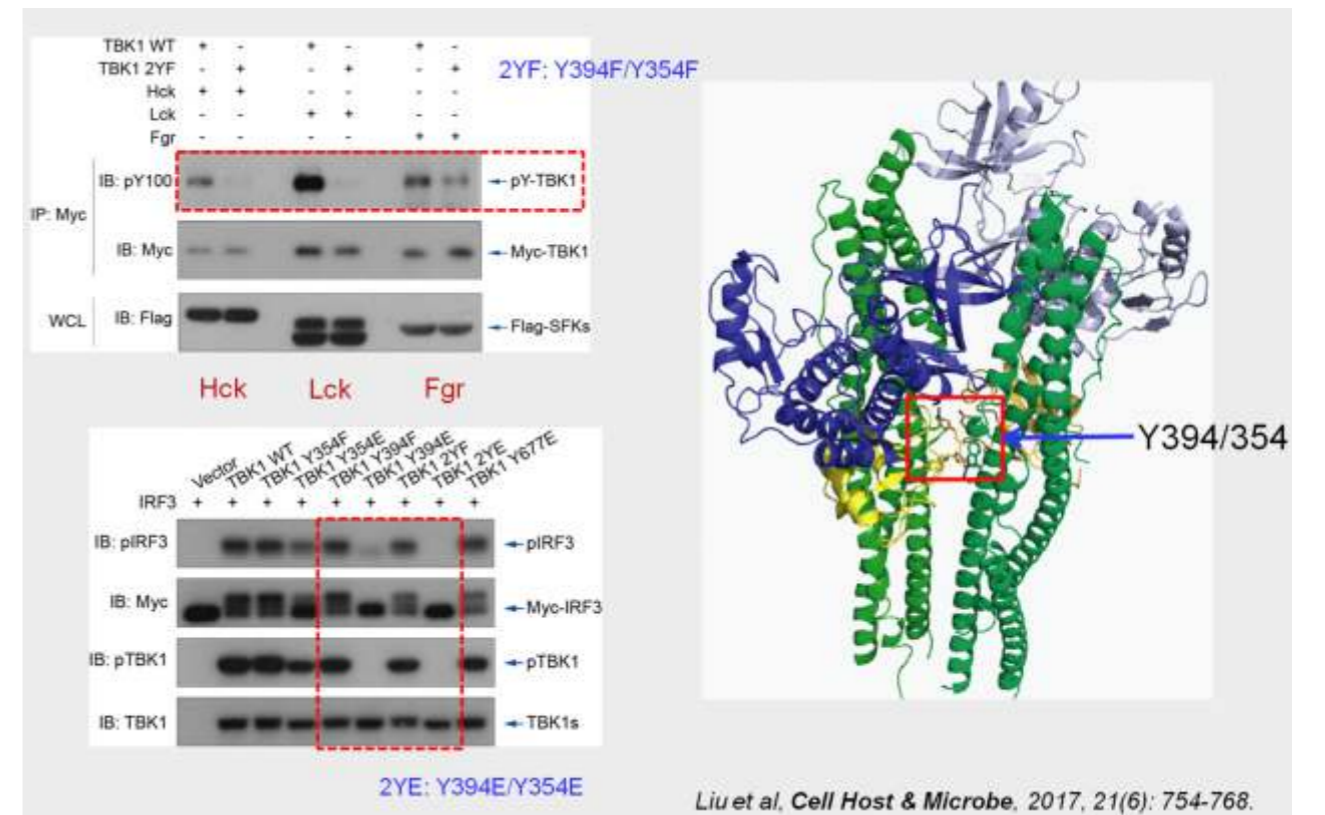
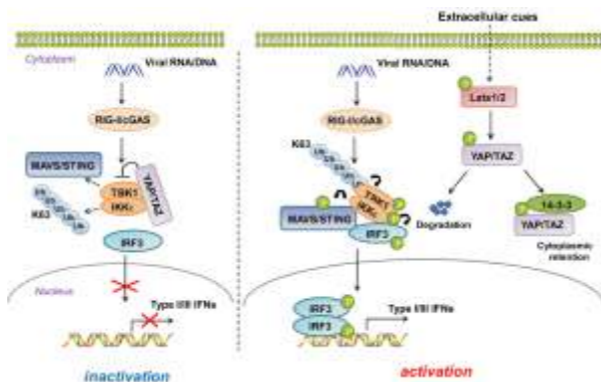
通过发表于国际著名学术期刊的一系列创新研究成果，徐平龙实验室系统地阐述了核酸天然免疫识别这一广泛存在且高度保守的生物学机制的调控新规律及干预途径。

项目负责人：徐平龙

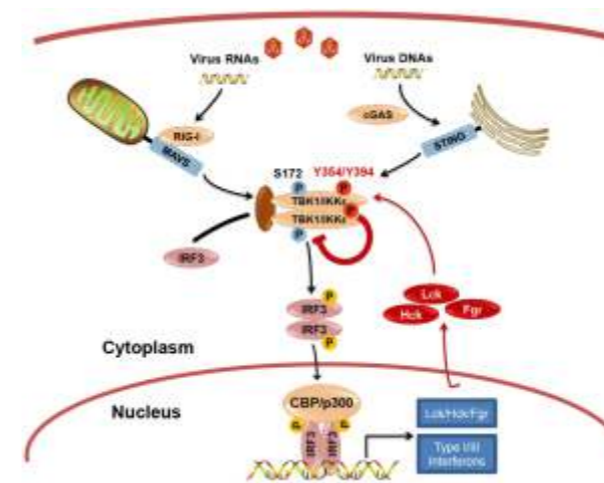
通过感知细胞质中的异源或因细胞损伤而泄露的自身核酸物质，核酸天然免疫识别激活高度敏感的信号机制而生成数以百计的基因产物，从而建立起自身和周边细胞的天然免疫状态。作为一类存在于所有类型细胞和进化上高度保守的细胞损伤识别机制，核酸天然免疫识别不仅对防御病原微生物的感染至关重要，也在自身免疫疾病、肿瘤发生和神经退行性疾病中有关键功能。富有哲学意味的是，能否对抗并逃逸该防御系统是病毒等病原微生物具有致病性的主要因素。因此，研究核酸免疫识别具有重要的科学认知价值和应用前景，也是当前国际生物医学发展的主要前沿之一。其中核酸免疫识别如何由细胞微环境影响控制，是领域内亟待解决的重要问题，但国际上对此的研究基本还是空白。



自2013年回国，徐平龙教授及其带领下的研究团队通过多学科交叉，致力于在细胞、分子与整体动物水平回答天然免疫识别领域内亟待解决的重要问题，特别是宿主防御的微环境/遗传因素调控、新信号机制及新生物学功能，并取得了一系列突破性进展。2017年，徐平龙教授团队通过两篇发表在国际著名学术期刊的研究论文，系统地阐述了核酸免疫识别的细胞内外微环境调控以及潜在的干预途径。在国际上首次提出了营养与细



Liu et al, Cell Host & Microbe, 2017, 21(6): 754-768.



胞张力微环境以及酪氨酸磷酸化修饰控制核酸天然免疫识别的新理论，突破了核酸识别机制由蛋白丝苏氨酸磷酸化所介导这一传统认知，并指出了酪氨酸激酶抑制剂在抗病毒防治中的重要应用价值。这两项重要研究成果分别于2017年4月和6月以研究长文形式发表于《Nature Cell Biology》(Nature子刊, 影响因子

20.06)和《Cell Host & Microbe》(Cell子刊, 影响因子14.95)。资深免疫专家、爱尔兰免疫学会主席Lavelle教授在同期《Nature Cell Biology》上发表专文高度评价此工作; Science子刊Science Signaling资深编辑Wong博士将此工作作为“编辑专选”进行正面评价; 研究工作也被《中国科学报》头版、新华社、凤凰网等数十个媒体亮点报道。此外，徐平龙教授团队在此前的研究中也发现了核酸免疫识别通路关键转录因子IRF3的全新修饰和调控模式(Genes & Development, 2016); 鉴定了核酸免疫识别信号复合体中一个关键的调控因子——蛋白磷酸酶PPM1A(Science Advances, 2016); 并首次提出了核酸免疫识别在调节性T淋巴细胞分化和上皮细胞间充质转化这些肿瘤免疫和转移过程中的关键功能和机制(Molecular Cell, 2014)。上述一系列的创新成果是核酸免疫识别基础研究上获得的关键理论突破，对病毒感染、自身免疫疾病和抗肿瘤免疫的基础与临床研究及新药研制具有重要指导意义。



2017年度浙江大学学术进展

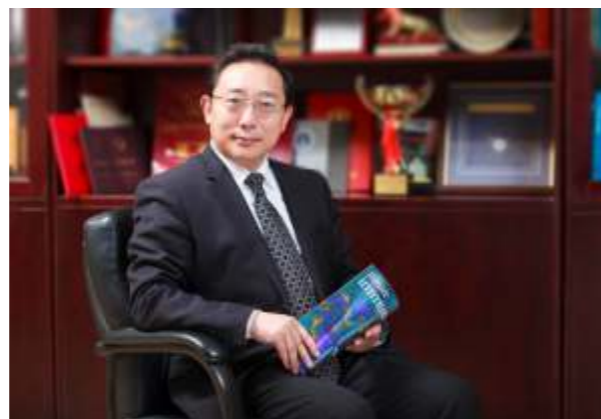
## 干扰素抗病毒效应的新型调控机制研究

★★★★★ (入选年度十大学术进展)

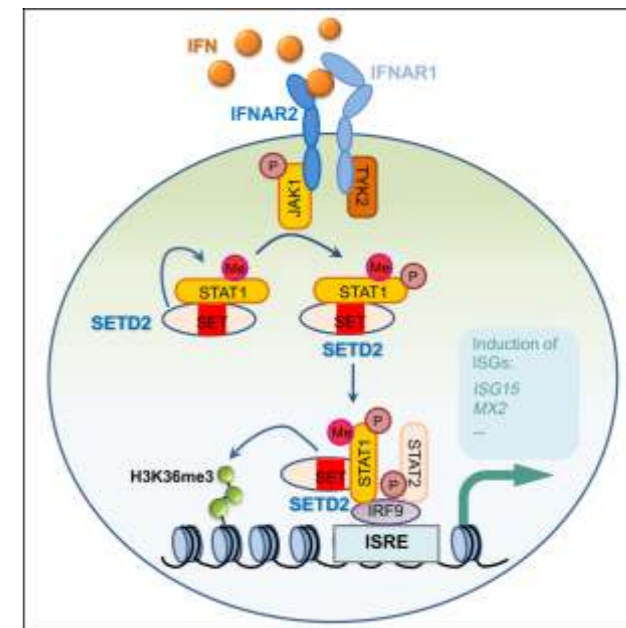
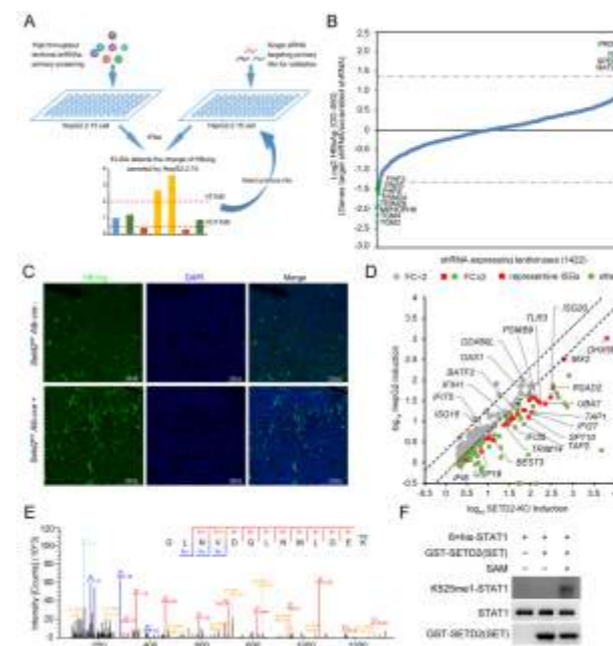
曹雪涛院士团队首次发现了组蛋白甲基转移酶SETD2在调控干扰素信号以及干扰素抗病毒活性中发挥了正向调节作用，揭示了干扰素抗病毒效应调控新机制，这一发现为增强干扰素抗病毒效应药物设计与应用提出了新角度。

项目负责人：曹雪涛

慢性乙型肝炎，简称乙肝，是由HBV病毒持续感染引起的一种危害严重的感染性疾病，是我国发病率最高传染病之一。世界卫生组织（World Health Organization）的统计数据显示，全球有超过3.5亿人慢性感染HBV，每年有超过68.6万人死于HBV感染引发的肝功能衰竭、肝硬化和肝癌。虽然近年来我国的乙肝发病率呈下降趋势，但全国仍有9,000万乙肝病毒携带者，其中2,800万为处于活动期的现患者。乙肝的防治形式仍不容乐观，控制HBV病毒的感染（预防），及促进机体对HBV的清除（治疗）成为控制乙型肝炎流行的两个重要研究方向。



干扰素是机体抵抗病毒感染的关键性细胞因子，通过激活胞内JAK-STAT信号通路诱导一系列干扰素诱导性基因的表达，从而激活机体的抗病毒能力，为机体建立抵抗病毒感染、维持免疫稳态的重要防线。干扰素信号调控异常与炎症性疾病、慢性感染性疾病发生发展等密切相关。目前，I型干扰素是目前临床用于治疗慢性乙型肝炎



炎的常用药之一，然而其总体有效率较低，治疗效果亟待提高。因此，全面深入认识干扰素抗病毒效应的具体机制以寻找有效防治病毒感染的免疫措施具有重要意义。

近年来生物医学的一个研究热点是探究表观遗传学机制在众多生理病理过程中如何发挥重要调节作用。甲基转移酶通过调控组蛋白甲基化参与多种免疫应答过程与免疫性疾病的发生，然而目前尚不清楚表观遗传酶分子如何直接调控细胞内信号转导蛋白质分子翻译后修饰机制及其在干扰素抗病毒免疫应答功能的具体作用。

浙江大学医学院曹雪涛院士团队研究发现组蛋白甲基转移酶SETD2分子能够直接催化干扰素下游信号蛋白分子STAT1的甲基化，从而增强干扰素效应信号，促进机体的抗病毒免疫功能。研究团队通过高通量RNA干扰筛选体系筛选了目前已报道的700余种表观遗传修饰相关基因，发现组蛋白甲基转移酶SETD2分子表达对于干扰素抵抗乙型

肝炎病毒HBV效应的至关重要。通过制备肝细胞中特异性敲除SETD2基因的小鼠模型体内实验，证实SETD2能显著增强干扰素抑制HBV体内复制的效应。机制研究表明，SETD2分子通过其SET结构域发挥甲基转移酶活性，直接催化信号蛋白STAT1的第525位赖氨酸发生单甲基化修饰（STAT1-K525me1），从而促进干扰素效应信号的活化。此外，SETD2还可以选择性地催化干扰素诱导性基因远端启动子区发生组蛋白H3K36me3的修饰，从而直接促进这些具有抗病毒作用基因的转录活化和表达。研究成果于2017年7月27日发表在国际著名杂志《细胞》（Cell）上。

该研究揭示了甲基转移酶SETD2分子在促进干扰素抗病毒效应中的重要功能，为临床上研发新的抗病毒药物提供了潜在的研究靶标。该工作也进一步完善了干扰素效应信号的调控网络，揭示了SETD2分子直接催化信号蛋白STAT1甲基化修饰的新机制，为免疫调控机制的研究提供了新的思路。



2017年度浙江大学学术进展

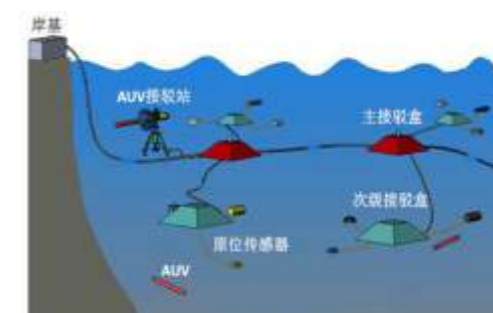
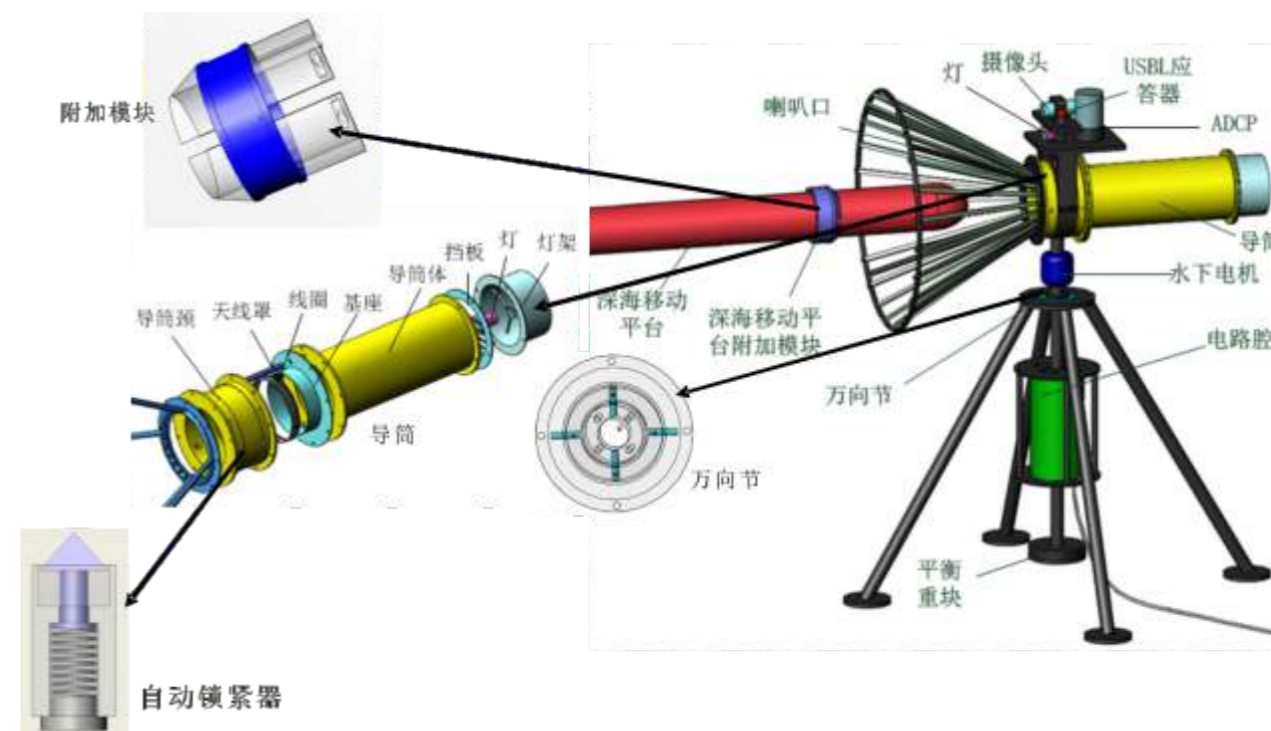
# 浙大成功实现无缆水下机器人 百米海底的充电传信

★★★★★ (入选年度十大学术进展)

研发的海底多功能海底接驳站，在105米深海域完成了无线充电和非接触信号传输，在解决AUV与水下支持系统对接这一世界性难题工作上，取得重要进展。

项目负责人：陈 鹰

浙江大学流体动力与机电系统国家重点实验室、海洋学院和信电学院等单位，组织学科交叉研究队伍，承担了国家“十二五”863计划海底观测网重大项目“深海移动平台与海底观测网非接触接驳技术”课题，开展了相关关键技术研究及设备攻关和实海试验研究。课题组完成了水下机器人的声光二段复合导航、基于海底观测网络的电能/信息无线传输、水下在线接驳等关键技术研究，并于2017年5月12日至16日，在我国南海某海域成功完成了海上试验。本次海上试验，首先在50米水深海域，AUV与海底观测



网非接触式海底对接系统成功进行了10次自主回坞对接操作。同时，水下接驳基站对AUV进行无线充电，最高功率达到681W；AUV与水下接驳站进行信息交互，非接触信号最大传输速率达到3.1MB/s。在105米水深海域，AUV与水下接驳站成功对接，并完成了对AUV的无线充电和非接触信号传输。这项技术成果，攻克了海底无缆水下机器人海底自动充电及传信的世界性难题，且这项研究工作成功突破了在水深超过100米的海域实现水下航行器与海底观测网对接试验技术，在人坞成功率、无线充电功率以及非接触信号传输速率上，均达到国际先进水平。这项工作，为实现我国的海底综合观测，奠定基础。



2017年度浙江大学学术进展

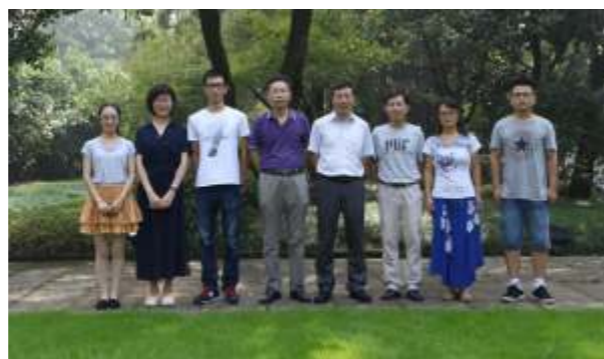
# 纳米照明首次实现片上大视场 无标记远场纳米显微成像

★★★★★

浙江大学光电学院刘旭教授、杨青教授团队利用微纳光源照明突破无标记远场超分辨显微成像的国际难题，成像视场相比其它无标记远场超分辨成像方法提升2个数量级以上。

项目负责人：刘旭 杨青

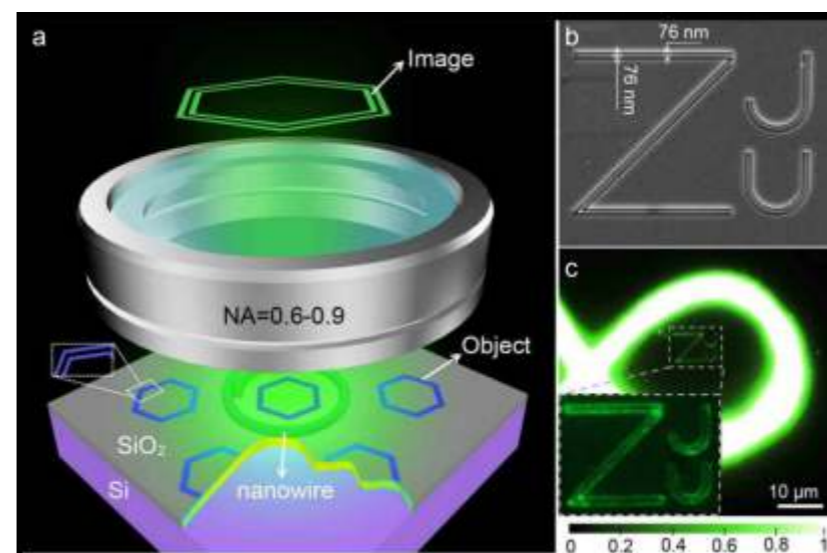
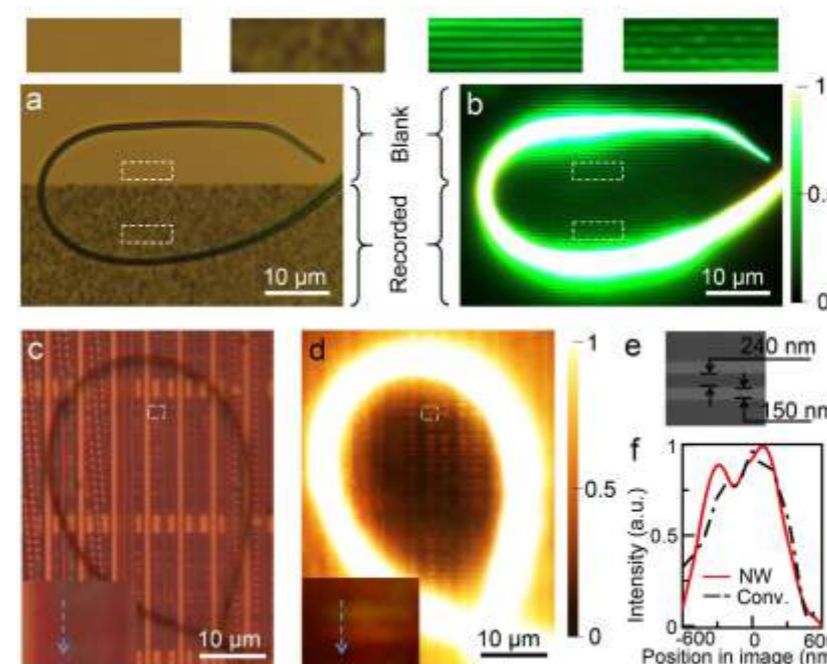
光学显微镜自16世纪发明以来，成为了人们探索微观世界的重要工具。在近一个世纪里显微技术突飞猛进，1953年、1986年、2014年三次诺贝尔奖都授予了在该领域获得重大成果的科学家，相关成果极大地促进了生物医学、物理、化学等领域的发展。



最初，人们认为，只要显微镜片的制作足够精细，理论上可以观察到任何微小的尺寸。然而，19世纪末，德国物理学家恩斯特·阿贝发现了“衍射极限”的存在，任何传统成像系统的分辨率都会受到数值孔径(NA)和光波长限制，在可见光波段，约为200nm。



亚波长分辨率的超分辨显微成像，对人类科学取得突破性发展至关重要。近年来，荧光标记型的超分辨显微技术发展迅速，并在2014年获得了诺贝尔化学奖。相比之下，无需标记的超分辨显微技术却一直发展缓慢，遇到了视场小、分辨率低、需近场扫描、适用性差的瓶



刘旭和杨青团队瞄准了国际上大视场、远场、无标记超分辨显微成像这一关键科学难题，他们创新地将发光纳米材料作为局域光源，巧妙地利用其小尺寸、大表体比和强倏逝场等特点，并与二维波导相复合，在国际上首次实现了大视场的远场无标记超分辨显微成像，打破了目前超分辨显微领域的瓶颈，获得的视场比以往报道的无标记型远场超分辨显微方法扩展了2个数量级，且方便快捷、普适性强，在集成芯片、蓝光DVD、3T3 11癌细胞等不同领域的亚波长样品上均得到了验证。该技术成本低廉、与广泛使用的显微镜系统具有优秀的兼容性，可设计成紧凑型照明模块使普通显微镜具备超分辨能力。这些特点使其在生物医学、集成工艺、材料科学等重要领域具有广阔的应用前景，同时也为推进微纳发光器件的实际应用迈出了重要的一步。

该成果被称为纳米线环照明显微术，发表在国际物理学顶级学术期刊《物理评论快报》上(PRL 118, 076101 (2017))；入选“2017中国光学十大进展-应用研究类”，被认为“纳米照明首次实现片上大视场无标记远场纳米显微成像”；以“我国学者在无标记远场超分辨领域取得突破”为题被中国科学网报道。

颈，同时，生物、医学、材料学等领域却对无标记超分辨显微成像又提出了迫切需求。近年来国际上多个研究小组持续加大对无标记超分辨显微成像技术的研究力度，并取得了一定成果，如基于近场扫描、超透镜结构、微球接触的技术相继出现，但仍面临着光谱范围单一、视场小、速度慢等限制。探索并发展宽场、远场、结构/相位均能快速成像的新型无标记超分辨显微技术成为国内外各研究组持续关注的难点与热点。



2017年度浙江大学学术进展

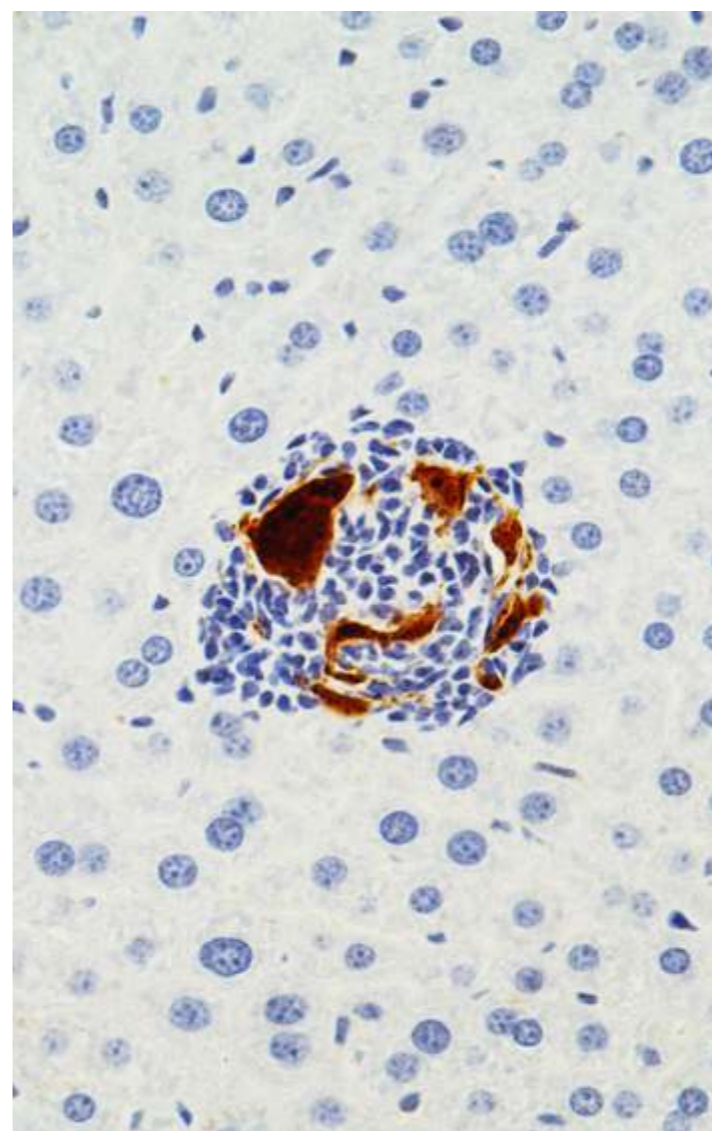
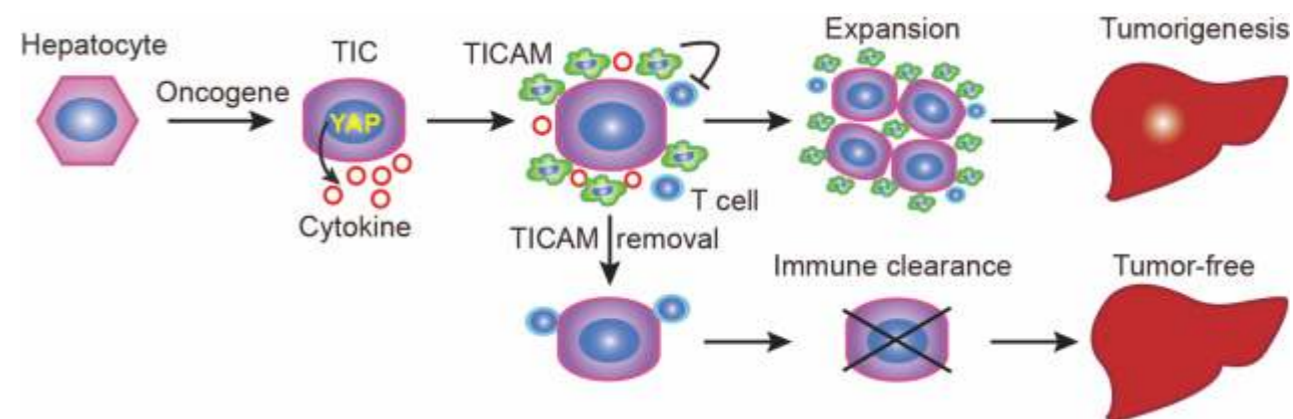
# 巨噬细胞在肝癌起始中的关键作用及其机制

★★★★★

通过自主研发的转座子液态高压注射基因编辑系统在小鼠体内诱导肝脏肿瘤起始细胞，首次发现了在肝癌起始阶段巨噬细胞的特异性招募并阐明了这一过程在肝癌发生中的关键作用和分子机制。

项目负责人：赵斌

肝癌发病率在世界范围内位于癌症中第五位，在我国位于前三位，其发病率呈现逐渐升高的趋势。更为严重的是肝癌造成的死亡率在癌症中高居第二位。这主要是因为大量病人在确诊时已经处于肿瘤晚期，发现后的治疗方案也非常有限。因此，深入了解肝癌的发病机理，找到新的早期诊断标志物，以及新的治疗靶点是肝癌研究的重点。肝癌治疗的困境有多个原因，其中的重要一点是肝癌的基因突变在不同病人之间有很大异质性，导致对病人进行基因型分型并有针对性的开展临床试验相当困难。所以，在动物模型上进行相关研究，然后应用于临床转化是更为可行的方案。然而，现有的肝癌小鼠模型却很难满足这一需求。本实验室通过三年多的摸索和优化建立了基于PB转座子液态高压注射的小鼠肝癌模型，并利用该体系首先研究了巨噬细胞在肝癌起始阶段的关键作用。巨噬细胞是免疫细胞的重要成分，在肿瘤



免疫中发挥重要作用。但由于技术的限制，肝肿瘤起始细胞是否特异性招募巨噬细胞，以及这些巨噬细胞在肿瘤起始过程中扮演何种角色尚不清楚。本项目通过新技术的建立解决了这一难题。

使用转座子液态高压注射基因编辑系统，我们实现了在体内对小鼠肝细胞基因组进行编辑，成功诱导出肝癌起始细胞并对其进行示踪。观察发现最早从单个细胞时期开始，肝肿瘤起始细胞即可特异性的招募巨噬细胞。并证明了Hippo信号通路是这一现象的关键分子机制。肿瘤起始细胞中Hippo通路下游效应分子YAP的激活强烈诱导趋化因子CCL2和CSF1的表达。敲减YAP诱导的趋化因子不但抑制了巨噬细胞招募，还完全阻止了YAP诱导的肿瘤发生。进一步研究发现在缺失成熟T细胞和B细胞的Rag1敲除小鼠中，巨噬细胞的缺失不再抑制肿瘤的发生。因此，YAP激活招募的巨噬细胞通过抵抗免疫监视帮助肿瘤起始细胞逃避清除进而扩增成瘤。这一研究提示特异性抑制YAP或YAP招募的巨噬细胞可能是清除肝脏肿瘤起始细胞，预防和治疗肝癌的有效手段；并证明了转座子液态高压注射模型灵活有效、经济快捷等特点，为这一系统在肝病基础研究和转化研究中的广泛应用奠定了坚实的基础。



2017年度浙江大学学术进展

# 空间微分器——亚波长厚度全光模拟运算

★★★★★

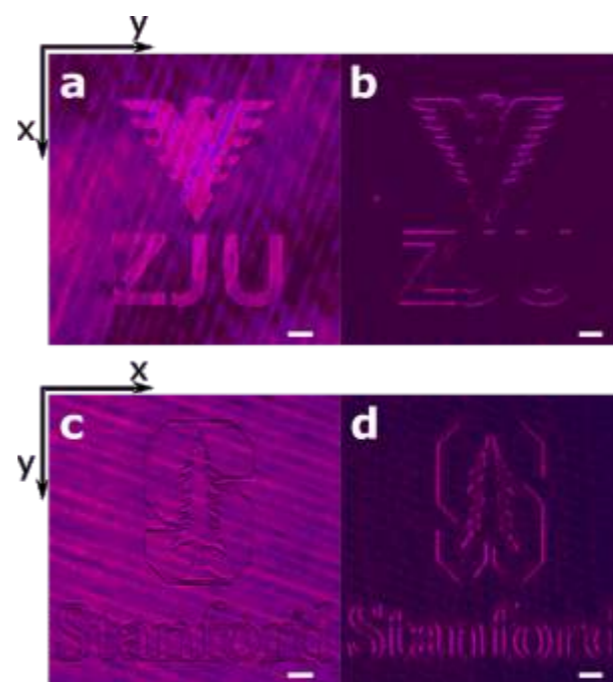
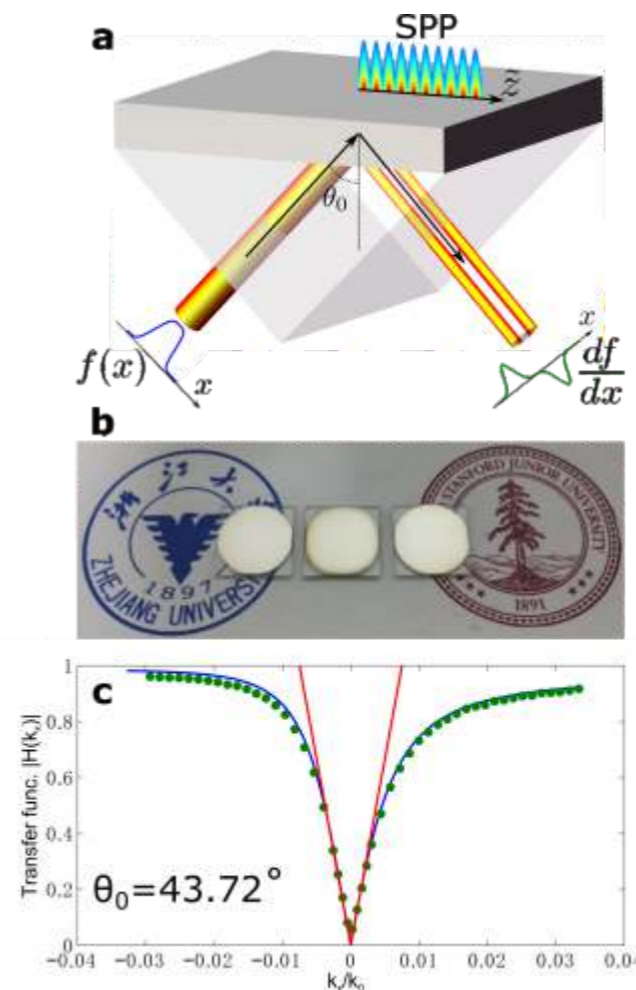
阮智超教授突破光信息处理的传统思路，提出并实现了基于表面等离激元的空间光场微分器，首次将宏观尺寸的光信息处理系统缩小至亚波长尺度，并应用于超快速、实时图像处理。

项目负责人：阮智超

随着信息技术的迅猛发展，对信息处理性能的需求正在不断提高。由于光学信息处理技术具有超快速、大带宽、高通量、低损耗等优势，利用微型、可集成化的微纳结构来实现光信息处理成为了近年来的重要课题。而在已有的报道中，相关微纳结构的设计都极其复杂，在实验上精确地制备这些器件并以之实现光学模拟运算存在非常大的难度，因此至今仍未有相应的实验成果出现。

针对这一挑战，物理学系阮智超教授突破传统光信息处理傅里叶变换的思路，通过构建空间耦合模理论[Ruan et al., 2014, Optics Letters, 39(12): 3587–3590]，提出利用空间光场与金属表面等离激元之间的耦合与干涉，使得反射的光场对应于一阶微分和积分的空间模拟运算[Ruan, 2015, Optics Letters, 40(4): 601–604]。所提出、设计的全光空间微分器采用了最简单的表面等离激元结构，可精确制备及大规模生产。

经过两年多的努力，2017年阮智超教授研究与光电学



院仇昱、叶辉教授，美国斯坦福大学 Shanhui Fan教授合作，在实验上取得了重要进展。课题组制备了一阶空间微分器，首次在实验上利用微纳结构实现了空间微分，并演示了直接对线偏振光场图像的边界检测。光学模拟微分运算的精度达到94%，边界检测的最小空间分辨率达到  $7\mu\text{m}$ ，时间频率带宽为3THz。空间微分器采用Kretschmann棱镜耦合结构，器件只需镀单层金属银，厚度仅为50nm，是目前唯一将厚度压缩至亚波长级别的光学模拟运算器件。

该技术为光信息处理提供了一种全新方法。特别是，课题组提出了若干在实时图像处理方面的重要应用。课题组利用该空间光场微分器实现对图像超快速的实时边界检测、边缘提取和边界方向判断，能够提取出物体的边界信息，是目标检测、特征分类、数据压缩等过程中的重要步骤，在高速、大通量图像处理（卫星和医学图像）、并行计算、目标识别等领域有着重要的应用前景，并有望用于光学神经网络和高速模式识别等人工智能领域。

该实验成果以题为“Plasmonic computing of spatial differentiation”的学术论文的形式已于2017年5月在Nature Communications[8, 15391 (2017)]上正式发表，并已经申请了发明专利《一种基于表面等离激元空间光场微分器的图像边缘提取方法及系统》。中国激光杂志社发表了《空间微分器——亚波长厚度全光模拟运算》专题报道，在各大平台上进行推送，阅读量超过2万次。经由中国工程院范滇元院士为主任的专家评委会评定，入选“2017中国光学十大进展——应用研究类”。



2017年度浙江大学学术进展

# 支架法空腔脏器吻合术

★★★★★

蔡秀军教授提出了“免缝合”空腔脏器吻合，研发了可降解支架，建立了支架法空腔脏器吻合术，其吻合方法简单，适合腹腔镜下实施，吻合后体内无金属异物残留。

项目负责人：蔡秀军

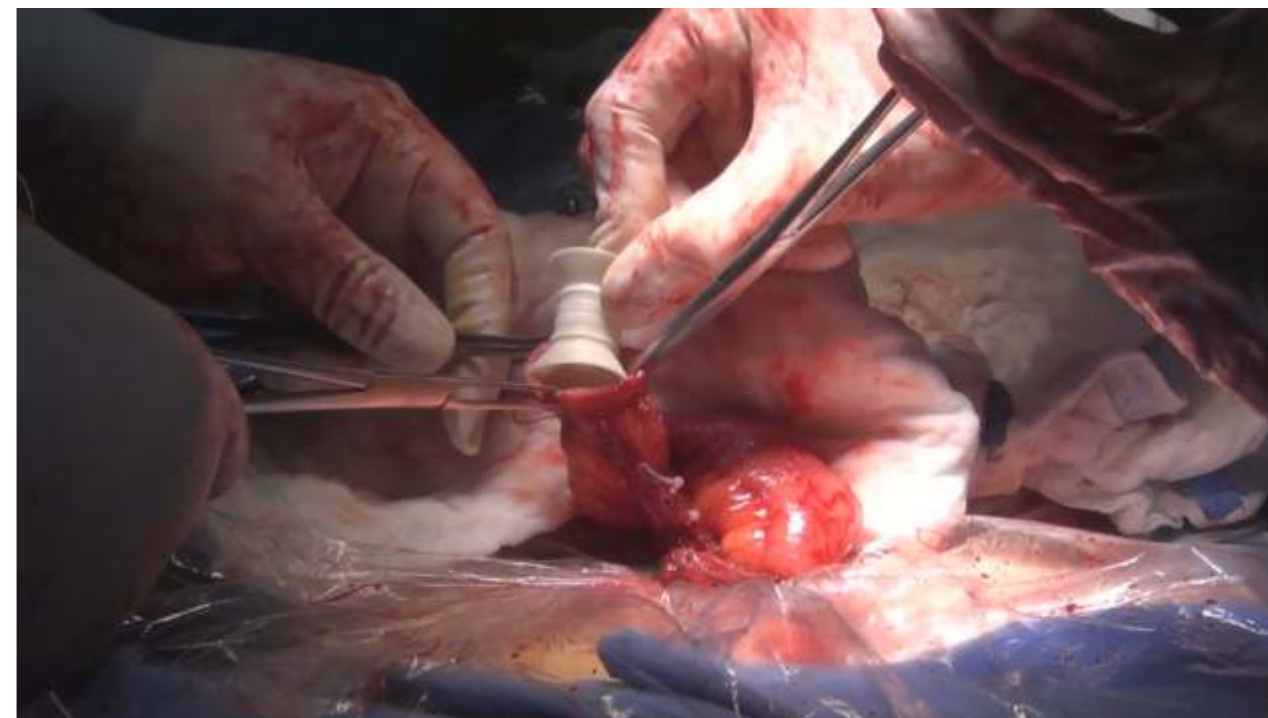
空腔脏器吻合是腹部外科最常见的手术方法，现有吻合方法主要包括手工缝合法及吻合器吻合法。手工缝合操作较繁琐，吻合时间长，难以在腹腔镜下实施；吻合器吻合方法简单、吻合时间短，但吻合器价格高，且吻合后腹腔内终生金属异物残留。此外，这两种方法吻合时都会破坏吻合口粘膜下血管，影响吻合口血供，不利于吻合口愈合。



蔡秀军教授针对目前空腔脏器吻合中存在的问题和难题，创造性地提出“支架法空腔脏器吻合技术”这一全新理念，得到国家863计划等重大科研项目的支持，研发了多种可降解支架，至今已授权发明专利5项；通过一系列动物实验、临床模拟研究、临床试用研究，建立了完整的“支架法空腔脏器吻合技术体系”。



这种吻合术具有诸多优点：（1）采用可降解支架实施腹腔空腔脏器吻合，吻合时间短，技术方法容易掌握，且



适合在腹腔镜下实施；（2）避免了在吻合口实施缝合或钉合，从根本上避免了吻合口粘膜下血管的破坏，有利于吻合口的愈合，防止吻合口漏的发生；（3）支架将吻合口与消化道内容物隔离，降低了吻合口漏及吻合口狭窄的发生；（4）支架为可降解高分子材料制成，吻合2周后，支架在消化道内降解成二氧化碳和水，随粪便排出，体内不留异物；（5）这种支架可用于肠漏、

肠穿孔的处理，能避免肠造口及二次手术，显著减少治疗周期（使治疗周期从3-6月减少为1-2周），减少医疗资源消耗，缓解我国医疗资源紧张的矛盾；（6）由于方法简单，军队卫生人员容易掌握，能在战地直接完成肠破裂或断裂的修复，避免了临时肠管结扎，提高战地救护水平。

可降解空腔脏器吻合支架已由杭州圣石科技有限公司生产，该吻合方法在北京大学第三医院、北京大学人民医院、首都医科大学附属友谊医院、浙江省肿瘤医院及浙江大学医学院附属邵逸夫医院临床试用19例，临床效果确切。



2017年度浙江大学学术进展

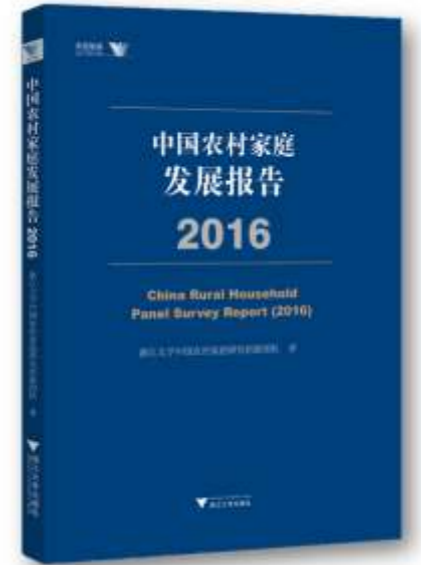
# 中国农村家庭调查数据库建设及其应用研究

★★★★★

微观数据是进行科学研究和探索宏观问题的基础。本项目通过规范的方法和技术，建设了一个能全方位满足农业农村研究的动态数据库，并以此为基础进行的研究系统刻画了中国农村的现状及演变情况，构建了中国农村问题研究的一个基准线。

项目负责人：钱文荣

2000年以来，随着国际化进程的快速推进，我国农林经济管理学科的研究也呈现出鲜明的国际化特点。一方面作为重要的转型国家，中国的“三农”问题引发了国际学术界的广泛关注和讨论；另一方面更多国内学者的研究开始走向国际，在国际学术界作出中国学者应有的贡献，传统的农业经济研究方法迅速被基于规范调研的大样本微观数据为基础的现代数理经济学和计量经济分析方法所取代。因此，为了全面、科学地开展中国农林经济管理学科相关问题的研究，迫切需要大样本农村家庭调查数据库的支撑。国内在相关数据库建设方面已取得了一定成绩，但“三农”问题研究还不能得到数据库数据的全面支撑。从已有数据库建设情况看，大



农村家庭关联在一起，记录了我国农村社会、经济、政治、文化、资源环境等各个维度的发展历程，刻画了我国农村家庭全方位的变迁，探究了各类社会问题的内在机制，从因果关系上解释和预测了中国农村社会的发展变化，从而为中国农村问题研究建立了基准线。

(3) 以大样本数据分析为基础，形成了若干具有新意的研究结论，如：农村性别失衡现象日趋严重，0-4岁少儿男女性别比例已达122:100，尤其是当第一胎是女孩时第二胎的男女性别比达到了194.3:100；农村大龄未婚人口比例逐渐上升，目前“剩男”是“剩女”的4倍以上；农村收入不均日渐严重，收入最高的20%家庭占所有家庭总收入的53%；新生代农民工劳动供给时间明显下降，加剧了人口红利下降速度；农民工家庭“离农”趋势十分明显，农地流转与规模化速度加快等等。

多数调查仅聚焦于农村家庭相关问题的某一或某几个方面，而不同数据库之间存在条块分割的遗憾，尚未有一项调查能系统全面地反映中国“三农”问题的基本情况。家庭是社会的细胞，而农村家庭是农村社区的基本组织单位，它不仅是农村区域消费与需求的基本单元，还是生产要素的供给侧所在单元。因此，农村家庭调查和数据库建设是“三农”研究的一项基础性工作。本项目在以下几个方面取得了重要突破：

(1) 形成了一套规范科学、适应中国农村实际情况的数据库建设技术，建成了具有独特价值的中国农村家庭调查数据库。在中国农村家庭调查的抽样框建设、家庭抽样、实地调查、质量控制等方面形成了科学、规范的方法和技术，建设了一个能全方位满足农业农村研究的数据库。该数据库不仅包含了具有全国、省级城市代表性的居住在农村的家庭样本，还包含了居住在城镇的农民工家庭样本，为系统研究转型时期中国农村的相关问题提供了全面的数据支撑。

(2) 系统刻画了我国农村家庭的现状及演变情况，建立了中国农村问题研究的基准线 (base line)。本项目将社会多维度的信息在微观层面上通过



2017年度浙江大学学术进展

# 稻田杂草-水稻竞争与协同进化分子机制

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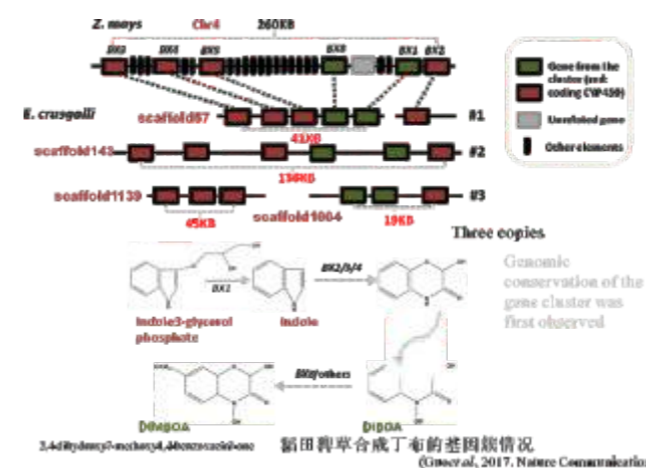
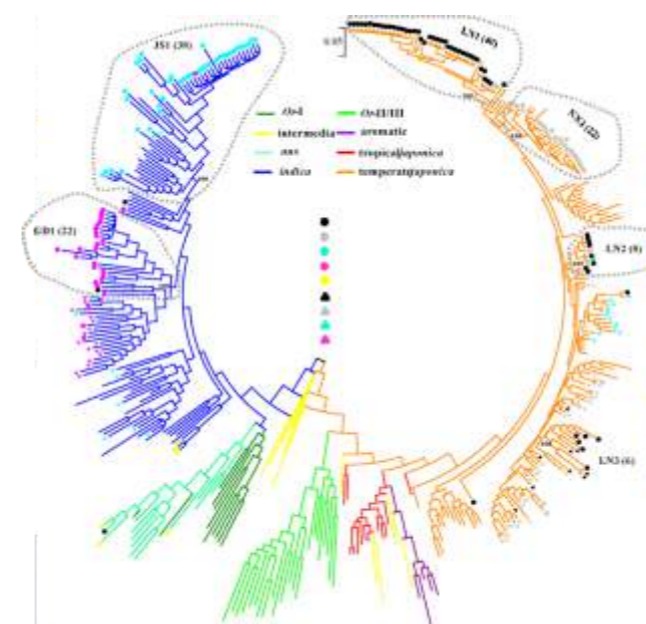
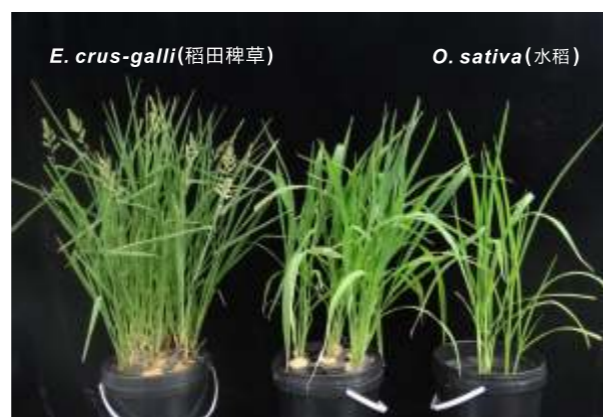
稗草和杂草稻是两种最恶性稻田杂草，与水稻及其相似，防治困难，目前水稻生产完全依赖除草剂。探明其竞争机制，对降低生产成本和环境污染意义重大。

项目负责人：樊龙江

我国水稻生产目前存在三个主要问题，一是除草剂用量越来越大（已成为我国农药中最大用量），严重污染环境和增加农民生产成本。目前急需减少除草剂用量，达到绿色控草，有机生产稻米；二是杂草稻等新型杂草近年大面积爆发，来源不明，无法控制，杂草稻主要表现为与水稻争肥，争光，竞争力强，严重影响正常水稻生长，影响产量同时也影响米质，一般情况，杂草稻造成水稻产量20-30%损失；三是水稻育种技术急需突破，培育更加高产和优质的水稻品种。水稻是我国最主要粮食作物，上述问题严重影响了我国水稻生产产量和质量。



通过本项目研究，我们（1）首次明确我国杂草稻均来自栽培稻群体。栽培稻在平衡选择等遗传机制作用下发生了去驯化过程，产生杂草类型稻种。杂草稻去驯化过程并非是简单的将栽培型恢复为野生型，而是利用新的变异和分子机制适应环境。我们还发现了一些重要的受到平衡选择的基因组区域，直接与杂草稻的果皮颜色和休眠有关。基于前述研究结果，我们提出了若干防控措



施，包括减少田间水稻收获遗留、主要籼粳稻杂种育种过程田间遗留材料、增加育苗移栽、减少部分轻型栽培环节等控草措施。浙江省近年来北部杂草稻问题突出，2017年10月省农业厅邀请项目负责人樊龙江教授赴杭嘉湖稻区实地进行考察，回复农民关切。我们经过多次考察和采样，对浙江省杂草稻危害面积、来源和防治措施等提出了具体意见，并给浙江省政府分管农业副省长孙景森提供了调研报告和建议，并得到省政府办公厅的回复；（2）明确了稻田稗草与水稻竞争分子机制，为稗草防控和水稻育种提供了重要遗传基础。生长过程中，植物会向环境释放特定的防御性化学物质，从而影响邻近植物生长。之前的研究显示，水稻自身会分泌一种稻壳素，帮助其与稻田杂草（如稗草）竞争。通过本项研究，我们首次发现稻田稗草同样通过基因簇合成防御性次生代谢产物丁布和稻壳素，与水稻进行竞争和适应稻田稻瘟菌等环境；稗草进化出种类繁多的基因家族，如GYP450和GTS，与除草剂非靶标抗性直接相关；（3）开展水稻育种遗传资源挖掘。基于本基础研究结果，通过定向稗草丁布育种获得的抑草水稻选育（化感稻），提高水稻品种抑草能力，预计可减少除草剂用量（30-50%），极大减少农药田间污染。同时对稗草抵抗稻田稻瘟菌机制将有助于水稻抗稻瘟菌抗性解析和利用。另外，稗草为C4植物，株型和生境与水稻一致，为C4水稻育种提供了绝佳C4途径模型。C4水稻育种预期可以提供水稻产量50%。



本项目有关稻田稗草研究论文获得国际“Faculty of 1000”（F1000）推荐（推荐为2星，表示“Very good”）。获得F1000的推荐，表明该论文得到了植物学界的认可，是对其研究成果重要性的充分肯定。正如推荐词所言，该研究对稻田稗草的极端竞争力给出了很好诠释。此外《人民日报》、《China Daily》、《科技日报》（头版）、《科学时报》、《环球科学》、《钱江晚报》（头版）等纸质媒体；央视网、新华网、科学网、搜狐网等知名网络媒体进行了广泛报道。



2017年度浙江大学学术进展

# 网络系统资源优化与控制基础理论及方法

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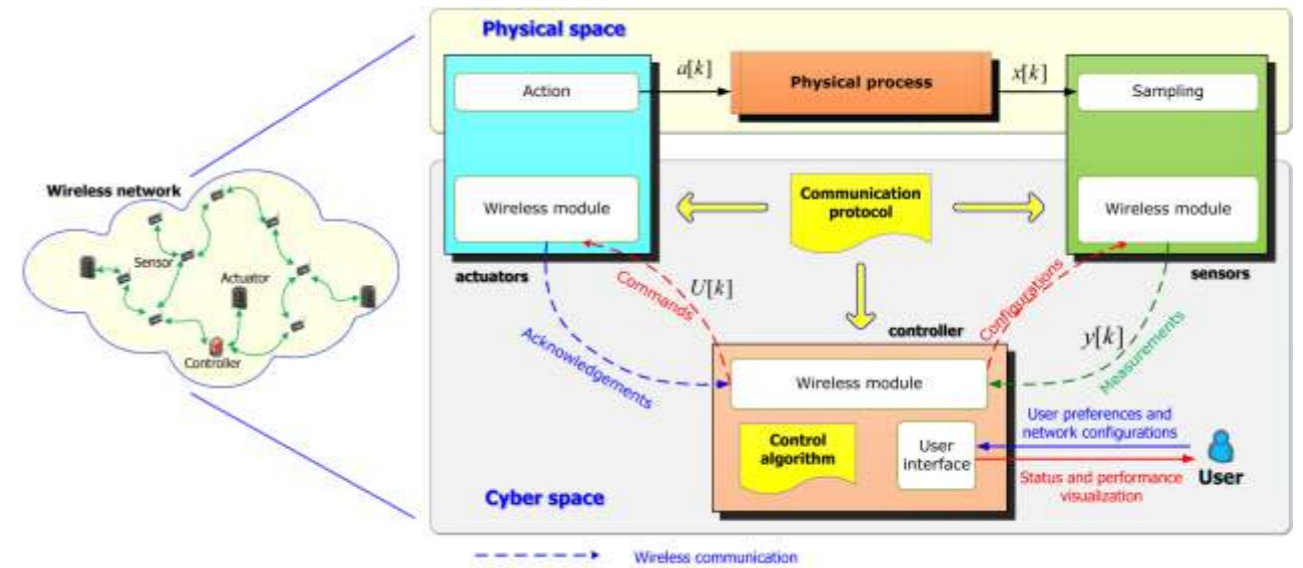
针对网络系统资源失配、估计失真、控制失准等挑战，研究了网络系统中数据传输、状态估计、协同控制等基础理论与关键技术，从根本上揭示了网络系统性能与网络资源的内在关系。

项目负责人：陈积明

控制、计算机和通信理论与技术作为推动近三十年来信息技术产业发展的核心学科，促使人类社会生产和生活快速迈入信息化时代。与此同时，人与自然万物及改造自然的机器之间，正向多尺度泛在互联的新模态转变。在信息化与工业化深度融合战略背景下，网络协同制造、智能电网等为代表的网络系统迅猛发展。面对复杂动态环境与多样化需求，迫切需要在局部信道、带宽、能量等资源约束下，保障网络泛在互联、功能灵活分散、控制协同自治，实现生产力的跨越提升。发展网络系统资源优化与控制基础理论及方法，提高系统性能和资源利用率，是解决上述问题的有效途径。



网络系统的复杂多样性与网络资源的时空受限性，导致网络系统面临资源失配、估计失真、控制失准三大研究挑战。陈积明教授研究团队从网络资源多目标优化出发，揭示网络资源及网络系统性能的内在关系，以传输性能、估计性能、控制性能为核心，在面向传输性能的资源动态分配、高效远程最优状态估计、分布式协同控



制三方面取得重要科学成果，实现了网络系统资源优化与控制理论研究的新突破，开辟了该方向研究的新思路。重要科学发现如下：

1. 发现并揭示了网络系统信道资源使用内在规律，建立了刻画频谱感知质量的长期性能指标；突破了已有网络传输性能的评价模型，有效解决了分布式多信道分配难题；提出了链路质量最优估计方法，构建了基于资源主动调配的网络传输性能跨层优化理论框架。
2. 提出网络系统有限时间窗远程状态估计性能评价新方法；刻画了可用网络资源与远程状态估计性能的直接量化关系；设计融合物理对象动态和实时可用资源的在线最优估计算法，显著提高资源约束下网络系统的状态估计精度。

3. 揭示了通信协议参数对系统性能的作用机理，建立了通信协议与控制算法的协同优化框架；提出了强可扩展的异构网络系统分布式协同控制方法；阐明了随机通信延时下时钟同步演化过程，在缩短收敛时间的同时大幅提升时钟同步控制精度。

部分项目成果获得2017年度教育部自然科学一等奖。相关成果共发表学术论文28篇（IEEE汇刊/Automatica论文22篇），Google Scholar引用1658次，SCI他引780次。其中，10篇代表作SCI他引568次，Google Scholar引用1179次，被186篇ACM/IEEE汇刊及Automatica论文引用，包括美国工程院院士、加拿大工程院院士及60余位ACM Fellow、IEEE Fellow等国际知名学者给予高度评价。4篇论文进入ESI前1%高被引论文。第一完成人入选2014、2015、2016年Elsevier中国高被引学者。项目组成员获2011、2015年IEEE通信协会亚太区杰出青年学者奖（Asian-Pacific Outstanding Young Researcher Award），培养中国自动化学会优秀博士学位论文获得者3人。



2017年度浙江大学学术进展

# 抗肿瘤诊疗一体化药物递送系统

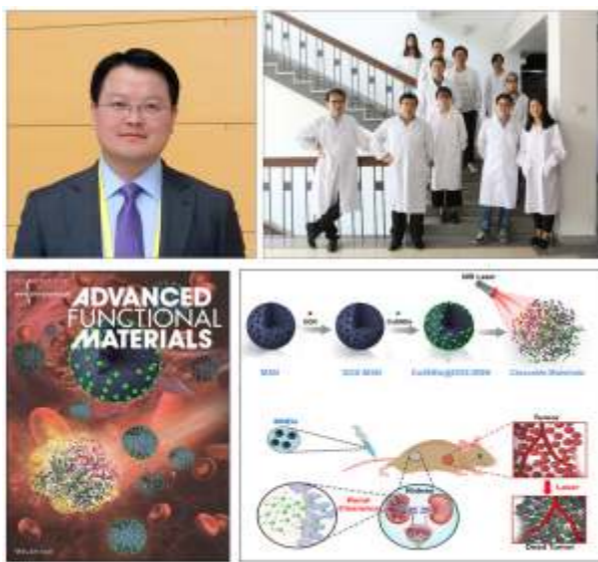
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周民团队研发了一种新型“抗肿瘤诊疗一体化药物递送系统”，实现多模态影像引导下的精准高效抗肿瘤药物递送。本项目从肿瘤化疗的实际需求出发，通过医工信等多学科交叉合作，推动了临床癌症治疗手段的不断变革与深化，为治疗中晚期的恶性肿瘤提供了新的前沿技术和研究思路。

项目负责人：周 民

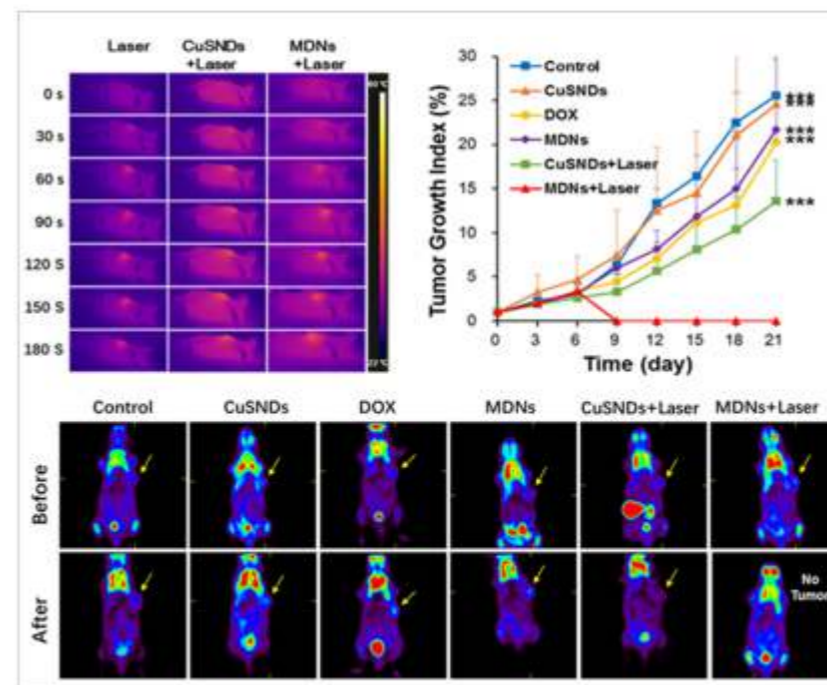
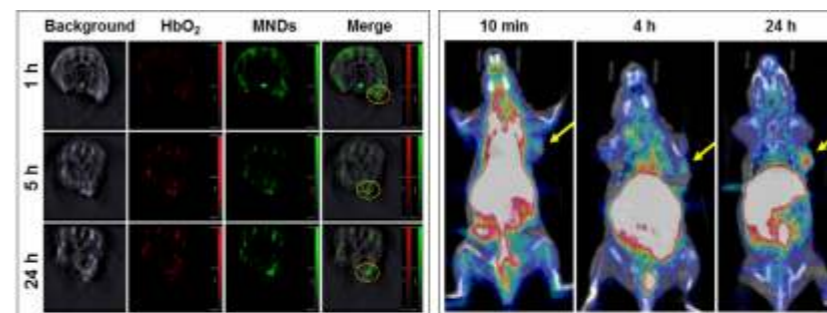
癌症是威胁人类健康的全球性疾病之一，也是我国首要的致死疾病和重要的公共卫生问题。在当前癌症临床治疗中，化学药物治疗（化疗）目前普遍存在缺乏选择性，具有较大毒副作用等问题。因此癌症的高效诊治，研发同时具有低毒副作用和高抗肿瘤效果的新型药物，具有重要的科学研究价值和社会经济效益。近年来，纳米医学的快速发展为癌症诊治带来了新的希望，通过优化材料构建稳定、高效和安全的纳米载体，结合抗癌药物和高准确度的癌症诊断探针，与药物靶向运输、活体示踪、药物治疗和预后监测等功能一起，构建多功能的纳米体系已成为世界范围内的研究趋势和热点，开发新型纳米药物不仅具有巨大发展前景，符合国家重大战略需求，而且必将导致疾病诊断和治疗的新技术革命。

本项目利用较大尺度的介孔硅纳米载体，将抗癌药阿霉素装载在纳米载体内部，并利用具有光热效应的超小尺度硫化铜纳米点进行包覆，合成出多级、多功能纳米级诊疗一体化药物递送系统。该系统在近红外激光激发下，利用系统中纳米点光热效应产生高温来击碎介孔硅结构，释放出小分子抗癌药物，从而具有肿瘤光热/化疗协同治疗效果。由于体系中纳米点和介孔硅碎片尺寸



非常小，能够高效通过肾脏代谢出体外，可显著减少药物在体内长期蓄积所带来的毒副作用。

该药物递送系统同时可实现正电子发射计算机断层扫描(PET)成像和光声成像，提供高灵敏度以及高分辨率肿瘤多模态协同精准影像信息。其中通过PET技术精准



确定药物在体内各个组织器官的动态分布及肿瘤摄取，通过光声成像对肿瘤进行深层次定位及获得肿瘤内部结构的信息。

该药物在体内具有较长的在血液循环能力，可从血管中溢出，高效进入并滞留在肿瘤组织。多个肿瘤模型实验表明，该药物具有良好的抑制肿瘤效果，并且可在体内迅速降解排出体外。因此，该新型药物递送系统不但可以作为PET/光声造影剂和热疗/化疗药物，实现多模态影像引导下的热疗/化学协同治疗，而且可以在

体内快速清除，减少毒副作用。

研究成果于2017年11月发表在生物材料顶级杂志Advanced Functional Materials（先进功能材料）上。论文同期被编辑部遴选为当期封底文章（Back Cover），也被杂志社选为Top 10 热点文章。本项目是医工信结合的交叉学科项目，整合了多个团队研究背景和资源，面向临床需求，由医工信多学科成员紧密配合，科研成果具有较高的实用价值，具有广阔的临床转化前景。论文共同第一

作者是我校第一批具有工科背景的交叉学科博士研究生以及我校附属第二医院临床医学专业博士研究生，工作获得我校2016年启动的医工信交叉学科博士生培养计划的支持，标志着该计划已经取得初步成果，全新的创新生态系统构建已经初见端倪。

本项目针对药物高效肿瘤输送和治疗科学难题，提出了在不同体内环境下尺寸可控的复合纳米药物输送系统，克服了药物低肿瘤摄取和深层组织难释放的限制，并解决其生理毒性问题。同时结合材料学与分子影像学，可以同时提供高分辨率和高灵敏度的影像信息，为药物在肿瘤精准治疗方面提供重要的参考依据。该药物递送系统的研发为未来的精准医疗和个性化药物发展提供新的思路，在生物医学领域具有广阔的应用前景，也为我国的抗肿瘤药物的研发提供了一种新研究思路和转化前景。

项目负责人周民研究员入选“国家青年千人计划”和浙江大学“百人计划”，并担任教育部恶性肿瘤预警与干预重点实验室副主任。自2016年回国以来，周民研究员及其带领的研究团队充分利用我校学科门类齐全、学科结构层次丰富、交叉学科平台集聚等学科生态多样化的优势，主要围绕“分子影像和纳米医学”在癌症诊断及治疗中的应用这一国际研究热点，致力于新型纳米药物的研发，取得了一系列创新性并具有较高临床转化前景的重要研究成果。



2017年度浙江大学学术进展

# 蛋白翻译后修饰与自噬调控

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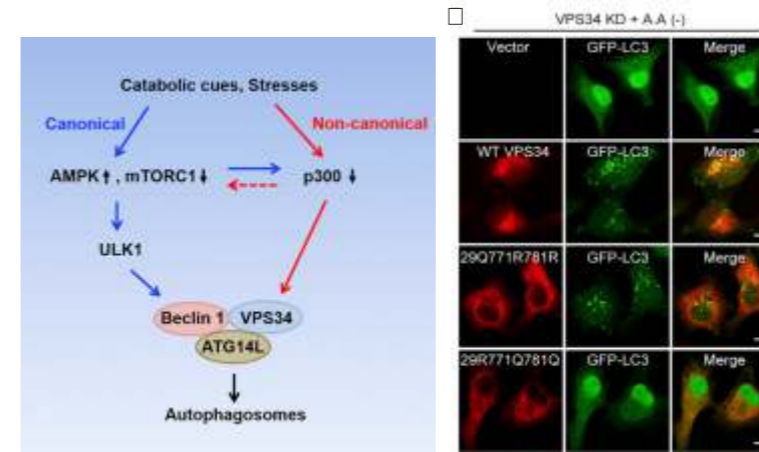
本项目发现了自噬关键蛋白的翻译后修饰调控并阐明其基本机制，解决了领域研究的关键科学问题，对自噬相关的代谢疾病和肿瘤发生等的药物研发和干预提供了靶点和理论依据。

项目负责人：刘伟

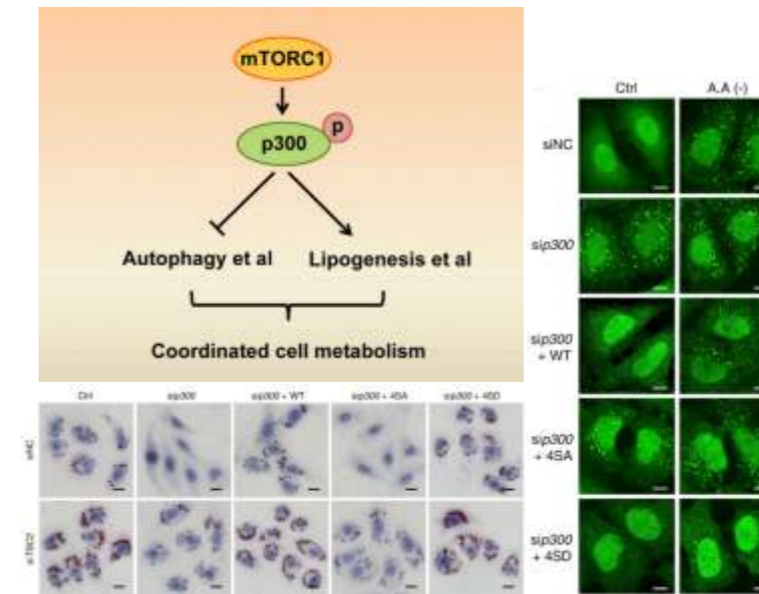
自噬是真核生物进化上高度保守的依赖溶酶体的分解代谢过程，在细胞稳态维持和应激环境的应对中发挥重要作用。自噬参与人类机体的多种生理病理过程，与发育、衰老、代谢综合征和肿瘤等的发生发展密切相关。既往的自噬研究主要利用单细胞酵母为主要研究对象，具有明显的局限性，无法阐释自噬在多细胞生物应对外界环境刺激时的应对机制，无法深入解析自噬的生理功能及其与人类疾病之间的关系。围绕多细胞生物中自噬的发生调控机制和功能等关键科学问题，在国家自然科学基金委、科技部等的资助下，近年来，医学院基础医学系刘伟教授团队系统研究了哺乳动物细胞中自噬的调控及其与肝癌发生发展的关系，取得了具有原创性和重要科学价值的研究成果。



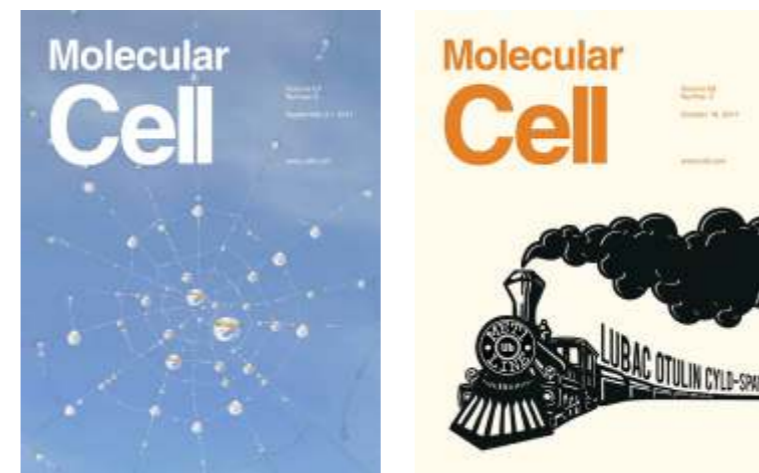
该项目研究的主要特色和创新点，是发现了在哺乳动物细胞主要的分解代谢途径细胞自噬中，关键蛋白的



VPS34脱乙酰化调控自噬启动通路



mTORC1介导的p300磷酸化调控自噬启动和脂肪生成



新的调控机理，建立了围绕这些关键蛋白活性调控的信号通路；并揭示了这些新通路在细胞应对胁迫条件，调节和协调细胞代谢的方式及其细胞学效应。P300-VPS34通路的鉴定，回答了领域内长期存在的非经典自噬的起始机制这一重要科学问题；mTORC-p300通路的阐明，建立了两大细胞内环境感受器间的调控关系，不仅发现了不依赖其辅酶浓度的p300的激活机制，也解释了mTORC1调控众多细胞代谢和生长相关基因表达的潜在机理。这条通路也为研究能量代谢状态影响细胞染色质重塑和基因损伤修复调控等提供了重要提示。结合该项研究在动物组织水平的发现，这些新机制为自噬相关的代谢疾病和肿瘤发生等的新的的小分子化合物的研发和干预提供了靶点和理论依据。

项目研究取得的主要标志性成果为2017年9月和2017年10月发表于Molecular Cell的两篇原创论文，均为刘伟实验室独立完成，实验室博士生苏华和万伟分别为两篇论文的第一作者，刘伟教授为唯一通讯作者。论文发表后，在领域内和社会产生的广泛影响。受Autophagy杂志主编邀请，苏华和刘伟在Autophagy发表专文介绍了研究发现；在国内生命科学界有较大影响的网站BioArt，发文对项目研究成果进行了报道、并对刘伟教授进行了介绍；百度网、搜狐网、生物帮、生物通等网站转载了BioArt的报道并列为推荐阅读；被浙大主页“科学封面”科学封面栏目报道。



2017年度浙江大学学术进展

# 首个无毒高抗肿瘤活性树枝状大分子的高效合成及抗癌活性研究

★★★★★

申有青教授领导的团队第一次提出了非细胞毒化物治疗肿瘤的概念，设计合成了首个高效抗肿瘤活性高分子，该高分子表现出比临床一线药物更好的抑瘤效果，且在实验过程中未发现明显体内毒性。该项工作开辟了无毒副作用的抗肿瘤药物这一新研究方向，具有重大意义。

项目负责人：申有青

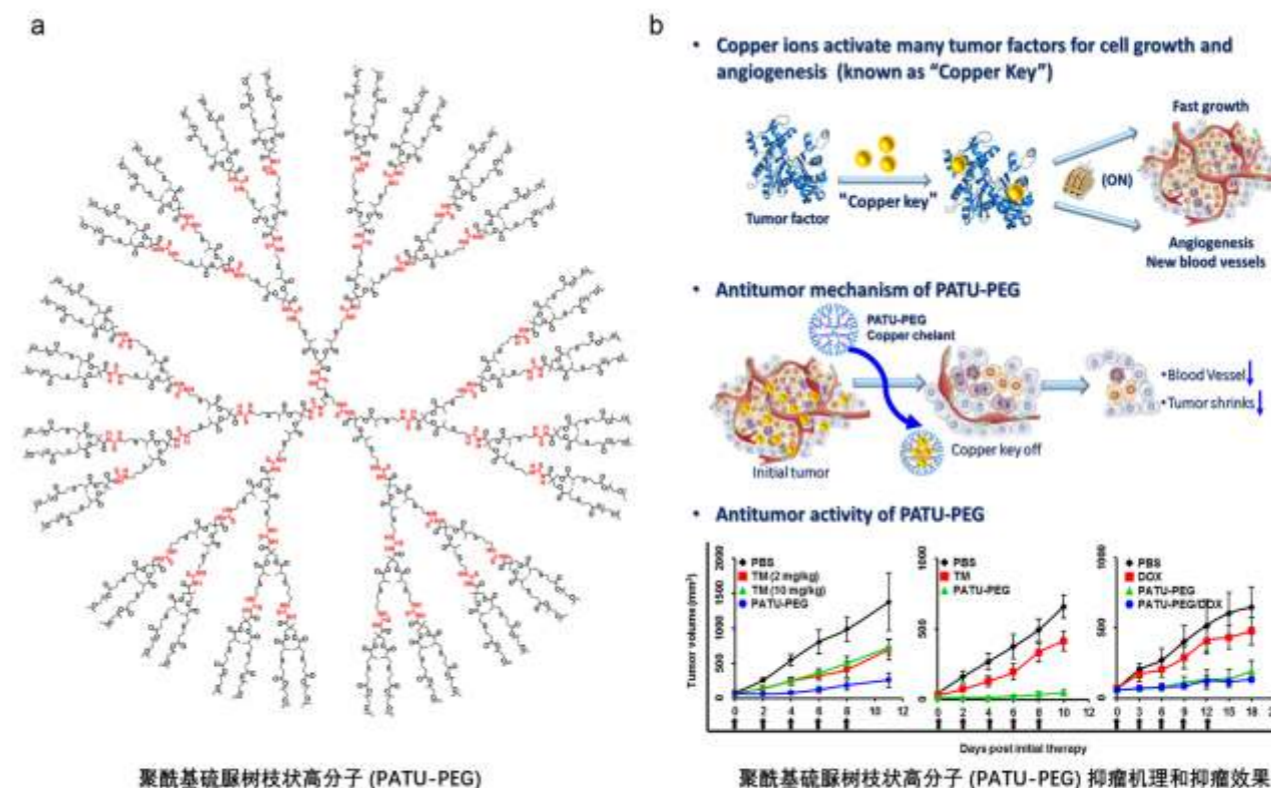
恶性肿瘤（癌症）在我国城市和农村居民的主要死亡原因中，分别位居第一位和第二位。近年来，新型癌症疗法大量涌现，但利用传统细胞毒化类药物（细胞毒药）杀死快速分裂的肿瘤细胞（化疗）仍是治疗癌症的主要手段。由于这些化疗药物缺乏肿瘤靶向性和选择性，大部分药物会扩散到正常组织器官中，引起严重的毒副作用，正所谓杀敌一万，自损三千。这不仅影响了患者的生存质量，更限制了药物的临床使用剂量和治疗的连续性，降低了治疗效果。利用纳米生物技术可减少药物在一些重要组织器官中的分布，从而降低药物的致命性毒副作用，但是，这类纳米药物并没有改变其细胞毒药的本质，仍会在肝、脾及其他健康组织器官中蓄积，不可避免地引发严重的肝脾毒性等系统毒性。



肿瘤细胞正是从该‘土壤’中吸取各种营养和各种生长因子来快速繁殖甚至转移到其他组织器官。因此，我们设想，利用无毒高分子把肿瘤组织微环境（土壤）中的关键营养元素吸附掉，肿瘤细胞得不到该关键元素就失去生长能力甚至死亡，从而获得抗肿瘤作用，如抑制新生血管生成、抑制肿瘤细胞的生长与转移。这样在达到肿瘤治疗效果的同时也避免了使用“细胞毒药”而导致的副作用。大量研究表明肿瘤患者体内的铜含量显著升高，肿瘤组织利用铜元素激活它所需要的生长因子和血管增生因子来支持它的生长。因此，我们用能够特异性络合铜的无毒聚合物就能使其生长因子和血管增生因子失活，达到抑瘤效果。

据此，博士生邵世群和周泉设计合成了一类无毒的聚硫脲树枝状高分

肿瘤微环境是肿瘤细胞生存的“土



子，其具有以下三方面特点：第一，在体外，它们对正常细胞和肿瘤细胞没有任何杀伤作用，也不影响细胞的增殖；在体内，它们也不显示任何毒副作用，其静脉注射的小鼠半致死剂量高达1克/千克以上。第二，在不携带任何药物分子的情况下，它们能够在荷瘤小鼠体内吸附过量的铜元素，从而有效地抑制肿瘤新生血管的生成并诱导肿瘤细胞死亡，呈现出比临床

一线抗肿瘤药物——阿霉素——更高效的抑瘤效果。第三，尤其重要的是，它们不但能够有效抑制实体瘤的肿瘤转移，而且能够抑制血液中的循环肿瘤细胞在肺中着床形成肿瘤，具有很强的抗转移能力，其效果远好于临床III期实验药物四硫代钼酸盐，能够大大延长实验动物生存期，并且在整个治疗期小鼠不显示明显系统毒性。初步机理研究表明，该聚硫脲树枝状高分子不是通过杀伤肿瘤细胞发挥抗肿瘤效果，而是通过改变肿瘤微环境间接抑制肿瘤的生长。研究进一步发现，聚硫脲树枝状高分子能够降低肿瘤中的铜元素水平，通过抑制肿瘤新生血管的形成从而抑制肿瘤的生长。此项工作开辟了无毒副作用的抗肿瘤药物这一新研究方向，具有重要意义。

2017年9月，此项目主要研究成果在线发表于Nature系列期刊《Nature Biomedical Engineering》，法国科学院的Ling Peng教授在同期杂志中发表了题为《Potent drugless dendrimer》的评论文章，高度肯定了此项工作。文章见刊以来，得到了广大媒体的公开报道，受到了广泛关注及好评。

## 2017年浙江大学主要获奖成果

序号	成果名称	完成人	奖励类别	奖励等级	完成单位
1	以防控人感染H7N9禽流感为代表的新发传染病防治体系重大创新和技术突破	李兰娟, 舒跃龙, 管轶, 冯子健, 袁国勇, 高福, 袁正宏, 王宇, 余宏杰, 王大燕, 高海女, 王辰, 郑树森, 杨仕贵, 杨维中, 曹彬, 陈鸿霖, 李群, 朱华晨, 周剑芳, 刘翟, 高荣保, 吴南屏, 胡芸文(去世), 姚航平, 张曦, 俞亮, 郑书发, 吴凡, 卢洪洲, 王嘉, 夏时畅, 崔大伟, 白天, 梁伟峰, 林贇育, 武桂珍, 揭志军, 郭静, 杜启泓, 盛吉芳, 刁宏燕, 向妮娟, 杨益大, 赵翔, 汤灵玲, 邹淑梅, 余斐, 朱丹华	国家科学技术进步奖	特等	浙江大学医学院附属第一医院(浙江省第一医院), 中国疾病预防控制中心病毒病预防控制所, 中国疾病预防控制中心, 汕头大学, 香港大学, 复旦大学, 中国科学院微生物研究所, 上海市疾病预防控制中心, 上海市第五人民医院, 首都医科大学附属北京朝阳医院, 浙江省疾病预防控制中心
2	燃煤机组超低排放关键技术研发及应用	高翔, 吴国潮, 朱松强, 郑成航, 胡达清, 岑可法	国家技术发明奖	一等	浙江大学, 浙江省能源集团有限公司, 浙江天地环保科技有限公司
3	危险废物回转式多段热解焚烧及污染物协同控制关键技术	严建华, 蒋旭光, 李晓东, 张文辉, 池涌, 陆胜勇, 王琦, 黄群星, 马增益, 李丽	国家科学技术进步奖	二等	浙江大学, 杭州大地环保工程有限公司, 中国市政工程华北设计研究总院有限公司, 中国环境科学研究院, 浙江物华天宝能源环保有限公司
4	《数学传奇——那些难以企及的人物》	蔡天新	国家科学技术进步奖	二等	
5	超高速数码喷印设备关键技术研发及应用	陈耀武, 汪鹏君, 周华, 葛晨文, 田翔, 周凡	国家技术发明奖	二等	浙江大学, 宁波大学, 浙江理工大学, 杭州宏华数码科技股份有限公司

6	网络系统资源优化与控制基础理论及方法	陈积明, 程鹏, 曹向辉, 施凌, 贺诗波, 何建平, 邓瑞龙	高等学校自然科学奖	一等	浙江大学, 香港科技大学
7	大麦遗传多样性与特异种质研究	张国平, 戴飞, 邬飞波, 吴德志, 叶玲珍, 邱龙, 蔡圣冠, 黄雨晴	高等学校自然科学奖	一等	浙江大学
8	基于声化效应提取及改性食源性功效因子的机制研究	刘东红, 陈士国, 叶兴乾, 丁甜, 陈健初, 胡亚芹, 吴丹	高等学校自然科学奖	一等	浙江大学
9	脑卒中防治的药物新靶点及新策略	陈忠, 韩峰, 盛瑞, 胡薇薇, 张翔南, 卢应梅, 韩蓉	高等学校自然科学奖	一等	浙江大学, 苏州大学
10	过渡金属氧化物微纳电极构筑及其储能性能改善	涂江平, 谷长栋, 王秀丽, 夏新辉	高等学校自然科学奖	二等	浙江大学
11	复合结构关键基础理论的分析 and 试验研究	徐荣桥, 吴宇飞, 陈伟球, 沈旭栋	高等学校自然科学奖	二等	浙江大学, 香港城市大学
12	先进涂装防护体系的构筑及相关基础研究	胡吉明, 张鉴清, 曹楚南	高等学校自然科学奖	二等	浙江大学

13	靶向肿瘤缺氧微环境的抗肿瘤药物作用靶点发现	杨波, 何俏军, 曹戟, 朱虹, 应美丹, 翁勤洁, 杨晓春	高等学校自然科学奖	二等	浙江大学
14	黎曼子流形的几何结构与拓扑结构研究	许洪伟, 顾娟如, 赵恩涛, 许智源, 付海平	高等学校自然科学奖	二等	浙江大学
15	细胞传感技术及其应用基础研究	王平, 刘清君, 吴春生, 陈星, 胡宁	高等学校自然科学奖	二等	浙江大学
16	大功率多能源不间断电源系统关键技术及应用	徐德鸿, 陈四雄, 吕征宇, 马皓, 陈敏, 于玮	高等学校技术发明奖	一等	浙江大学, 厦门科华恒盛股份有限公司
17	重大新发传染病快速诊断技术研发及应用	陈瑜, 郑书发, 谢国良, 陈晓, 李兰娟, 郭仁勇	高等学校技术发明奖	二等	浙江大学
18	大型油气锅炉燃烧振动控制技术	周昊, 莫春鸿, 王鲁军, 岑可法, 胡修奎, 樊建人, 霍锁善, 张洪松, 徐鹏, 罗坤, 张焕祥, 陈灿, 刘泰生, 朱骅, 李毅	高等学校科技进步奖	一等	浙江大学, 东方电气集团东方锅炉股份有限公司, 山东电力建设第三工程公司
19	宫颈癌筛查新技术研发与防控体系的建立及应用	吕卫国, 程晓东, 谢幸, 王新宇, 叶枫, 李阳, 王芬芬, 沈源明, 胡杰锋, 丁田, 田其芳, 叶轶青	高等学校科技进步奖	一等	浙江大学, 杭州德同生物技术有限公司
20	千吨级高性能注塑成型装备关键技术及应用	张树有, 冯毅雄, 王珏, 傅南红, 伊国栋, 袁卫明, 焦晓龙, 徐敬华, 周巨栋, 孙产刚, 裘乐森, 刘晓健, 高一聪, 沈雪明, 叶群方, 厉永福, 李瑞森, 何挺, 吴俊	高等学校科技进步奖	一等	浙江大学, 海天塑机集团有限公司, 浙江申达机器制造股份有限公司

21	茶叶生产全过程品质安全管控及加工关键技术和设备	何勇, 李革, 刘飞, 李晓丽, 聂鹏程, 潘家荣, 周仁桂, 苏鸿, 孔汶汶, 何乐, 徐贤春, 顾永跟, 王丽丽, 舒伟军, 宋革联, 官少辉, 赵力勤, 李鉴方, 黄静, 姜小文, 洪勇	高等学校科技进步奖	二等	浙江大学, 浙江理工大学, 浙江农林大学, 浙江农林大学, 中国计量大学, 湖州师范学院, 杭州千岛湖丰凯实业有限公司, 浙江春江茶叶机械有限公司, 浙江省公众信息产业有限公司, 杭州市西湖区农业技术推广服务中心
22	真实感图形的高效绘制理论与方法	周昆, 陈为, 彭群生, 石教英, 刘新国	浙江省自然科学奖	一等	浙江大学
23	肝癌微环境与癌细胞耐药关系机制及其治疗策略研究	梁廷波, 白雪莉, 陈伟, 章琦, 杨菲	浙江省自然科学奖	一等	浙江大学医学院附属第二医院, 浙江大学
24	大肠癌微环境的关键免疫调控机制及其干预研究	黄建, 邱福铭, 伍品, 倪超, 叶俊	浙江省自然科学奖	一等	浙江大学医学院附属第二医院
25	DNA损伤修复的分子机制	黄俊, 刘婷, 万力, 陈红霞, 韩金花	浙江省自然科学奖	一等	浙江大学
26	微生物转化生物质制油气燃料的能质传递强化机理	程军, 岑可法, 周俊虎, 刘建忠, 何勇	浙江省自然科学奖	一等	浙江大学
27	软土地基上轨道交通长期沉降评价与控制技术及工程应用	边学成, 陈云敏, 陈仁朋, 蒋建群, 叶肖伟, 黄博, 周燕国	浙江省科学技术进步奖	一等	浙江大学
28	道路工程中复合地基关键技术及其应用	龚晓南, 俞建霖, 张玲, 吴德兴, 卢萌盟, 刘世明, 陈昌富, 毛斌, 常雷, 徐日庆, 赵明华, 姜正晖, 俞红光	浙江省科学技术进步奖	一等	浙江大学, 湖南大学, 浙江省交通规划设计研究院, 中国电建集团华东勘测设计研究院有限公司, 中国矿业大学

29	非电燃煤锅炉烟气污染物深度处理技术及应用	吴忠标, 王海强, 莫建松, 王岳军, 陈雄波, 刘越, 程常杰, 官宝红, 唐念, 高珊, 盛重义, 夏纯洁, 寿冬金	浙江省科学技术进步奖	一等	浙江大学, 浙江天蓝环保技术股份有限公司
30	柑橘优质生产与贮藏物流关键技术研究与推广应用	陈昆松, 孙崇德, 刘春荣, 张波, 徐云焕, 殷学仁, 吴文明, 徐昌杰, 朱潇婷, 李杰, 朱长青, 金国强, 叶先明	浙江省科学技术进步奖	一等	浙江大学, 衢州市农业科学研究院, 浙江省种植业管理局, 临海市特产技术推广总站, 衢州市柯城区经济特产站, 衢州市柯城区柴家柑桔专业合作社, 浙江求是人工环境有限公司
31	畜禽抗生素减量和养分减排的新型微生态制剂技术研究及产业化	汪以真, 杨彩梅, 冯杰, 刘金松, 路则庆, 徐欢根, 王凤芹, 王新霞, 余东游, 单体中, 杜德华, 曾新福, 石常友	浙江省科学技术进步奖	一等	浙江大学, 浙江农林大学, 浙江惠嘉生物科技股份有限公司, 浙江科盛饲料股份有限公司
32	肾小球疾病治疗关键技术创新及推广应用	陈江华, 刘必成, 李恒, 李夏玉, 韩飞, 马坤岭, 程军, 杨毅, 吕林莉, 田炯, 吴建永, 姜虹, 王仁定	浙江省科学技术进步奖	一等	浙江大学医学院附属第一医院, 东南大学附属中大医院
33	抗肿瘤分子靶向新药BZG和光热消融-化疗靶向治疗新模式的研究	裘云庆, 游剑, 楼燕, 丁列明, 周珏, 康心汕, 谭芬来, 郭晓萌, 裘文奇, 郭静, 徐丽倩, 喻玮	浙江省科学技术进步奖	一等	浙江大学医学院附属第一医院, 浙江大学, 贝达药业股份有限公司, 浙江工商大学
34	儿童青少年代谢综合征预警及防治技术研究	傅君芬, 梁黎, 黄轲, 王春林, 戴阳丽, 张洪锡, 许晓琴, 董关萍, 陈雪峰, 梁建凤, 朱建芳, 方燕兰, 吴蔚	浙江省科学技术进步奖	一等	浙江大学医学院附属儿童医院, 浙江大学医学院附属第一医院



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# The Outstanding Achievements of Zhejiang University in 2017

No.	Project Title	Achiever	Award Type	Levels	Department
1	A major innovation and technological breakthrough in the prevention and control system of emerging infectious diseases represented by human infection with H7N9 avian influenza	Lanjuan Li, Yuelong Shu, Yi Guan, Zijian Feng, Guoyong Yuan, Fu Gao, Yu Wang, Hongjie Yu, Dayan Wang, Hainv Gao, Chen Wang, Shusen Zheng, Shigui Yang, Weizhong Yang, Bin Cao, Hongling Chen, Qun Li, Huachen Zhu, Jianfang Zhou, Di Liu, Rongbao Gao, Nanping Wu, Yunwen Hu, Hangping Yao, Xi Zhang, Liang Yu, Shufa Zheng, Fa Wu, Hongzhou Lu, Jia Wang, Shichang Xia, Dawei Cui, Tian Bai, Weifeng Liang, Zanyu Lin, Guizhen Wu, Zhijun Jie, Jing Guo, Qihong Du, Jifang Sheng, Hongyan Diao, Nijuan Xiang, Yida Yang, Xiang Zhao, Lingling Tang, Shumei Zou, Fei Yu, Danhua Zhu	National Award for Science and Technology Progress	Grand Prize	The First Affiliated Hospital, School of Medicine, Zhejiang University, National Institute for Viral Disease Control and Prevention, Chinese Center for Disease Control and Prevention, Shantou University, The University of Hong Kong, Fudan University, Institute of Microbiology, Chinese Academy of Sciences, Shanghai Municipal Center for Disease Control and Prevention, The Fifth People's Hospital of Shanghai, BeijingChao-YangHospital, Zhejiang Provincial Center for Disease Control and Prevention
2	Ultra-Low Emission Technology (ULE) for coal-fired power plants and its application	Xiang Gao, Guochao Wu, Songqiang Zhu, Chenghang Zheng, Daqing Hu, Kefa Cen	National Award for Technological Invention	First Prize	Zhejiang University, Zhejiang Energy Group Co. LTD., Zhejiang Tiandi Environmental Protection Technology Co. LTD.
3	Rotary Kiln based hazardous waste pyrolysis/incineration and Pollutants control technology	Jianhua Yan; Xuguang Jiang; Xiaodong Li; Wenhui Zhang; Yong Chi; Shenyong Lu; Qi Wang; Qunxing Huang; Zengyi Ma; Li li	National Award for Science and Technology Progress	Second Prize	Zhejiang University; Hangzhou Dadi Environmental protection Co., Ltd; North China Municipal engineering design & research institute Co. LTD.; Chinese Research Academy of Environmental Sciences; Zhejiang Best Energy and Environment Co. LTD.
4	Mathematical Legends	Tianxin Cai	National Award for Science and Technology Progress	Second Prize	
5	Research and Application of Key Technologies in Ultra-High-Speed Digital Textile Printer	Yaowu Chen, Pengjun Wang, Hua Zhou, Chenwen Ge, Xiang Tian, Fan Zhou	National Award for Technological Invention	Second Prize	Zhejiang University, Ningbo University, Zhejiang Sci-Tech University, Hangzhou Honghua Digital Technology Stock Co., Ltd.
6	Resource Optimization and Control for Network Systems	Jiming Chen; Peng Cheng; Xianghui Cao; Ling Shi; Shibo He; Jianping He; Ruilong Deng	Ministry of Education Award for Natural Science	First Prize	Zhejiang University; Hongkong University of Science and Technology
7	Studies on genetic diversity and elite germplasm in barley	Guoping Zhang, Fei Dai, Feibo Wu, Dezhi Wu, Linzeng Ye, Long Qiu, Shengguang Cai, Yuqing Huang	Ministry of Education Award for Natural Science	First Prize	Zhejiang University

8	Study on the Mechanism of Acoustic Effect Extraction and Modified Foodborne Efficacy Factors.	Donghong Liu, Shiguo Chen, Xingqian Ye, Tian Ding, Jianchu Chen, Yaqin Hu, Dan Wu	Ministry of Education Award for Natural Science	First Prize	Zhejiang University
9	Novel drug targets and therapeutic strategies for ischemic stroke	Zhong Chen, Feng Han, Rui Sheng, Weiwei Hu, Xiangnan Zhang, Yingmei Lu, Rong Han	Ministry of Education Award for Natural Science	First Prize	Zhejiang University, Soochow University
10	Fabrication of micro/nano-structured transition metal oxide electrodes and their performance improvement for energy storage	Jiangping Tu, Changdong Gu, Xiuli Wang, Xinhui Xia	Ministry of Education Award for Natural Science	Second Prize	Zhejiang University
11	Analytical and experimental studies of the fundamental theories for composite structures	Rongqiao Xu, Yufei Wu, Weiqiu Chen, Xudong Shen	Ministry of Education Award for Natural Science	Second Prize	Zhejiang University, City University of Hong Kong
12	Construction of advanced painting protection system and its fundamental problems	Jiming Hu, Jianqing Zhang, Chunan Cao	Ministry of Education Award for Natural Science	Second Prize	Zhejiang University
13	Antitumor target discovery based on tumor hypoxia microenvironment	Bo Yang, Qiaojun He, Ji Cao, Hong Zhu, Meidan Ying, Qinjie Weng, Xiaochun Yang	Ministry of Education Award for Natural Science	Second Prize	Zhejiang University
14	Geometric and topological structures of Riemannian submanifolds	Hongwei Xu, Juanru Gu, Entao Zhao, Zhiyuan Xu, Haiping Fu	Ministry of Education Award for Natural Science	Second Prize	Zhejiang University
15	The Basic Research on Cell-based Biosensors in Application	Ping Wang, Qingjun Liu, Chunsheng Wu, Xing Chen, Ning Hu	Ministry of Education Award for Natural Science	Second Prize	Zhejiang University
16	The key Techniques and application of high power uninterruptible power supply with multiple energy storages	Dehong Xu, Sixiong Chen, Zhengyu Lu, Hao Ma, Min Chen, Wei Yu	Ministry of Education Award for Technological Invention	First Prize	Zhejiang University, Xiamen Kehua Hengsheng Co., Ltd.
17	Development and Application on Fast Molecular Diagnosis Technology of Major Novel Infectious Disease	Yu Chen, Shufa Zheng, Guoliang Xie, Xiao Chen, Lanjuan Li, Renyong Guo	Ministry of Education Award for Technological Invention	Second Prize	Zhejiang University
18	Combustion Vibration Control Technology for Large Capacity Oil/Gas fired Utility Boiler	Hao Zhou, Chunhong Mo, Lujun Wang, Kefa Cen, Xiukui Hu, Jianren Fan, Suoshan Huo, Hongsong Zhang, Peng Xu, Kun Luo, Huanxiang Zhang, Can Chen, Taisheng Liu, Hua Zhu, Yi Li	Ministry of Education Award for Science and Technology Progress	First Prize	Zhejiang University, Dongfang Boiler Group Co., Ltd. SEPCOIII Electric Power Construction Co., Ltd.

19	The development and application of new technology and prevention system for cervical cancer screening	Weiguo Lv, Xiaodong Cheng, Xing Xie, Xinyu Wang, Feng Ye, Yang Li, Fenfen Wang, Yuanming Shen, Jiefeng Hu, Tian Ding, Qifang Tian, Yiqing Ye	Ministry of Education Award for Science and technology progress	First Prize	Zhejiang University, Hangzhou DALTON BioSciences, Ltd.
20	Key Technology and Engineering Application of Kiloton High Performance Injection Molding Equipment	Shuyou Zhang, Yixiong Feng, Jue Wang, Nanhong Fu, Guodong Yi, Weiming Yuan, Xiaolong Jiao, Jinghua Xu, Judong Zhou, Changang Sun, Limiao Qiu, Xiaojian Liu, Yicong Gao, Xueming Shen, Qunfang Ye, Yongfu Li, Ruisen Li, Ting He, Jun Wu.	Ministry of Education Award for Science and technology progress	First Prize	Zhejiang University, Haitian Group, Zhejiang Sound machinery manufacture Co., Ltd.
21	Key technologies and equipment for tea quality safety control of the whole production procedure and processing	Yong He, Ge Li, Fei Liu, Xiaoli Li, Pengcheng Nie, Jiarong Pan, Rengui Zhou, Hong Su, Wenwen Kong, Le He, Xianchun Xu, Yonggen Gu, Lili Wang, Weijun Shu, Gelian Song, Shaohui Guan, Liqin Zhao, Jianfang Li, Jing Huang, Xiaowen Jiang, Yong Hong	Ministry of Education Award for Science and Technology Progress	Second Prize	Zhejiang University, Zhejiang Sci-Tech University, Zhejiang A&F University, China Jiliang University, Huzhou University, Hangzhou Qiandao Lake Fengkai Industrial Co., Ltd, Zhejiang Chunjiang Tea Machinery Co. Ltd, Zhejiang Public Information Industry Co., Ltd., Hangzhou Xihu District Agricultural Technology Extension Service Center.
22	Theory and Methods for Efficient Rendering of Realistic Graphics	Kun Zhou, Wei Chen, Qunsheng Peng, Jiaoying Shi, Xinguo Liu	Zhejiang Province Award for Natural Science	First Prize	Zhejiang University
23	Development of liver cancer treatment strategy by targeting the relation between tumor microenvironment and drug resistance	Tingbo Liang, Xueli Bai, Wei Chen, Qi Zhang, Fei Yang	Zhejiang Province Award for Natural Science	First Prize	The Second Affiliated Hospital, Zhejiang University School of Medicine, Zhejiang University
24	Key Immune Modulatory Mechanism and Its Intervention for Human Colorectal Cancer Human Colorectal Cancer Microenvironment	Jian Huang, Fuming Qiu, Pin Wu, Chao Ni, Jun Ye	Zhejiang Province Award for Natural Science	First Prize	Second Affiliated Hospital, Zhejiang University School of Medicine, Zhejiang University
25	Molecular mechanism of DNA repair	Jun Huang, Ting Liu, Li Wan, Hongxia Chen, Jinhua Han	Zhejiang Province Award for Natural Science	First Prize	Zhejiang University
26	Strengthening Energy and Mass Transfer in Biodiesel and Biogas Fuels Production from Biomass through Microbial Conversion	Jun Cheng, Kefa Cen, Junhu Zhou, Jianzhong Liu, Yong He	Zhejiang Province Award for Natural Science	First Prize	Zhejiang University
27	Long-term settlement of rail transport infrastructure on soft soils :evaluation, controlling technology and engineering applications	Xuecheng Bian, Yunmin Chen, Renpeng Chen, Jianqun Jiang, Xiaowei Ye, Bo Huang, Yanguo Zhou	Zhejiang Province Award for Science and Technology Progress	First Prize	Zhejiang University

28	Key technology and application of composite foundation in road engineering	Xiaonan Gong, Jianlin Yu, Ling Zhang, Dexing Wu, Mengmeng Lu, Shiming Liu, Changfu Chen, Bin Mao, Lei Chang, Riqing Xu, Minghua Zhao, Zhenghui Jiang, Hongguang Yu	Zhejiang Province Award for Science and Technology Progress	First Prize	Zhejiang University, Hunan University, Zhejiang Provincial Institute of Communications Planning, Design & Research, Huadong Survey and Design Research Institute Co., Ltd. China University of mining and technology
29	Deep treatment technology and application for non-power coal-fired boiler flue gases	Zhongbiao Wu, Haiqiang Wang, Jiansong Mo, Yuejun Wang, Xiongbo Chen, Yue Liu, Changjie Cheng, Baohong Guan, Nian Tang, Shan Gao, Zhongyi Sheng, Chunjie Xia, Dongjin Shou	Zhejiang Province Award for Science and Technology Progress	First Prize	Zhejiang University, Zhejiang Tianlan Environmental Protection Technology Co., Ltd.
30	Research and Application of Key Technologies for High Quality Production and Storage Logistics of Citrus Fruit	Kunsong Chen, Chongde Sun, Chunrong Liu, Bo Zhang, Yunhuan Xu, Xueren Yin, Wenming Wu, Changjie Xu, Xiaoting Zhu, Jie Li, Changqing Zhu, Guoqiang Jin, Xianming Ye.	Zhejiang Province Award for Science and Technology Progress	First Prize	Zhejiang University, Quzhou Academy of Agricultural Sciences, Administration of planting industry of Zhejiang Provincial, Economy and specialty Station of Quzhou Kecheng, Chai Jia Citrus Cooperatives of Quzhou Kecheng, Zhejiang Qushi Artificial Environment Co., Ltd.
31	Research and industrialization of novel Probiotics for purpose of antibiotic use restraining and nutritional efficiency improving in domestic livestock	Yizhen Wang, Caimel Yang, Jie Feng, Jinsong Liu, Zeqing Lu, Huang Xu, Fengqin Wang, Xinxia Wang, Dongyou Yu, Tizhong Shan, Huahua Du, Xinfu Zeng, Changyou Shi	Zhejiang Province Award for Science and Technology Progress	First Prize	Zhejiang University, Zhejiang A&F University, Zhejiang Huijia biological technology Co., Ltd. Zhejiang Kesheng Feed Co., Ltd
32	The key technology innovation and application of the treatment of glomerular nephritis	Jianghua Chen, Bicheng Liu, Heng Li, Xiayu Li, Fei Han, Kunling Ma, Jun Cheng, Yi Yang, Linli Lv, Jiong Tian, Jianyong Wu, Hong Jiang, Rending Wang	Zhejiang Province Award for Science and Technology Progress	First Prize	The first affiliated hospital, College of Medicine, Zhejiang University; Zhongda Hospital, Dongnan University
33	Study on the molecule targeted anti-tumor drugs BZG and the enhanced photothermal tumor treatment by the combination with chemotherapy	Yunqing Qiu, Jian You, Yan Lou, Lieming Ding, Jue Zhou, Xinshan Kang, Fenlai Tan, Xiaomeng Guo, Wenqi Qiu, Jing Guo, Liqian Xu, Wei Yu	Zhejiang Province Award for Science and Technology Progress	First Prize	The First Affiliated Hospital, Zhejiang University; Zhejiang University; Beta Pharmaceuticals Co., Ltd; Zhejiang Gongshang University
34	Early warnings and preventive treatment strategies of metabolic syndrome in Children and adolescents	Junfen Fu, Li Liang, Ke Huang, Chunlin Wang, Yangli Dai, Hongxi Zhang, Xiaoqin Xu, Guanping Dong, Xuefeng Chen, Jianfeng Liang, Jianfang Zhu, Yanlan Fang, Wei Wu	Zhejiang Province Award for Science and Technology Progress	First Prize	The Children's Hospital, Zhejiang University School of Medicine, The first affiliated Hospital, Zhejiang University School of Medicine

# Rational Design of Noncytotoxic Polymers of Native Anticancer Activity via Targeting Tumor Microenvironment

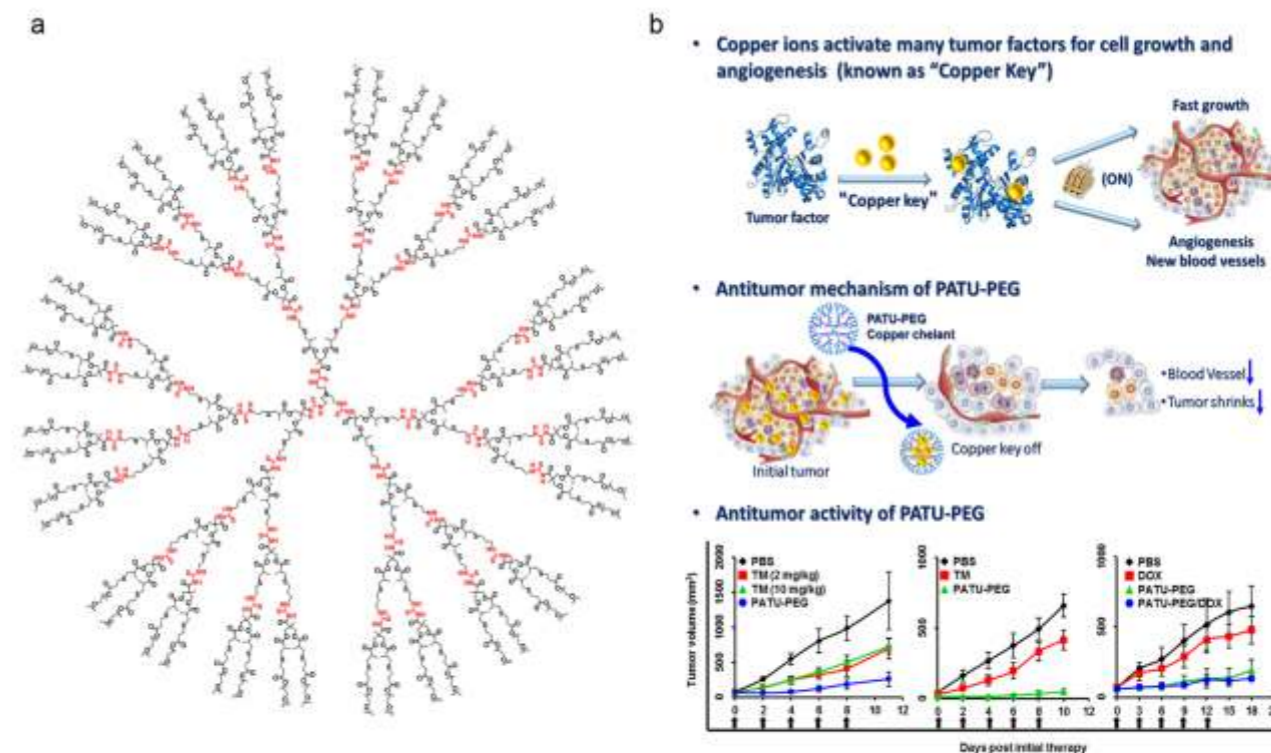


Professor Shen and his team reported the first example of a noncytotoxic synthetic macromolecule having potent and inherent in vivo anticancer activity. This work shows a breakthrough in synthetic polymers for biomedical applications, and may also provide a new direction in anti-cancer drug discovery.

Project Leader: Youqing Shen



In general, synthetic polymers used in medicine, unlike many natural polymers such as antibodies, are of no therapeutic activities and thus are only used as helpers in formulations. For instance, synthetic polymers have been conjugated with cytotoxic-based anticancer drugs. They are called “macromolecular drugs” or “polymer drugs” but the real therapeutic functions are realized by the cytotoxic molecules. However, Off-targeted intoxication-induced adverse effects of cytotoxic-based anticancer drugs have been the main bottleneck of cancer chemotherapy. To solve these dilemma, Shen Shao Zhou and his group members tried to develop a series of noncytotoxic polymers exerting potent anticancer activities via targeting the tumor microenvironment, e.g., its key trace elements, enzymes or signaling proteins on cancer cell membrane, to inhibit tumor angiogenesis, growth and metastasis.



聚酰基硫脲树枝状高分子 (PATU-PEG)

聚酰基硫脲树枝状高分子 (PATU-PEG) 抑癌机理和抑癌效果



In this projects, we show the first example of a noncytotoxic synthetic macromolecule having potent and inherent in vivo anticancer activity without any drug conjugations. A fourth generation polyaclythiourea dendrimer is nontoxic in vitro and in vivo; however, it not only efficiently inhibits the growth of various xenografted tumors and even drug-resistant tumor, but also effectively suppresses highly metastatic solid tumor metastasis and prevents circulating tumor cells from seeding in lung. A

mechanism study has found that it is the synergy of the dendrimer’s high copper-depletion capability and strong reducibility that induces strong inhibition on tumor angiogenesis and cell proliferation, accounting for the potent anticancer activity. This dendrimer has a precise molecular structure and is readily available by our new synthesis approach. Furthermore, a structure-activity study shows that a subtle change of the thiourea group can give dendrimers of different anticancer activities.

Equally importantly, this dendrimer does not cause any observable adverse side effects to the animals during the treatment, and thus overcomes the dilemma of conventional cytotoxic drugs.

In conclusion, the dendrimer is an exciting synthetic macromolecule mimicking anti-VEGF monoclonal antibody bevacizumab that has strong anti-angiogenesis. Thus, It shows a breakthrough in synthetic polymers for biomedical applications. This work was published in Nature Biomedical Engineering on Sep 12<sup>th</sup>, 2017. Professor Peng made highly comments on this study via a special preview article entitled “Potent drugless dendrimers” at the same issue. Extensive attentions from peers have been received since the paper was published and this work has also been reported by multiple news agencies.

# Regulation of autophagy by protein post-translational modification



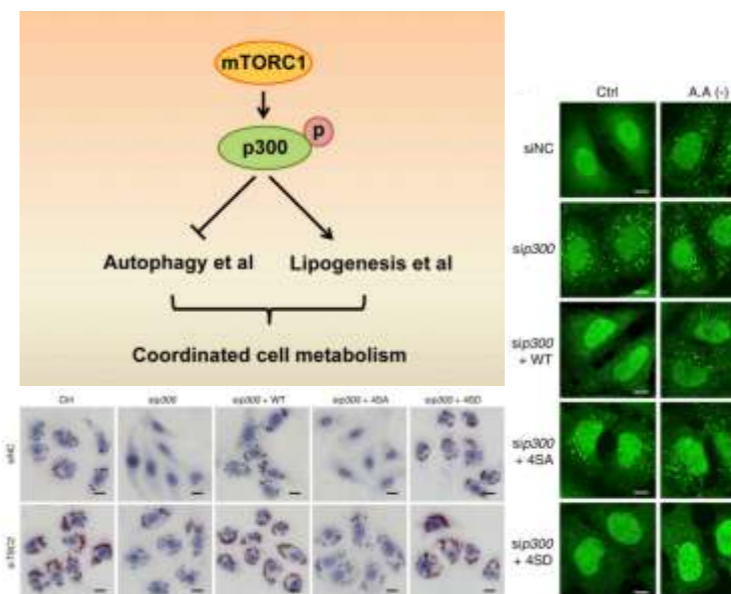
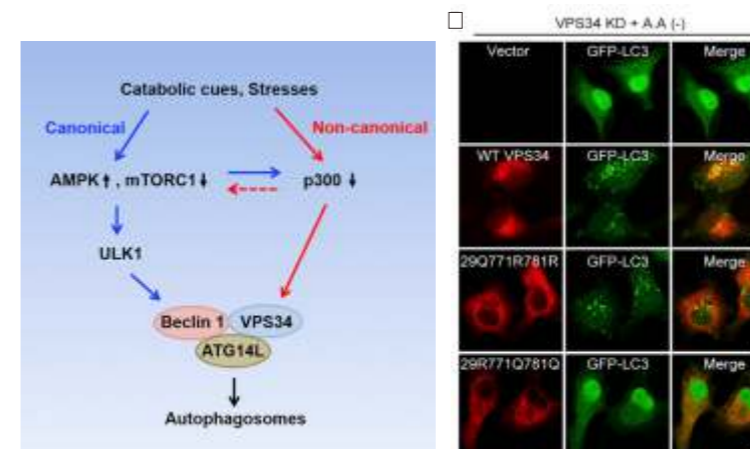
This study unveiled novel post-translational modification of several key proteins involved in autophagy regulation in mammalian cells, which are considered as a breakthrough in the research field of autophagy.

These achievements will lead to discovery of novel therapeutic targets and strategies for autophagy related diseases, such as cancer and metabolic disorders.

**Project Leader: Wei Liu**

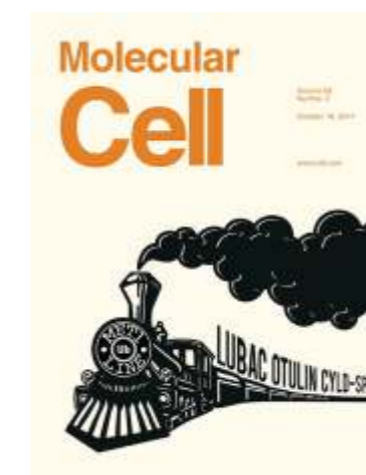
Autophagy is a lysosome-dependent intracellular degradation pathway in eukaryotic cells. It serves as a powerful booster of metabolic homeostasis by recycled the degraded contents back to cytoplasm. Autophagy is critical in various physiological and pathological processes, including cell survival, cell death, aging, immunity and cellular metabolism. Our group mainly focus on the key questions raised in this field, including molecular regulatory mechanisms and physiological functions of autophagy.

In this study, we unveiled novel post-translational modification of several key proteins involved in autophagy regulation in mammalian cells. These pathways are not only utilized by autophagy regulation, but also contribute to cellular response to metabolic and nonmetabolic



cues. Firstly, we report that VPS34 is specifically acetylated by the acetyltransferase p300, and p300-mediated acetylation represses VPS34 activity. Acetylation at K771 directly diminishes the affinity of VPS34 for its substrate PI, while acetylation at K29 hinders the VPS34-Beclin 1 core complex formation. By identification of this p300-VPS34 pathway, we unveiled the initiation mechanism of non-canonical autophagy, which is an important and unsolved problem in autophagy field. Secondly, we identify the homeostatic sensor mTORC1 as a direct activator of p300. Functionally, mTORC1-dependent phosphorylation of p300 suppresses cell-starvation-induced autophagy and activates cell lipogenesis. These results uncover p300 as a direct target of mTORC1 and suggest that the mTORC1-p300 pathway plays a pivotal role in cell metabolism by coordinately controlling cell anabolism and catabolism.

Our findings are considered as a breakthrough in the field of autophagy. These innovative discoveries were both published in *Molecular Cell* in 2017. The journal *Autophagy* have also highlighted the study about P300-VPS34 by a special punctum article. Research achievements from Dr. Liu's group have also been reported by multiple agencies in online media, such as BioArt and the Colum called Scientific Cover in the official website of Zhejiang University.



# Antitumor theranostic drug delivery systems

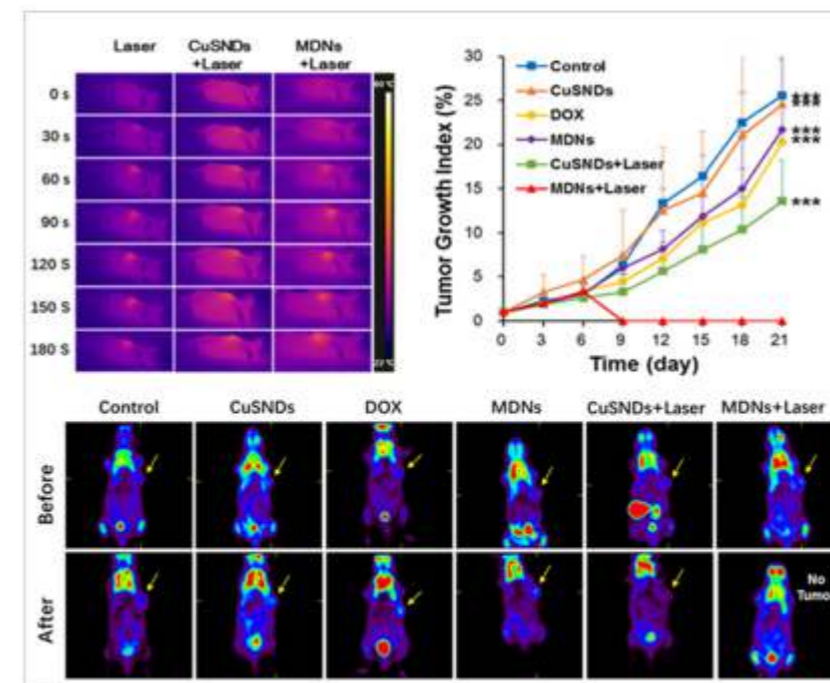
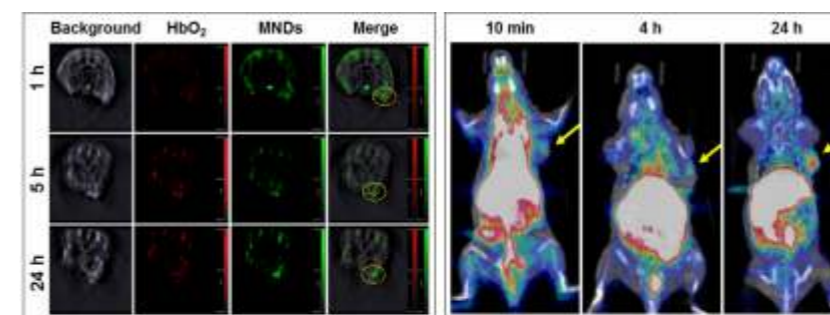
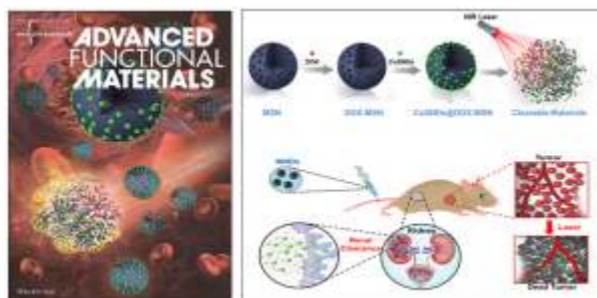


The research team headed by Dr. Min ZHOU developed a new "anti-tumor theranostic drug delivery system", to achieve multi-modal imaging and image-guided cancer precision therapy. The project was performed by several groups with different backgrounds, including clinical medicine, engineering, and other disciplines, and provided a new cutting-edge technology for the treatment of malignant tumors.

## Project Leader: Min Zhou

Cancer is one of the global diseases that threaten human health. It is also the leading cause of death and an important public health problem in China. Nevertheless, current clinical used chemodrug possess serious side effects and toxicity issues. Therefore, the development of new drug delivery systems with low toxicity and high anti-tumor efficacy has important scientific research value and socio-economic benefits. In recent years, the rapid development of nanomedicine has brought new opportunities for theranostic application, through the optimization of nanomaterials to develop stable, efficient, and safe nanocarriers, combined with antitumor drugs, cancer diagnostic probes, and targeted drug delivery system. The development of new nanoformulations has not only great development prospects, but also meets the national major strategic requirements, and thus make innovations for diagnosis and therapy of various diseases.

This project developed renal-clearable nanosystem by a controlled coating of ultras-small CuS nanodots on doxorubicin laden mesoporous silica nanoparticles for the multimodal theranostic application. High tumor uptake of the nanosystem is achieved due to the longer blood circulation time. Under near-infrared laser irradiation, small-molecule anti-cancer drug



detained deep information of the tumors were acquired by the photoacoustic imaging.

The nanosystem demonstrate a photothermally sensitive drug release and pronounced synergetic effects of chemo-photothermal therapy, which are confirmed by two different tumor models in vivo. A novel key feature of the proposed synthesis is the use of renal-clearable nanodots and biodegradable mesoporous silica nanoparticles which also are renal-clearable after degradation. Therefore, the nanosystem would be rapidly degraded and excreted in a reasonable period in living body and avoid long-term toxicity. Such biodegradable and clearable single-compartment theranostic agents with highly integrated multifunctional imaging modalities and multiple therapeutic functions may have substantial potentials to clinical practice.

The relevant findings are published as a back-cover article in *Advanced Functional Materials*, a top journal of biomaterials, in November 2017. Meanwhile, the paper was selected as Top 10 hot paper by the editorial office. The co-first authors are interdisciplinary doctoral students with a chemical engineering background and clinical medicine, respectively. This work was supported by the doctoral cross-disciplinary training program launched in our school in 2016, indicating that the plan has achieved preliminary success, and a broad prospects.

Dr. Min Zhou, the project leader, was selected as the "National Youth Thousand Talents Program" and the "Hundred Talents Program of Zhejiang University". He is also the deputy director of the MOE Key Laboratory of Cancer Prevention and Intervention. Since 2016, Dr. Min Zhou and his group members have taken the advantage of the disciplines' diversity of Zhejiang University, and focused on "molecular imaging and nanomedicine". They have currently achieved a series of innovative and high-level research results with clinical translational prospects.

is released from broken nanostructures owing to the laser mediated high temperature. A synergistic therapeutic effect (photothermal therapy combined with chemotherapy) is achieved. Therefore, the nanosystem could be rapidly degraded and excreted in a reasonable period in living body to avoid long-term toxicity.

This system is capable for dual imaging modalities, including positron emission computed tomography (PET) imaging and photoacoustic (PA) imaging, and provide precise, sensitive, and high-resolution information of the living body. The dynamic biodistribution and tumor uptake were accurately obtained by PET, whereas the

# Resource Optimization and Control for Network Systems



To address the challenges of resource mismatch, estimation distortion, and control misadjustment in network systems, we established a novel optimization and control framework for network systems.

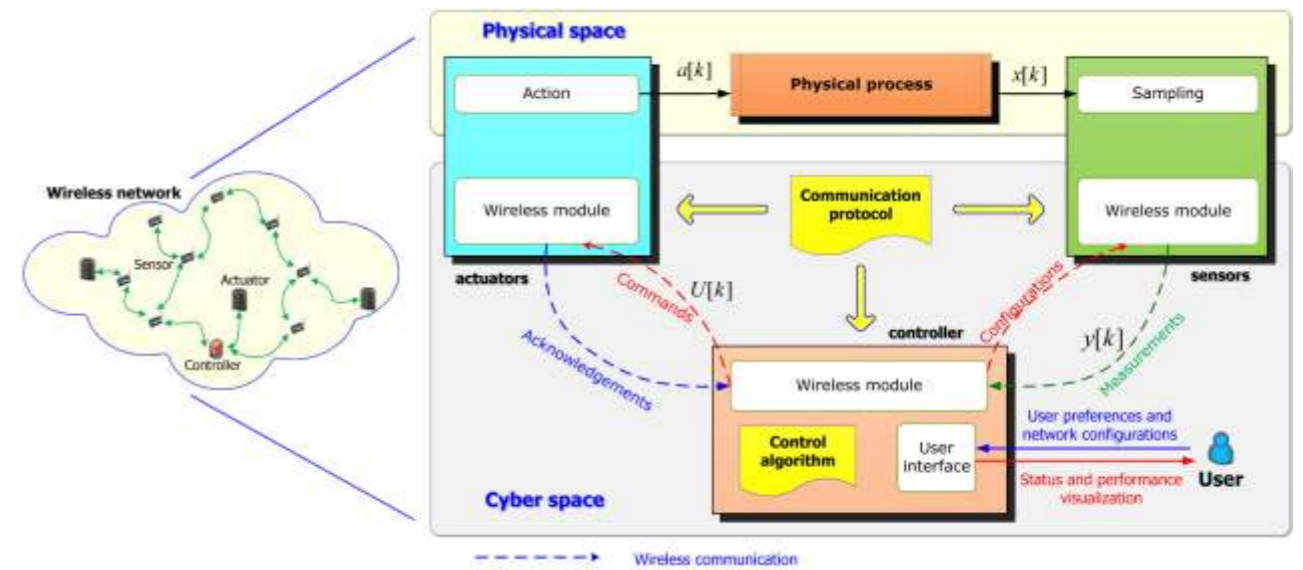
We successfully solved a series of fundamentally theoretical and key technological problems related to data transmission, state estimation, and cooperative control, and quantified the relationships between network system performance and network resources.

## Project Leader: Jiming Chen

Control, Computing and Communication theory and technology have accelerated the advancement of information technology in the last three decades. Meanwhile, the interaction among human, nature and machine has shifted to the new model of multi-scale and ubiquitous interconnection. Driven by the in-depth integration of informatization and industrialization, network systems such as network collaborative manufacturing and smart grid are rapidly developing. To quickly adjust to complex dynamic environments and meet diversified requirements, it is imperative to ensure the ubiquitous interconnection of networks, the decentralization of functions, the autonomous collaborative control of collaboration, improving the productivity, under the resource constraints of limited channels, bandwidth, and energy. To effectively solve the above problem, it is of great importance to investigate the fundamental theory and methodology of network system resource optimization and control, so as to improve the system performance and resource utilization.



Due to the complexity of network systems and the spatiotemporal limitation of network resources, there are three major challenges in network systems: resource mismatch, estimation distortion, and control misadjustment. From the perspective of multi-objective optimization of network resources, Prof. Jiming Chen's team revealed the inherent relationship between network resources and network system performance. Focusing on transmission performance, estimation performance and control performance, they have



made remarkable achievements in dynamical resource allocation for transmission performance, optimal remote state estimation and distributed cooperative control. Further, we have made breakthroughs in resource optimization and control theory for network systems, providing new ideas in this area. Major scientific discoveries are as follows.

We revealed the inherent laws of channel resource usage in network systems, established long-term performance indicators that characterize the quality of spectrum sensing. In order to effectively solve the problem of distributed multi-channel allocation, they established new efficient evaluation models of network transmission performance. Further, the optimal link quality estimation method is proposed, and a cross-layer optimization framework for network transmission performance based on active resource allocation is constructed.

We proposed a new approach for evaluating the remote state estimation performance of network systems with finite-time window. We described the direct quantification relationship between the available network resources and the remote state estimation performance. We designed an optimal online estimation algorithm that efficiently utilizes the dynamic and real-time available resources of the physical objects. Our design significantly improved

the state estimation accuracy of the network system with resource constraints.

Our paper gains the insight that how communication protocol parameters influence system performance, and established a collaborative optimization framework of communication protocols and control algorithms. We proposed a highly scalable and distributed cooperative control method for heterogeneous network systems. We clarified the evolution process of clock synchronization under random communication delays, which significantly improved the accuracy of clock synchronization control while shortening the convergence time.

Parts of the achievements have won the Natural Science Award of the Ministry of Education, China, 2017. The project has published 28 academic papers which received more than 1600 citations according to Google Scholar and more than 780 non-self SCI citations. Ten representative papers have received 568 citations from SCI journal papers, and have been cited by 186 ACM/IEEE Transactions and Automatica papers. Our results have also received very positive comments from more than 60 world-wide famous researchers such as member of the American Academy of Engineering, member of the Canadian Academy of Engineering, as well as ACM/IEEE Fellows. Four papers are ESI 1% highly cited papers. Dr. Chen was selected as highly cited scholar by Elsevier from 2014-2016. Two Members of the research team won the Asian-Pacific Outstanding Young Researcher Award 2011 and 2015, Three of them received the best thesis award of Chinese Association of Automation.

# Molecular mechanisms of competition and co-evolution between paddy weeds and rice.



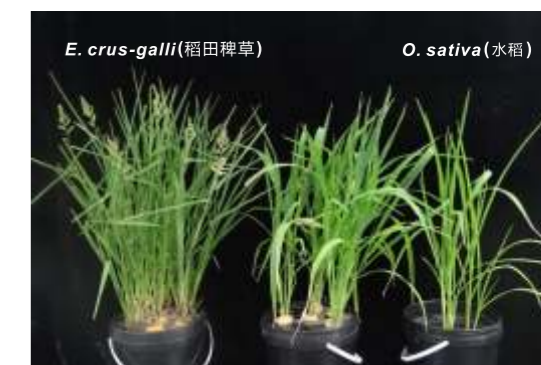
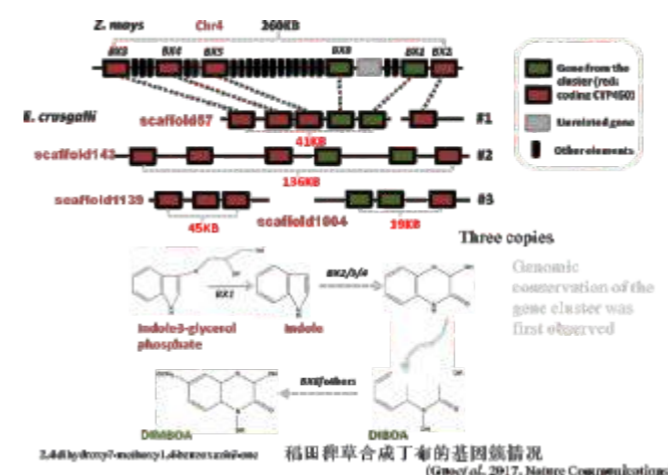
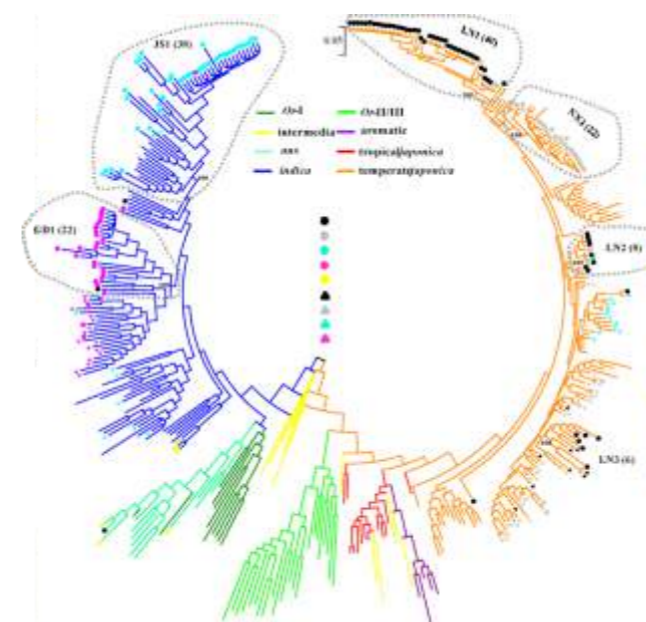
Barnyardgrass and weedy rice are the two notorious weeds and mimic of rice in paddy field, and herbicide is the only way to control them for current rice production. The understanding of their competition and co-evolution will promise a lot for the decrease of production cost and environmental pollution.

## Project Leader: Longjiang Fan

Currently, there are three major problems in China's crop production. The first is the increasing use of herbicides (has become the largest one in pesticides in China), which seriously pollutes the environment and increases farmers' production costs. At present, there is an urgent need to reduce the amount of herbicide to achieve green control of glass and organic rice production. Secondly, new weeds such as weedy rice have been erupted in large areas in recent years. The source is unknown and cannot be controlled. Thirdly, crop breeding technology is in urgent need of breakthroughs to breed more high-yielding and high-quality crop varieties. Rice is the most important grain crop in China. The above problems have seriously affected the production and quality of rice in China.



Through the study of this project, we (1) identified that weedy rice in China is all from cultivated rice population for the first time. Under the influence of genetic mechanisms such as balance selection, cultivated rice populations undergo



de-domestication and produce weed-type rice seeds. Based on the results of the study, we put forward a number of prevention and control measures, including the reduction of rice harvest in the field, the remaining materials in the main breeding of indica-japonica hybridization, increasing seedlings and transplanting, reducing some light cultivation links and other grass control measures. In recent years, the problem of weedy rice in the northern part of Zhejiang Province has been prominent. In October 2017, Prof. Longjiang Fan, was invited to the Hangzhou-Jiaxing Lake paddy field to inspect and answer the concerns of farmers. After inspections and sampling, we put forward specific opinions on the damage area, source, and prevention and control measures of weedy rice in Zhejiang Province, and provided investigation reports and recommendations to the deputy governor of Zhejiang Province, Jingmiao Sun, and received a reply from the office of the provincial government; (2) revealed the molecular mechanism of the competition between barnyardgrass and rice, provides an important genetic basis for the prevention of barnyardgrass and control of rice breeding. It is the first time to find that barnyardgrass can synthesize defensive secondary metabolites DIMBOA and momilactones through gene clusters, to compete with crop and could enhance its adaptability to pyricularia oryzae in the paddy field environments. Barnyardgrass has evolved a large repertoire of detoxification-related genes like GYP450 and GTS, which are directly related to the non-target-site herbicide resistance; (3) we have been developing genetic germplasm for rice breeding. Based on the results of this study, the scanning of clutivars with highly-suppression to barnyardgrass (so-called "allelopathic rice") and further breeding targeting barnyardgrass DIMBOA can increase the weed-suppression ability of rice varieties and are expected to reduce the amount of herbicide (30-50%) and greatly reduce the field pollution of pesticides. At the same time, the pyricularia oryzae resistance mechanism will contribute to rice blast resistance. Moreover, barnyardgrass is C4 plant, with similar plant structure and habitat of rice, which provides a perfect C4 pathway model for C4 rice breeding. C4 rice breeding is expected to provide 50% of the rice yield.

# Construction and Application of China Rural Household Panel Survey Database



Microdata are the foundation for scientific research and macro studies. With normative methods and techniques, this project establishes a dynamic database, which can comprehensively fulfill the studies of agriculture and rural areas. Moreover, this program demonstrates the status quo and evolution of rural China and builds a baseline in the studies of Chinese rural issues.

## Project Leader: Wenrong Qian

Since 2000, with the rapid advance of globalization, the studies of agriculture and forestry economics and management present distinctive international characteristics. On the one hand, as an important transition country, Chinese agriculture issues have aroused wide concern and discussion among international scholars. On the other hand, more domestic scholars have made global contributions to agricultural economics. Traditional research methods are quickly replaced by modern mathematical economics and econometric analysis based on a standardized research of large samples microdata. Therefore, in order to carry out researches on Chinese agriculture and forestry economics and management in a comprehensive and scientific way, it is urgent



to build a China rural household database of large samples. Some achievements have been made in the construction of related databases in China, but the research on three rural issues cannot be fully addressed based on these datasets. The majority of these existing databases only focus on part of the rural household issues and these datasets cannot be used together. Therefore, a dataset that can comprehensively reflect the full page of the three rural issues is necessary. Household is the cell of society, and rural household is the basic organization of rural communities. It is not only the basic unit of consumption and demand in rural areas, but the production unit on the supply side. Therefore, rural household survey and database construction is a basic but essential work of the research on agriculture, rural areas and farmers. This project has made important breakthroughs in the following aspects. 1) It has formed a set of normative database construction technology that adapts to the current condition of rural China. And it has built a unique database of Chinese rural household panel survey. 2) It demonstrates the status quo and evolution of rural China and builds a baseline in the studies of Chinese rural problems. 3) Based on the analysis of large sample data, a number of innovative research conclusions have been formed.

# Gastrointestinal anastomosis using a degradable stent



Prof. Xiujun Cai proposed the “no suture” gastrointestinal anastomosis. He developed degradable anastomosis stents and established the technique of Gastrointestinal anastomosis using a degradable stent.

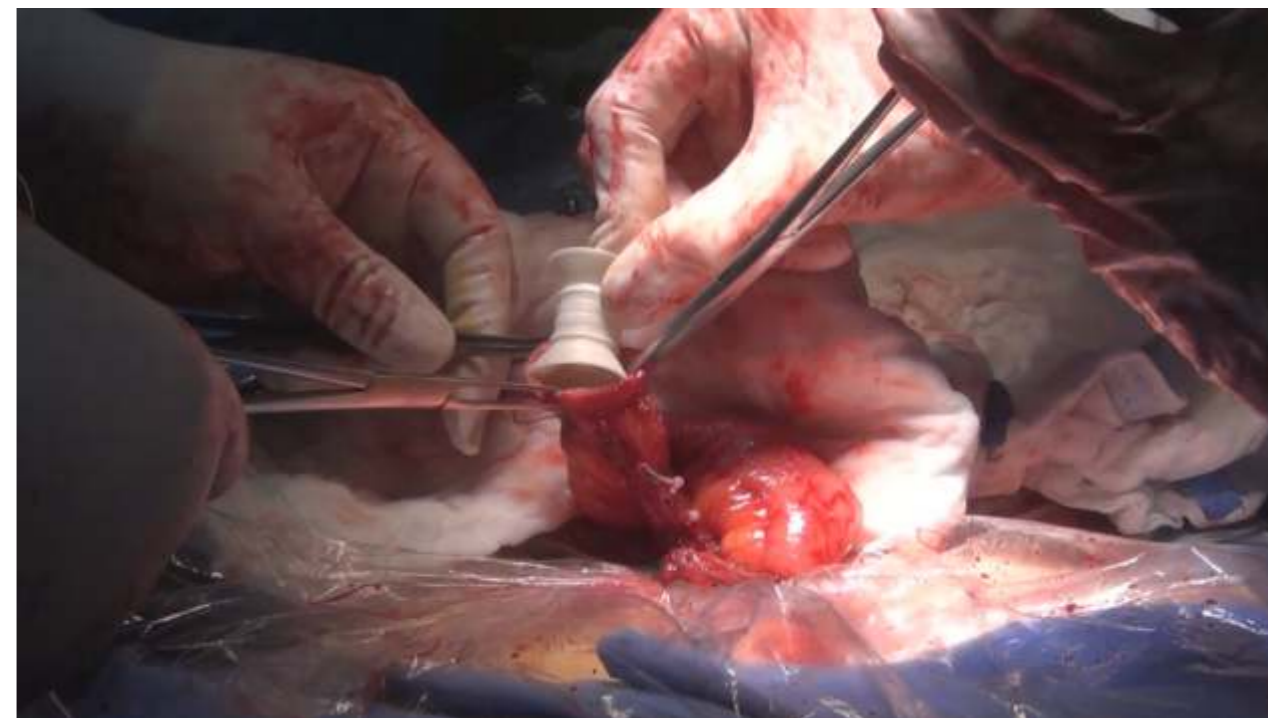
This technique is simple and suit for the anastomosis in laparoscope.

There is no metallic remains left in abdominal cavity after anastomosis.

## Project Leader: Xiujun Cai

Gastrointestinal anastomosis is the most common procedure in abdominal surgery. The existing anastomosis methods include the hand-sewn anastomosis and the stapler anastomosis. The hand-sewn anastomosis is complicated and is difficult to perform in laparoscopy. The stapler anastomosis is simple and the anastomotic time is short, but the price of stapler is high. And the metallic remains were left in abdominal cavity forever. Besides, by using the conventional technique, the anastomotic submucosal vessel was destroyed that will affect the anastomotic blood supply and be detrimental to anastomotic healing.

To solve the problem in the conventional techniques, Professor Xiujun Cai creatively proposed a new concept of “sutureless gastrointestinal anastomosis”, and developed a variety of degradable stents. Finally, he established the technique of Gastrointestinal anastomosis using a degradable stent.



This novel method has a short anastomosis time and is suitable for laparoscopic operation. At the same time, it avoids suturing or stapling at the anastomosis stoma. The destruction of the anastomotic submucosal vessels could be avoided that is conducive to the healing of the anastomotic stoma and prevents the occurrence of anastomotic leakage. The stent is made of degradable polymer material and finally degrades into carbon dioxide and water in the digestive tract, and was discharged with the feces without foreign material left in the abdominal cavity. The stent can be used for the treatment of anastomosis leakage or primary repair of intestinal perforation avoiding intestinal colostomy and shortening the treatment cycle from 3-6 months to 1-2 weeks as well.

From January 2017, this technique was tried clinically in Peking University Third Hospital, Peking University People's Hospital, Capital Medical University Affiliated Friendship Hospital, Zhejiang Cancer Hospital and Sir Run Run Shaw Hospital of Zhejiang University School of Medicine and got good results.

# Spatial differentiator: all-optical analog computing within subwavelength scale

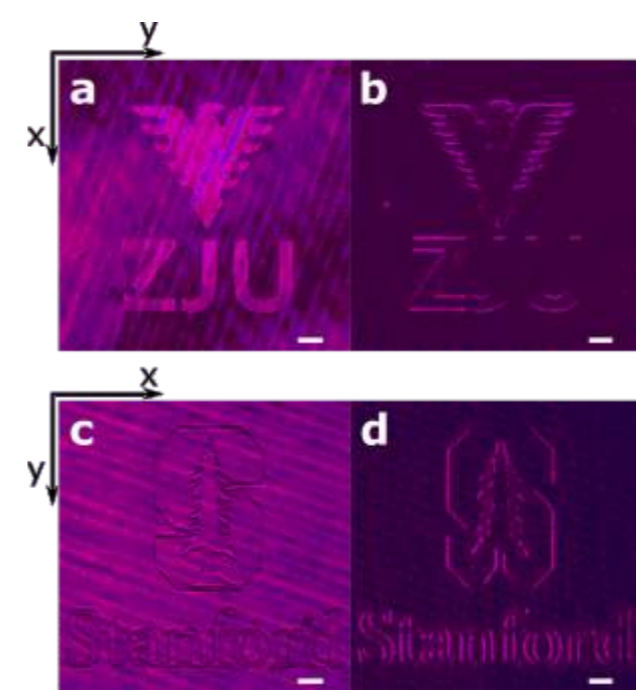
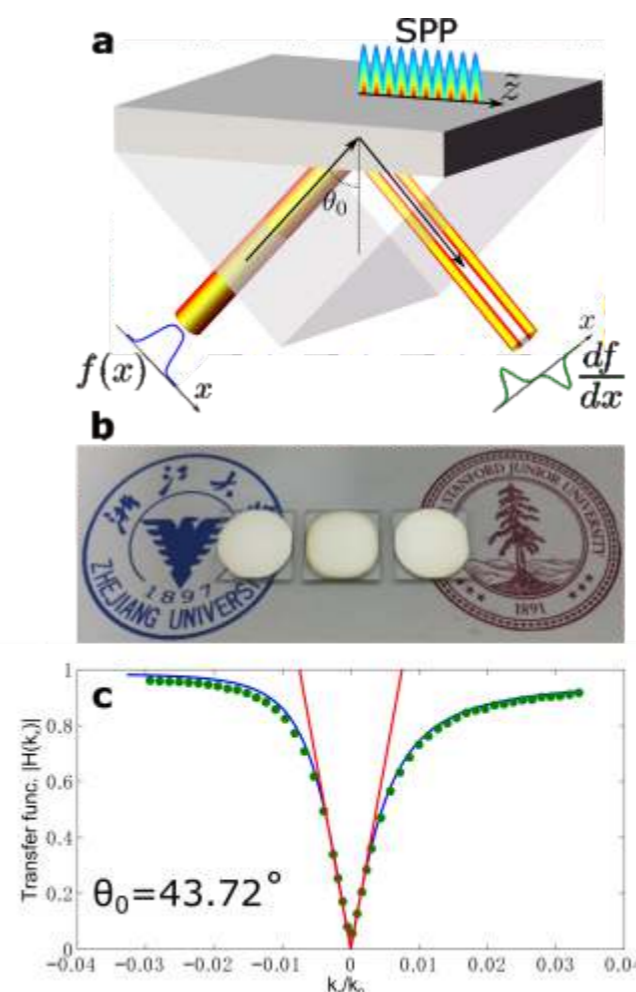


Traditionally, optical analog computing in the spatial domain uses a bulky system of lenses and filters. Professor Zhichao Ruan's group has experimentally realized a surface-plasmon-based optical spatial differentiator, which miniaturizes traditional bulky system into subwavelength scale, and also demonstrated its application for ultrafast real-time image processing.

## Project Leader: Zhichao Ruan

Optical analog computing has attracted particular attention and offers high-throughput low-power-consumption operation for ultrafast real-time computational tasks. Traditionally, optical analog computing in the spatial domain requires a bulky system of lenses and filters. Over the past few years, there have been significant efforts seeking to miniaturize such optical systems down to wavelength or even subwavelength scale. However, since all reported proposals are with complex structures, it is extremely challenging to fabricate them precisely and none of these structures have been demonstrated experimentally yet.

To address this challenge, Professor Zhichao Ruan developed a spatial coupled-mode theory to model the surface plasmon polariton (SPP) excitation process [Ruan et al., 2014, Optics Letters, 39(12): 3587-3590]. Based on this theory, Prof. Ruan proposed that through a spatial-mode



coupling and interference process, a Kretschmann prism coupling configuration can directly perform spatial differentiation to the incident beam profile [Ruan, 2015, Optics Letters, 40(4): 601-604]. Such a design is far simpler, which greatly simplifies the fabrication process and reduces the influence of fabrication imperfection.

Prof. Ruan's team members, cooperating with Prof. Min Qiu and Prof. Hui Ye from College of Optical Engineering and Prof. Shanhui Fan from Stanford University, have made new progress in analog optical computing. For the first time, the research team has experimentally demonstrated spatial differentiation with the plasmonic device and further exploited it in image processing for edge detection. The precision of the differentiation operation is about 94% and the resolution of the edge detection reaches 7  $\mu\text{m}$ . The temporal bandwidth is as wide as 3 THz. The differentiator adopts the Kretschmann prism configuration and only requires 50nm-thick single silver layer, which is the only subwavelength optical analog device so far.

Such a method offers a brand-new approach for optical information processing. Particularly, the research team demonstrated substantial application to detect the edges for either amplitude or phase sharp change in the incident field, which is a vital step in object detection, feature classification and data compression. With standard thin-film deposition technology, the plasmonic differentiator can be fabricated in large scale. Therefore, such an ultrafast optical computing scheme with sufficient space-bandwidth product is capable of processing an entire image on a single shot, which is critically important for high-throughput real-time image processing and might be applied in artificial intelligence, such as optical neural network and ultrafast pattern identification.

This work has been published in *Nature Communication* in May 2017 titled *Plasmonic computing of spatial differentiation* [8, 15391(2017)]. Chinese Laser Press published a special report titled Spatial differentiator: subwavelength all-optical analog computing about this work. Under assessment by an award committee led by CAE Academician Prof. Dianyan Fan, this work has been selected as "2017's China top ten breakthroughs in optics -- applications" recently.

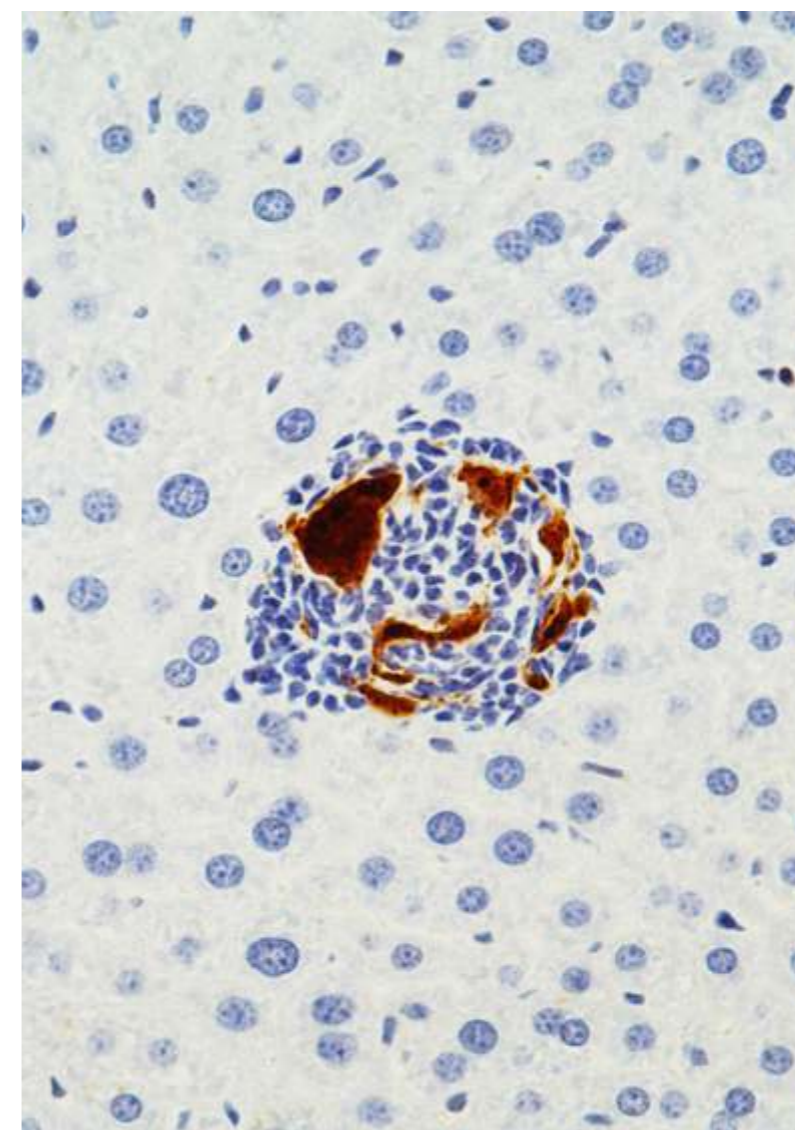
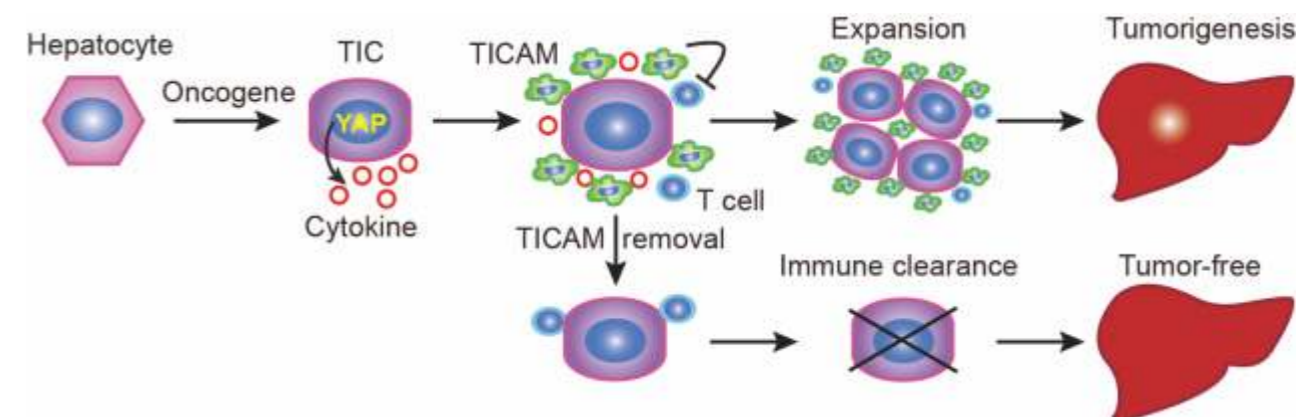
# Single tumor-initiating cells evade immune clearance by recruiting type II macrophages



Established mouse liver cancer models based on hydrodynamic injection method. Demonstrated for the first time that macrophages play a decisive role in the survival of single tumor-initiating cells in vivo, and provide a proof of principle for tumor inhibition by targeting YAP or M2 macrophages.

**Project Leader: Bin Zhao**

Tumor infiltrated type II (M2) macrophages promote tumorigenesis by suppressing immune clearance, promoting proliferation and stimulating angiogenesis. Interestingly, macrophages were also found to enrich in small foci of altered hepatocytes containing liver tumor-initiating cells (TICs). However, whether and how TICs specifically recruit macrophages and the function of these macrophages in tumor initiation remain unknown due to technical difficulties. In this report, by generating genetically defined liver TICs, we demonstrate that TICs actively recruit M2 macrophages from as early as the single cell stage. Elimination of TIC-associated macrophages (TICAMs) abolishes tumorigenesis in a manner dependent on the



immune system. Mechanistically, activation of the Hippo pathway effector YAP is underlying macrophage recruitment by TICs. These results demonstrate for the first time that macrophages play a decisive role in the survival of single TIC in vivo, and provide a proof of principle for TIC elimination by targeting YAP or M2 macrophages.

# Nanoscale illumination based on-chip large-field far-field label-free nanoscopy



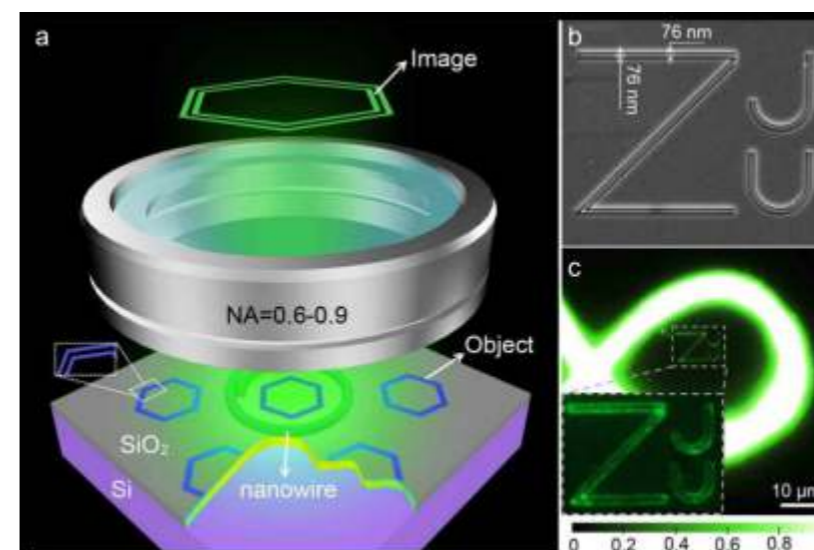
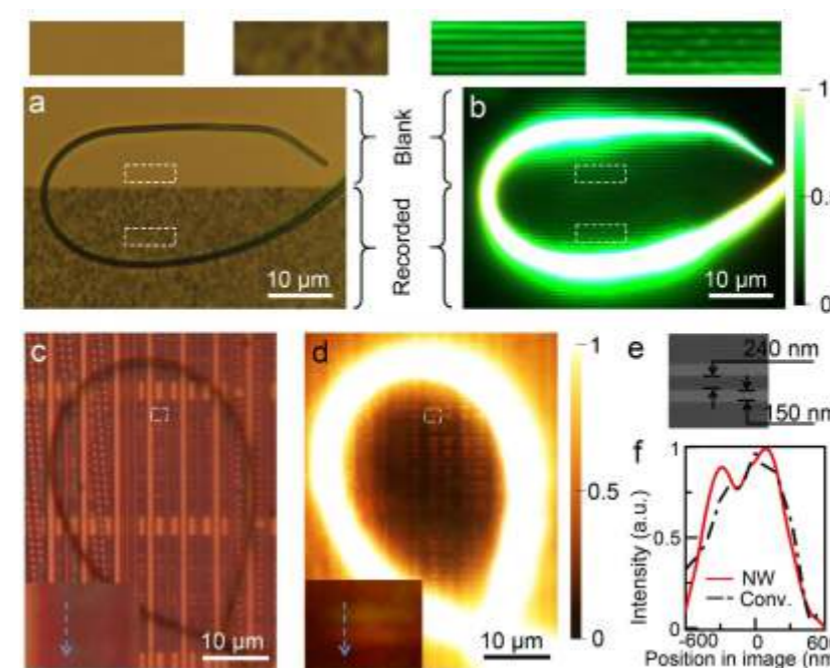
A group led by Dr. Xu Liu and Dr. Qing Yang in Zhejiang University demonstrates a novel active nanoscopy based on the nanoscale light source which has broken the bottleneck in wide-field, far-field, label-free subdiffraction imaging, and achieved a 2 magnitudes order improved field of view compared with other reported counterparts.

**Project Leader: Xu Liu Qing Yang**

The resolution of conventional optical imaging systems is limited to 200 nm at the visible spectrum due to their inability to capture exponentially decaying evanescent waves in the near field, which carry subwavelength spatial information about the objects being examined. To break this stubborn limit and achieve super resolution imaging will promise significant improvements in relating fields, such as bio-medicine, material science, etc. In recent decades, relying on the labelling techniques, nanoscopy develops very fast, and especially, the stimulated emission depletion microscopy and single molecule localization microscopy were granted the Nobel Prize in 2014. While in contrast, the label-free nanoscopy, which is vital for antirejection and chromophore-incompatible conditions, develops rather slow. In particular, near-field scanning optical microscopy has achieved spatial resolutions down to 20 nm by scanning objects using a nanotip in the near field. However, to avoid invasion and perturbation, breaking the diffraction limit in the far field is highly desirable.



Far-field label-free super resolution imaging has great potential in physics, materials, biology and chemistry, and has drawn great interest from



researchers worldwide. Recent developments in hyperlens and microsphere contacting technologies to achieve label-free far-field subwavelength resolution have brought new opportunities but still face the limitations of a confined spectral range and a small field of view. Achieving wide-field, label-free optical images for diverse subwavelength objects in the far field would be a significant breakthrough, with promising applications in biology, chemistry, and physics.

Targeting at this significant bottleneck in label-free super-resolution nanoscopy, Dr. Xu Liu and Dr. Qing Yang demonstrate an active method which pioneers in utilizing a combination of a spatial frequency shift and a Stokes frequency shift, and for the first time achieved the large-field, far-field, label-free super resolution imaging. The method is called nanowire ring illumination microscopy (NWRIM). A fluorescent NWR acts as a localized source and is combined with a film waveguide to produce omnidirectional evanescent waves with large transverse wave vectors to interact with an object in a wide area. The high spatial frequencies of the object can be shifted to the central position of the frequency domain, in the passband of a conventional imaging system. Consequently, the final wide-field image captures fine features of the object and possesses an enhanced resolution. The ring-shaped light source enables a 2D spatial frequency shift for 2D imaging. The versatility of this approach has been demonstrated by imaging integrated chips, Blu-ray DVDs, biological cells, and various subwavelength 2D patterns, with a viewing area of up to 1000 μm<sup>2</sup>, which is 2 orders of magnitude larger than the previous far-field and full-field nanoscopy methods. This new label-free resolving technique is compatible quite well with other microscopy or nanoscopy methods, can potentially become an important tool in cellular biology, the on-chip industry etc., and has also put forward a significant step for the real applications of nanoscale devices.

The research was published by the classical journal-Physical Review Letter (PRL 118, 076101 (2017)), and was awarded "The top 10 progress of Chinese Optics in 2017-for application researches".

# Power Charging and Data Transmission for AUV at Seafloor of 100 Meters Depth Successfully Realized

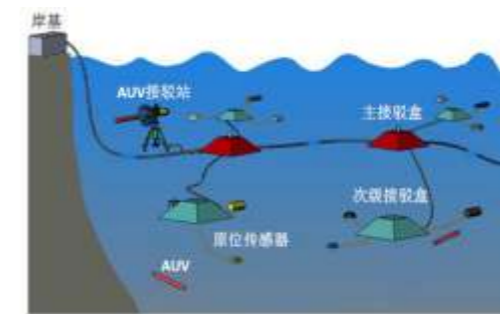
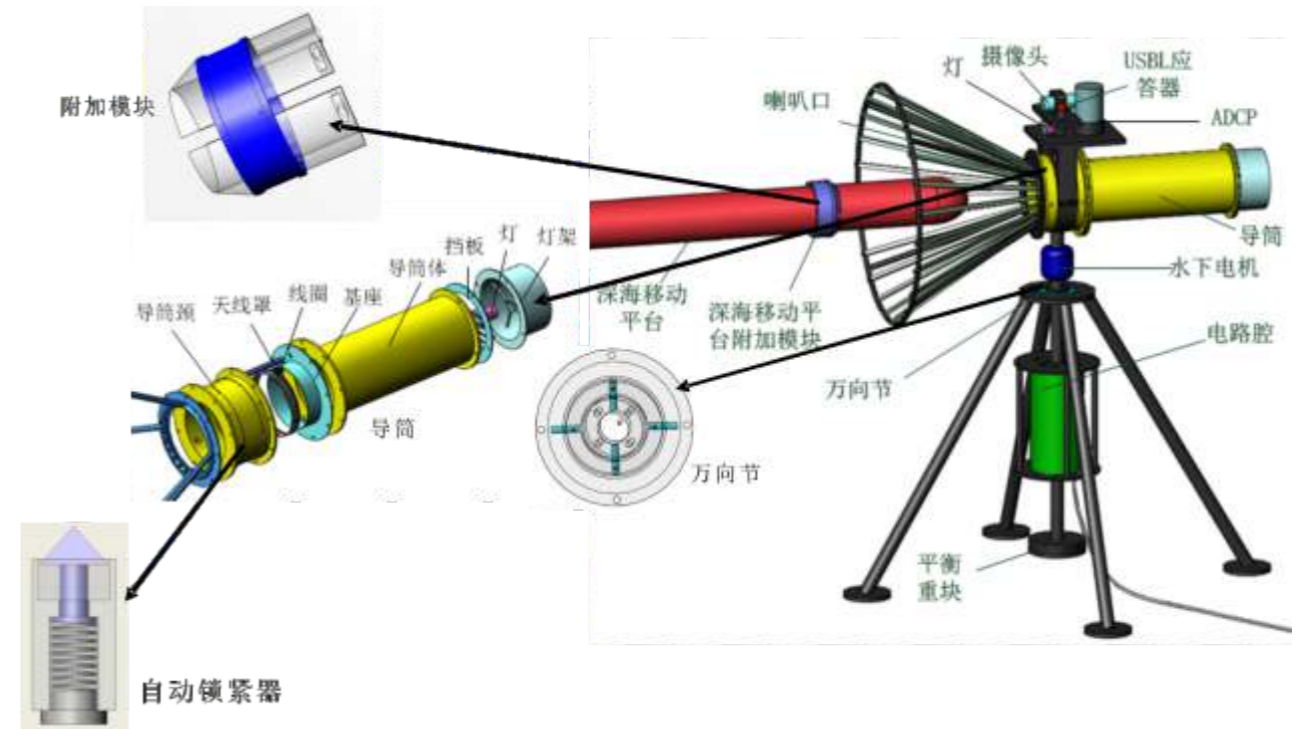


Selected as The TOP 10 Academic Advances of The Year

Seafloor multifunction docking station, developed by Zhejiang University, has implemented the contactless electrical charging and signal transmission at the depth of 105 meters recently. This is a world-class achievement to solve the problem of the docking process between Autonomous underwater vehicle (AUV) and its supporting system on the deep seafloor.

## Project Leader: Ying Chen

The State Key Laboratory of Fluid Power and Mechatronic Systems, Ocean College, College of Information Science and Electronic Engineering, from Zhejiang University, organized Interdisciplinary scientific research team to undertake the major project of China's 863 program "Research on technology of contactless power and data transmission between cabled seafloor observatory network and deep sea mobile platform". The team has successfully implemented the research of related key technologies, development of equipment and sea trials. They developed technologies including composite AUV navigation based on acoustic navigation at long distance and optical navigation at short distance, contactless power and data transmission based on seafloor



observatory network, docking procedure and so on. The sea trial of the project of 863 program was successfully completed in the South China Sea from May 12th to 16th 2017. Firstly the docking station system was deployed on seafloor of 50 meters deep, 10 missions of AUV homing and docking were carried out successfully. The docking station carried out contactless power charging to the AUV with maximum power of 681 W, and data transmission to AUV with maximum rate of 3.1 MB/s. The same experiment was performed in 105 meters deep once more, and the docking procedure, contactless power charging and data transmission were implemented successfully. This technological achievement has conquered the worldwide highlighted problem of automatic charging and data transmitting of AUV on the seafloor. The research work has successfully broken through the docking technology between AUV and seafloor observatory network with a depth of more than 100 meters. The success rate of docking procedures, the power of contactless charging, the rate of contactless data transmission, have reached the international advanced level. This work lays the foundation for the realization of the comprehensive seabed observation in China.

# A New Regulatory Mechanism for the Interferon-mediated Antiviral Activity



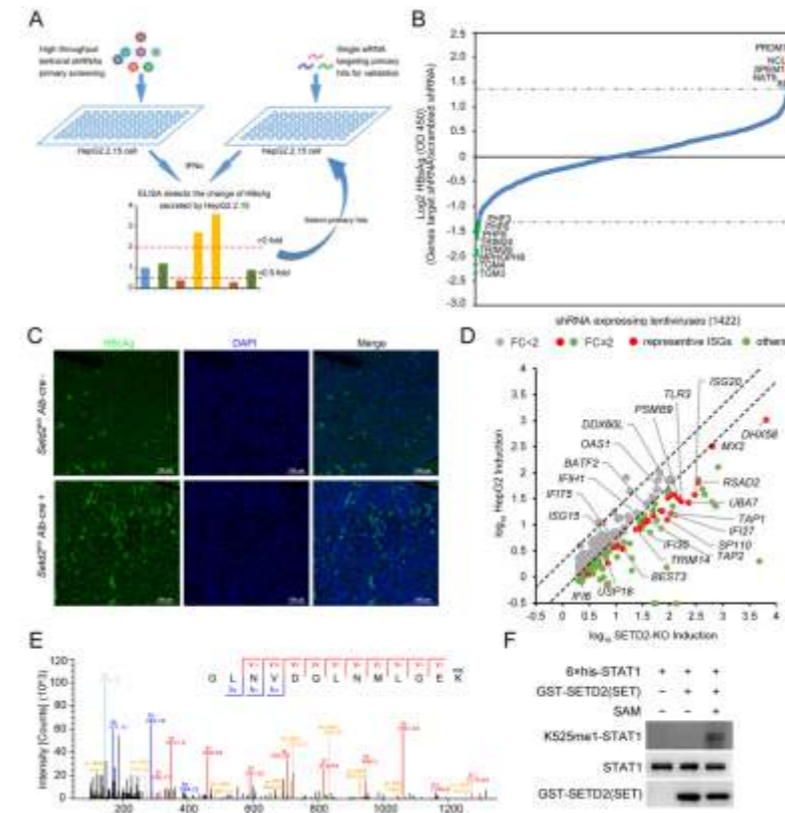
Selected as The TOP 10 Academic Advances of The Year

Prof. Xuetao Cao and his group discovered a new mechanism of histone methyltransferase SETD2 in the regulation of IFN-mediated antiviral immunity. This finding improves our understanding of regulatory network of IFN signaling and provides new insights into the development of new therapeutic strategies against infectious diseases.

Project Leader: Xuetao Cao

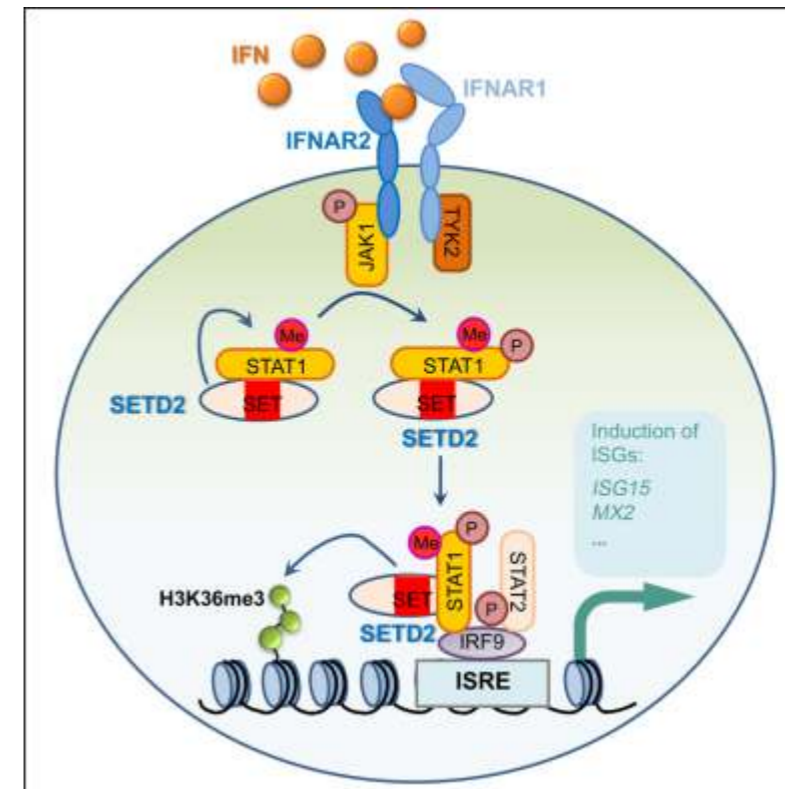
Type I interferons (IFNs) is critical for host defense against viral infection via induction of IFN-stimulated genes (ISGs) through the Janus kinase-signal transducer and activator of transcription (JAK-STAT) signaling pathway. Dysregulation of IFN signaling has been closely associated with pathogenesis of various infectious and inflammatory disorders. While the crucial role of IFN-induced signaling pathways in host antiviral responses is well established, the mechanisms for the regulation of IFN signaling and ISGs expression remain to be fully elucidated.

In this research, Prof. Cao revealed a new function of methyltransferase SETD2 which is critical for enhancing the IFN signaling and promoting the IFN antiviral function. The author firstly performed a non-biased high-throughput RNAi screening of 711 known epigenetic modifiers for their potential roles in IFN-mediated inhibition of HBV replications and identified SETD2 as an important regulator that promotes IFN-mediated cellular



response against HBV replication. Further investigation showed that SETD2 can directly bind to STAT1 and catalyze its methylation on lysine 525 residue, which consequently resulted in an enhanced phosphorylation and activation of STAT1, and higher ISGs expression. Importantly, they also found that SETD2 selectively regulated the H3K36me3 levels of some ISGs to promote their transcription induced by IFN. Thus, SETD2 enhances host antiviral immunity by strengthening IFN signaling both post-translationally and epigenetically.

Dr. Kun Chen from Zhejiang University is the first author of this paper. Prof. Xuetao Cao is the corresponding author. This work was supported by grants from the Natural Science Foundation of China and Ministry of Science and Technology of China (973 Program).



# Environmental and Chemical Modulation of Innate Immune Sensing of Nucleic Acids

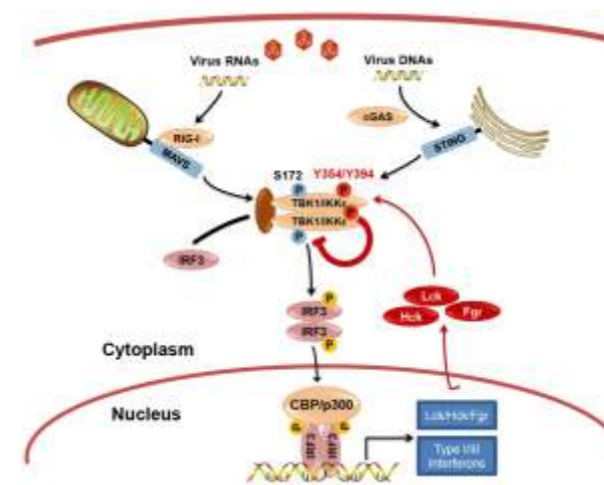
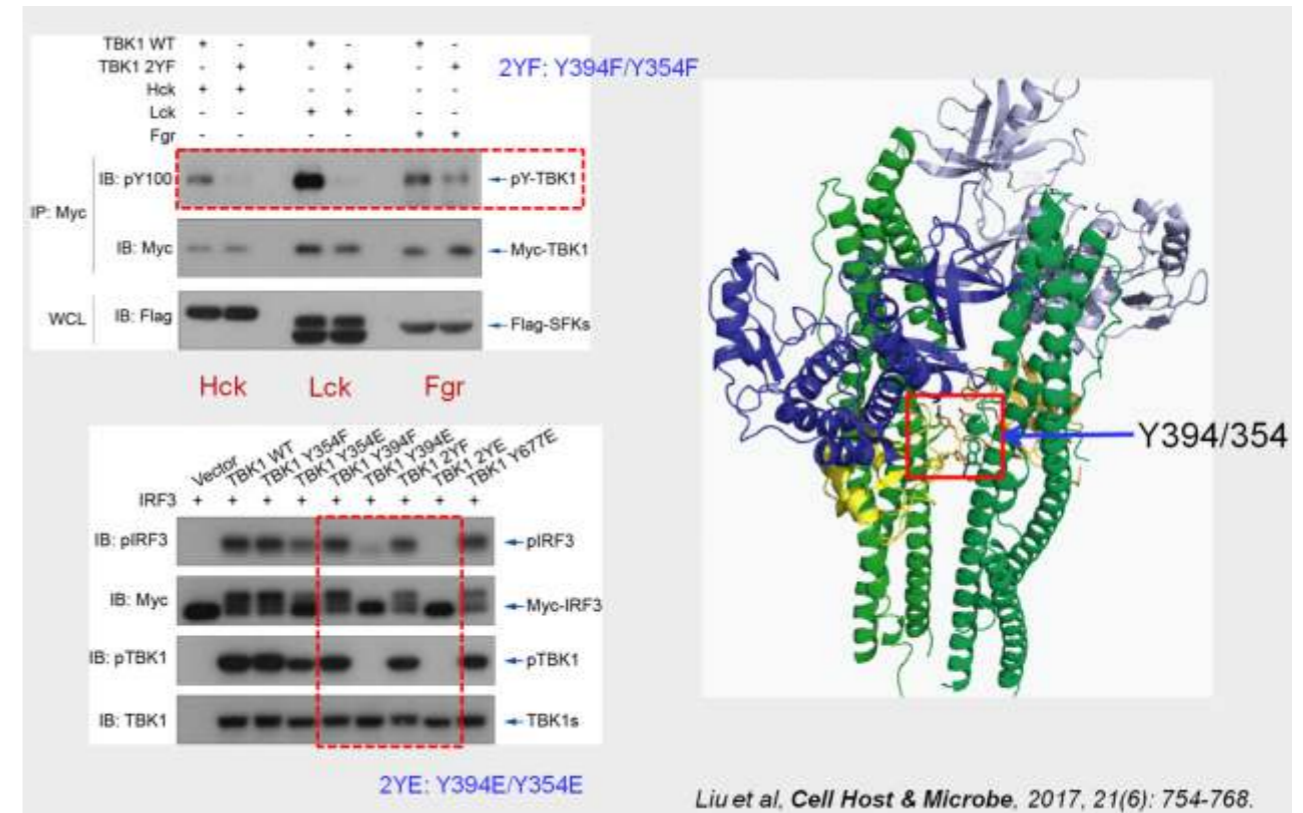
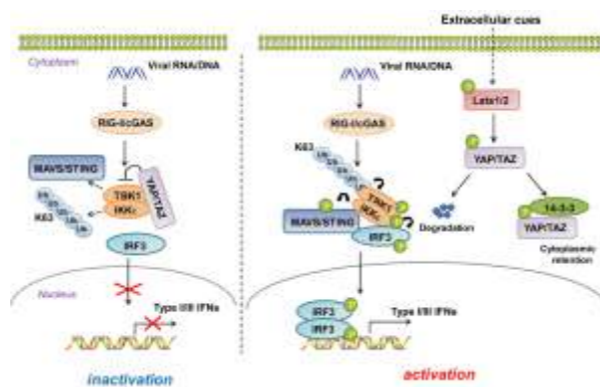


Selected as The TOP 10 Academic Advances of The Year

Through a set of discoveries published in prestigious journals, Xu laboratory elucidates a few exciting breakthroughs for the environmental and small molecule modulation of an ubiquitous and highly conserved cellular mechanism.

Project Leader: Pinglong Xu

Sensing of exogenous or self nucleic acids in cytosol by pattern recognition receptors (RIG-I/MDA5 and cGAS) initiates the robust cell signaling through adaptors MAVS/STING, kinases TBK1/IKKε, and transcriptional factor IRF3, which resulting in production of type I and III interferons and subsequent induction for hundreds ISGs, to establish the innate immune state for self and neighboring cells. Innate immune sensing of nucleic acids is an ancient and evolutionally highly conserved cellular mechanism, which in presence ubiquitously in immune and non-immune cells, acts as a key determinant in host defense, autoimmune disorders, tumorigenesis, and neurodegenerative diseases. Markedly, the capability to evade or resist this immune sensing system is the key decisive factor for infection of pathogenic microbes. Therefore, cytosolic nucleic acid sensing is one of the major research focuses and a frontier of current biomedical research. Nevertheless, how the innate immune sensing of nucleic acids is regulated by cellular microenvironments is largely unknown.



Dr. Pinglong Xu and his team have achieved a series of accomplishments to answer the key questions of nucleic acid immune sensing in environmental regulation, signaling mechanism, and new biological function, through interdisciplinary approaches at the molecular, cellular, and whole animal levels. Previously, they elucidated a new modification/regulatory mode and the physiology of modifier Mst1 kinase in nucleic acid sensing (*Genes & Development*, 2016 May), identified a key phosphatase PPM1A in antiviral signaling complex (*Science Advances*, 2016 July), and unveiled a critical role of nucleic acid sensing in iTreg lymphocyte differentiation and epithelial-

mesenchymal transition (EMT) (*Molecular Cell*, 2014 December). In 2017, by focusing on the interplay between cellular environments and nucleic acid sensing, Dr. Xu and his team discovered a nutrient/contact stresses regulation of nucleic acid immune sensing, which is through Hippo-YAP signaling by the YAP/TAZ-mediated blockade of TBK1 kinase (*Nature Cell Biology*, 2017 April). They also unveiled a critical role of protein tyrosine phosphorylation and tyrosine kinase in regulation the feedback of nucleic acid immune sensing and identified a few small molecules in manipulating this innate immune sensing (*Cell Host & Microbe*, 2017 June). These exciting findings, for the first time, revealed the nutrient and contact-mediated environmental regulation and tyrosine phosphorylation-mediated modulation of nucleic acid immune sensing. It also provides evidence for the value of small molecules in prevention and cure of viral infectious diseases.

These innovative discoveries are considered as breakthroughs in the field of innate immune sensing, which shed light on the basic and clinical researches of viral infection and autoimmune disorders, and are also valuable for drug discovery in infectious and inflammatory diseases. Notably, these research achievements have also been highlighted in the prestigious journals including *Nature Cell Biology* and *Molecular Cell*, and selected as the Editor's Choice in *Science Signaling*, as well as reported by multiple news agencies in traditional or online media, such as *China Science Daily*, *Xinhuanet*, *iFeng*, and *ScienceNet*.

# The first domestic 60 GHz phase-locked loop chip with full intellectual property rights



Selected as The TOP 10 Academic Advances of The Year

Once upon a time, the chips had overtaken oil as the biggest import in our country. Especially the high performance chip, its design and manufacturing technology has been monopolized by foreign countries. Today, Zhejiang University has made the first domestically designed and manufactured 60 GHz phase-locked loop high-end chip.

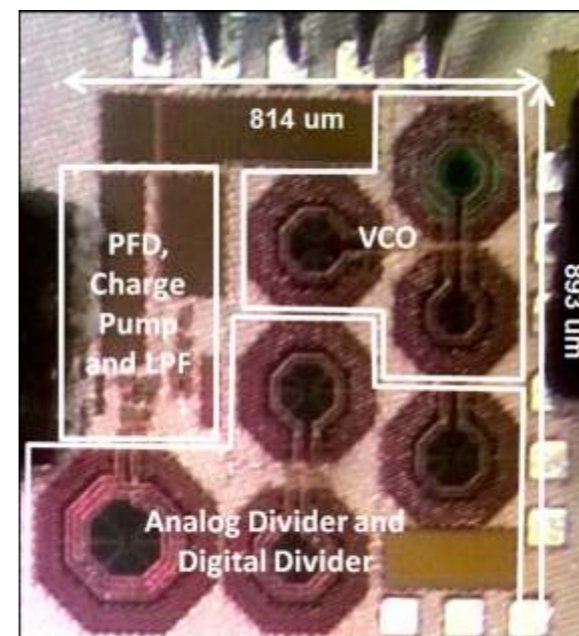
## Project Leader: Yan Han

Over the past half century, the whole human society has been transformed by the rapid development of wireless communication technology. However, the data transmission rate provided by bluetooth, indoor RF, WiFi and UWB protocol is less than 1Gbps, making the development of these technologies limited by the bottleneck inherent in them. Therefore, since the beginning of the 21st century, the wireless communication band of 60 GHz has been opened to the public free of charge, and the technology in related fields has become a hot topic of research. For example, in an unmanned adaptive cruise system, more than 60 GHz radar becomes the key component. In terms of military security communication, because 60 GHz has a high attenuation peak, there is a great attenuation outside the range or the range of direction, so it is not easy to be intercepted by the enemy.

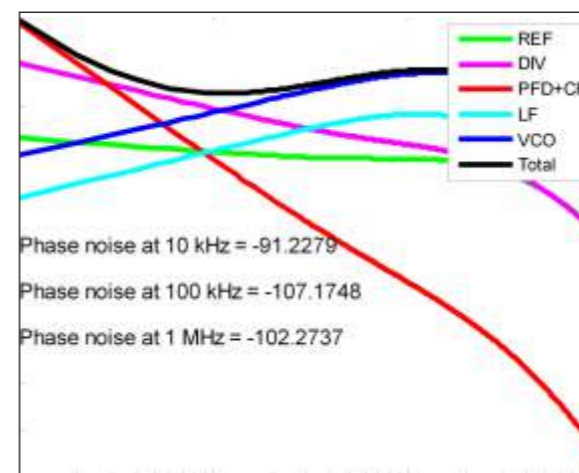
In the 60 GHz wireless communications, wireless transceiver is its hardware carrier, and phase lock



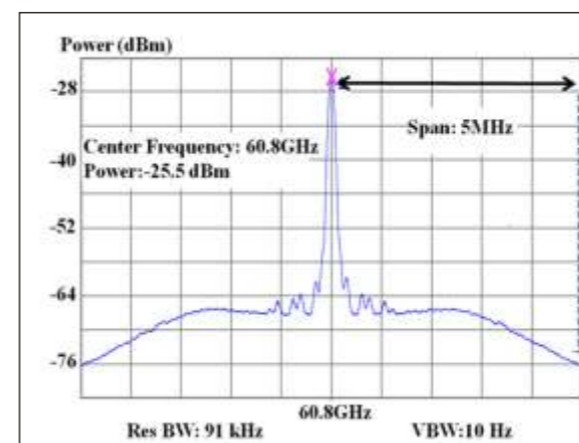
The team members were awarded the first prize in the national graduate student IC professional competition.



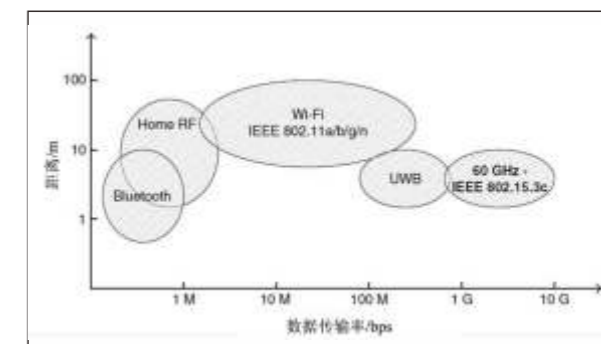
The 60 GHz PLL layout design in 40 nm CMOS technology.



Phase noise simulation curves of the 60 GHz PLL chip



Test curve of the 60 GHz phase-locked loop chip



The data transmission rate of each available communication frequency band

loop (PLL) is the key of the wireless transceiver module, its performance affects and decides the whole transceiver signal bandwidth and signal-to-noise ratio (SNR). This project based on the domestic design and manufacture, has realized a fully independent intellectual property rights of the localization of 60 GHz PLL high-end chip. Zhejiang University people break the curse of that the domestic high-end chip can only rely on the import. Zero breakthrough is achieved.

The difficulty of localization of high-end chips mainly lies in two aspects: one is design and the other is manufacturing. In terms of design, due to our weak foundation, there has been a large technical gap with advanced countries. RF chip technology in terms of manufacturing, the domestic foundries are lack of completed process library, named PDK, makes the designers looking abroad for manufacturing their chips. So that the domestic manufacturers are more lack of chance to accumulate their experience, enhance the level of technology, which in turn makes the designers more reluctant to rely on domestic process to do their high-end chip designs, into a vicious cycle.

This project not only overcome the difficulties of chip design, but also addressed the problem that the most advanced domestic IC manufacturers lack of 60 GHz PDK. Making SMIC company which originally has only 20 GHz model library, become China's first with the 60 GHz RF chip production manufacturing capacity. In the future, domestic RF chip design engineers will not need to find and rely on foreign process to complete their designs. And truly realize the dream of domestic integration of high-end chip design and manufacturing.

# Optical stabilization technology for Remote Sensing Satellite

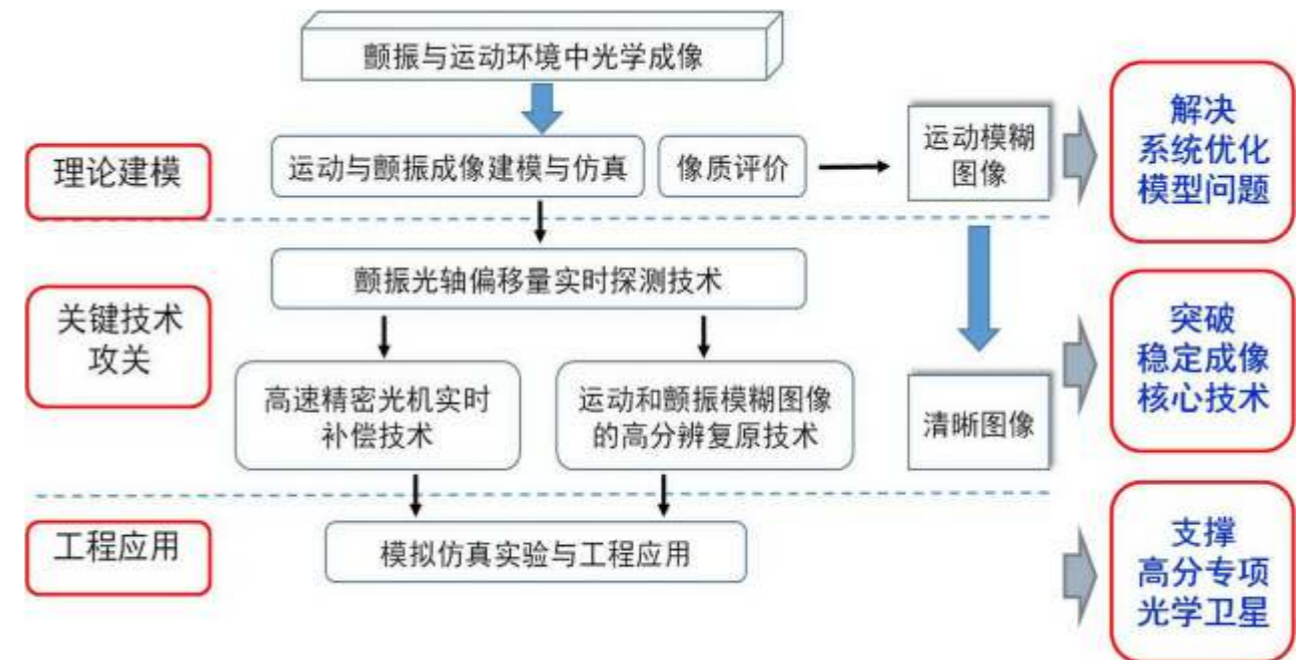


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The satellite motion and vibration is one of the main bottle-neck to obtain high quality images in optical remote sensing systems. After 12 years research on this area, Professor XU Zhihai's team have made a breakthrough, and helped China step onto the international advanced level in optical remote sensing.

## Project Leader: Zhihai Xu

The High Resolution Earth Observation System is one of the China most significant science & technology projects. It plays an important role in the development of national economy and national security. With the resolving power of optical satellites becoming higher and higher, the satellite motion and vibration appear to be one of the main bottle-neck to obtain high quality images in optical remote sensing systems. Professor XU Zhihai's team focused on the research to solve this problem. After 12 years continuously hard working, the team has made a breakthrough in 2017. Its main achievements have been successfully applied to some earth observation satellites, and helps China step on the international advanced level in the field of optical remote sensing.



The research team studied on the modeling and simulation of motion and vibration imaging, real time accurate detection of motion vector, real time image motion correction in space camera, and motion blur image reconstruction. The main achievements include:

1. The mathematical model of the remote sensing imaging quality deterioration influenced by the satellite motion and vibration was established. The research team developed a software which can analysis and simulate the image deterioration in detail. This software provided a useful tool for the satellite designer to evaluate the relationship between the various mechanical motions and the optical imaging quality, and helps to optimize the parameters between the satellite control and the on-board space camera.
2. A high precision motion and vibration detection method based on support vector machine was invented. It could precisely forecast the next time motion position by means of intelligent study system, solve the problem of detection time delay, and successfully acquire the motion data in the real-time.
3. A motion error correction strategy which is based on a closed cycle control on optical axis was invented. The research team developed a set of optical stabilization hardware and its controlling software for the space camera. It realized the high precision motion real-time compensation for high resolution optical imaging system by means of mechanical-optical control.

4. A series of algorithms for the reconstruction of motion blur images by use of the imaging forming theory and motion detection information was developed. The algorithms were specially designed for the images acquired by TDI (Time Delayed Integration) camera, which is the main optical imaging pattern in earth observation. Avoiding some defects of the image blind de-convolution, these algorithms greatly improved the quality and accuracy of the restored images.

Professor Xu's research team has acquired 25 intellectual property rights (15 patents'10 software copyrights') on optical stabilization technology, published 29 Sci. academic papers' which have been cited more than 200 times by the experts from France, USA, Belgium' on their publications on Optics Express, SIAM Journal on Imaging Sciences, etc.

The Key technologies of this research achievement have successfully applied by China Academy of Space Technology in some high-resolution earth observation optical satellites and lunar exploration vehicle CE-5T. It helped CE-5T successfully obtained the China highest resolving-power pictures of the Moon surface.

This research achievement is significant to improve the imaging ability and quality of china high-resolution optical satellites, and have great effectiveness on national economy and security.

# A novel mechanism of the host subversion by bacterial pathogens



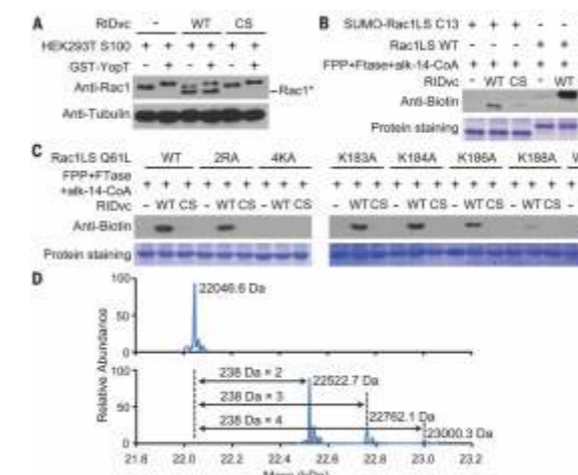
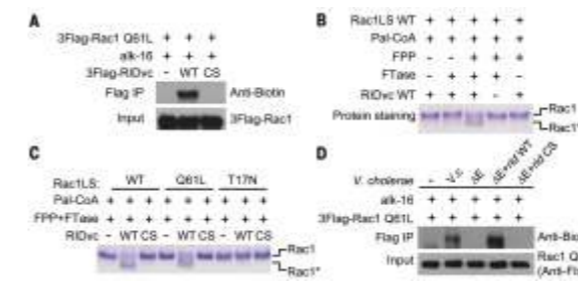
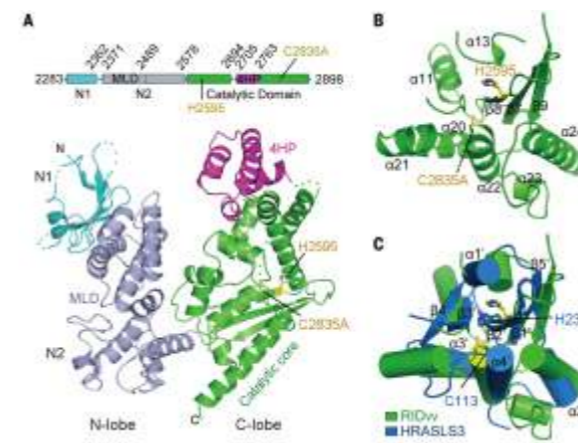
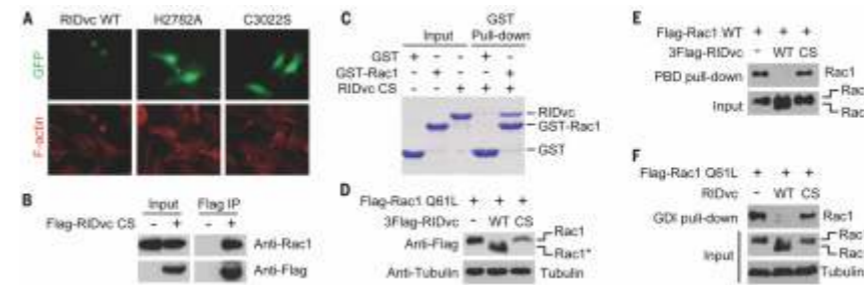
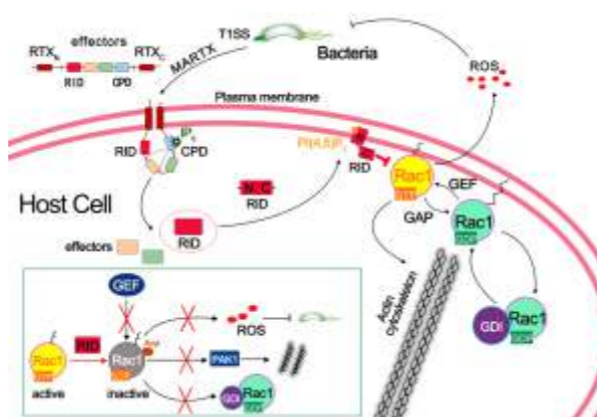
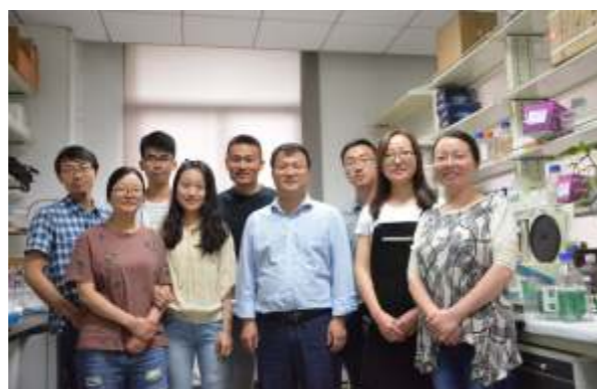
Selected as The TOP 10 Academic Advances of The Year

This study revealed a novel mechanism of the host Rho GTPase regulation by a bacterial effector protein. It identified an enzyme that represents a family of bacterial toxins able to catalyze lysine long-chain fatty acylation on mammalian proteins and found the key role of the polybasic region of Rho GTPases in cell signaling transduction.

Project Leader: Yongqun Zhu

MARTX toxins are critical virulence factors of many bacterial pathogens including *Vibrio cholerae* and *Vibrio vulnificus*. The secreted MARTX toxins insert into the host cell plasma membrane, where they can be autocatalytically cleaved by their conserved inositol hexakisphosphate-activating cysteine protease domain to release multiple effector domains into the cytosol of host cells. The Rho guanine triphosphatase (GTPase) inactivation domain (RID) was implicated in cell rounding by inducing a substantial decrease in the cellular levels of active GTP-bound Rho GTPases and disrupting the host actin cytoskeleton through an unknown mechanism.

Dr. Yongqun Zhu's lab found that *V. cholerae* RID specifically bound to Rac1, a Rho GTPase family member, and trapped Rac1 at the cell membrane. They found that the host Rac1 underwent a post-translational modification by RID in cells which caused a downward shift of Rac1 on SDS-PAGE gels. They determined the crystal structure of *V. vulnificus* RID. The crystal structure revealed a bipartite structure of



RID with a membrane-binding N lobe and a catalytic C lobe. The C-terminal catalytic domain shows high structural similarities to the human fatty acyltransferase HRASLS3. Consistently with the potential fatty acyltransferase activity, RID also bound palmitoyl coenzyme A. They performed in vitro- and in vivo- click chemistry and fatty acylation assays and further confirmed that RID is a long-chain fatty acyltransferase to modify Rac1 and that Rac1 prenylation is a prerequisite for this modification. The following mutagenesis and MS analysis revealed that RID catalyzes the Nε-fatty acylation of lysines in the C-terminal polybasic region of Rac1. Fatty acylation of Rac1 inhibited its activation by guanine nucleotide exchange factors and blocked Rho GTPase-mediated signaling in the host.

This study revealed a novel mechanism of the host Rho GTPase regulation by a bacterial effector protein. It identified an enzyme that represents a family of bacterial toxins able to catalyze lysine long-chain fatty acylation on mammalian proteins and found the key role of the polybasic region of Rho GTPases in cell signaling transduction. The structural insights into the RID Nε-fatty acylation mechanism may be useful for future drug design.

The study was published on October 27, 2017 in Science and also highlighted in the journal in the same issue. The Nature Chemical Biology journal published a letter entitled "Trapping Rac1" as Editors' Choice on January, 2018 and made high comments on this study.

# Dolphin Attacks --- Protecting the Security of Speech Recognition Systems against Microphone Hardware Vulnerabilities

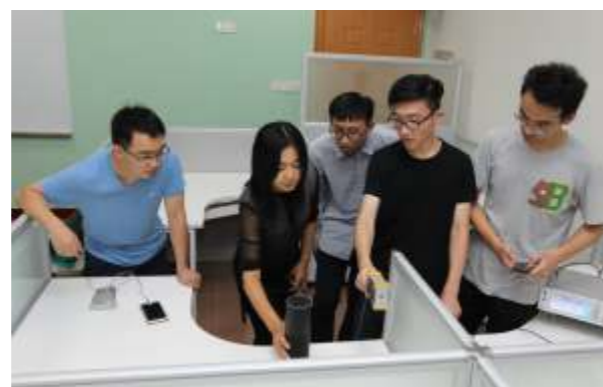


Selected as The TOP 10 Academic Advances of The Year

Microphones are widely used in smart devices. "Dolphin Attacks" utilize the hardware vulnerabilities of microphones to manipulate voice controllable systems with inaudible voice commands. Dolphin attacks provide a breakthrough in understanding the consequence of hardware vulnerabilities on the software and system level. The ability to defend against Dolphin Attacks can greatly improve the security of smart devices.

Project Leader:Wenyuan Xu

Speech recognition (SR) technologies allow machines or programs to identify spoken words and convert them into machine-readable formats. It has become an increasingly popular human-computer interaction mechanism because of its accessibility, efficiency, and recent advances in recognition accuracy. As a result, speech recognition systems have turned a wide variety of systems into voice controllable systems (VCS), e.g., Apple Siri and Google Now allow users to initiate phone calls by voices. Thus, it is important to understand the security of these systems: how speech recognition and the voice controllable systems behave under intentional and sneaky attacks.



The contribution of the work includes the following. (1) We design DolphinAttack that can inject covert voice commands into state-of-the-art speech recognition systems by exploiting inaudible sounds and the hardware vulnerabilities of audio circuits. The attacks can inject a sequence of inaudible voice commands and can lead to unnoticed security breaches to the voice controllable systems. (2) We suggest both hardware-based and software-based defense strategies to alleviate the attacks.

The underlying principles of Dolphin attacks are device non-linearity. For instance, amplifiers are known to have nonlinearity. By leveraging the nonlinearity of the microphone circuits, the modulated low-frequency audio commands can be successfully demodulated, recovered, and more importantly interpreted by the speech recognition systems. We validate DolphinAttack on popular speech recognition systems, including Siri, Google Now, Samsung S Voice, Huawei HiVoice, Cortana and Alexa. By injecting a sequence of inaudible voice commands, we show a few proof-of-concept attacks, which include activating Siri to initiate a FaceTime call on iPhone, activating Google Now to switch the phone to the airplane mode, to visit a malicious website, to send fake text messages and emails, and even manipulating the navigation system in an Audi automobile. We believe this list is by far not comprehensive. Nevertheless, it serves as a wake-up call to reconsider what functionality and levels of human interaction shall be supported in voice controllable systems. We propose hardware and software defense solutions to alleviate the attacks, and we provide suggestions to enhance the security of voice controllable systems. We validate that it is feasible to detect DolphinAttack by classifying the audios using supported vector machine (SVM), and suggest to re-design voice controllable systems to be resilient to inaudible voice command attacks.

Manuf.	Model	OS/Ver.	SR System	Attacks		Modulation Parameters			Max Dist. (cm)	
				Recog.	Activ.	$f_c$ (kHz) &  Prime $f_c$	Depth	Recog.	Activ.	
Apple	iPhone 4s	iOS 9.3.5	Siri	✓	✓	20-42 [27.9]	≥ 9%	175	110	
Apple	iPhone 5s	iOS 10.0.2	Siri	✓	✓	24.1 26.2 27 29.3 [24.3]	100%	7.5	10	
Apple	iPhone SE	iOS 10.3.1	Siri	✓	✓	22-28 33 [22.6]	≥ 47%	50	25	
Apple	iPhone SE	iOS 10.3.1	Chrome	✓	N/A	22-28 33 [22.6]	≥ 37%	16	N/A	
Apple	iPhone SE	iOS 10.3.2	Siri	✓	✓	21-29 31 33 [22.4]	≥ 43%	21	24	
Apple	iPhone 6s	iOS 10.2.1	Siri	✓	✓	26 [26]	100%	4	12	
Apple	iPhone 6 Plus	iOS 10.3.1	Siri	✗	✓	- [24]	-	-	2	
Apple	iPhone 7 Plus	iOS 10.3.1	Siri	✓	✓	21 24-29 [25.3]	≥ 30%	18	22	
Apple	watch	watchOS 3.1	Siri	✓	✓	20-37 [22.5]	≥ 3%	111	104	
Apple	iPad mini 4	iOS 10.2.1	Siri	✓	✓	22-48 [28.8]	≥ 25%	91.6	50.5	
Apple	MacBook	macOS Sierra	Siri	✓	N/A	29-32 24-25 17-37 39 [22.8]	≥ 76%	51	N/A	
LG	Nexus 5X	Android 7.1.1	Google Now	✓	✓	30.7 [30.7]	100%	9	31	
Asus	Nexus 7	Android 6.0.1	Google Now	✓	✓	24-39 [24.1]	≥ 5%	88	87	
Samsung	Galaxy S6-edges	Android 6.0.1	S Voice	✓	✓	20-38 [28.4]	≥ 17%	36.1	56.2	
Huawei	Honor 7	Android 6.0	HiVoice	✓	✓	29-37 [29.5]	≥ 17%	13	14	
Lenovo	ThinkPad T440p	Windows 10	Cortana	✓	✓	23.4-29 [23.6]	≥ 33%	50	8	
Amazon	Echo	5569	Alexa	✓	✓	20-21 23-31 33-34 [24]	≥ 10%	165	165	
Audi	Q5	N/A	N/A	✓	N/A	21-23 [22]	100%	10	N/A	

<sup>‡</sup> Prime  $f_c$  is the carrier wave frequency that exhibits highest baseband amplitude after demodulation. - No result  
<sup>†</sup> Another iPhone SE with identical technical spec.  
<sup>\*</sup> Experimented with the front/top microphones on devices.



# Development of the first batch of safe pigs for xenotransplantation



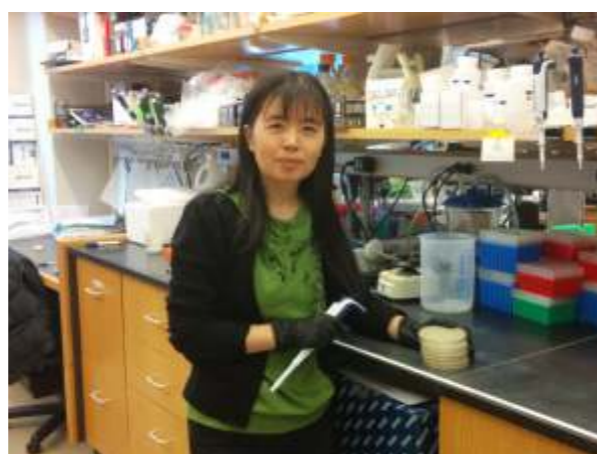
Selected as The TOP 10 Academic Advances of The Year

Pig is considered to be the best organ donor for human transplantation. Dr. Dong Niu and her collaborators developed the first batch of porcine endogenous retrovirus-inactivated pigs, which eliminates the safety concern of xenotransplantation and brings new hopes to this field.

## Project Leader: Dong Niu

Organ transplantation is a key medical treatment to replace a damaged organ, which can save or improve millions of lives worldwide. Porcine organs are considered to be the most promising resource since they are similar to human organs in size and function, and pigs can be bred in large numbers. While, the clinical use of porcine organs has been impeded by two barriers, immunological incompatibilities and the potential risk of porcine endogenous retroviruses (PERV) transmission to humans.

Dr. Dong Niu and her collaborators at eGenesis, Yunnan Agricultural University and Harvard University detected robust pig-to-human and human-to-human PERV transmission. Therefore, it is necessary to eradicate PERVs in



xenotransplantation. Niu et al. first identified the PERV copy number of Bama pig to be 25, and they inactivated all 25 copies of PERVs in Bama primary fibroblast cell line, then used this cell line to conduct somatic cell nuclear transfer to produce cloned pigs. So far, they have achieved 37 PERV-inactivated pigs and 15 of them are alive, and no PERV reinfection was detected in all the pigs. These pigs can serve as a foundation

pig strain for further engineering to provide safe and effective organs and tissues for xenotransplantation, bringing new hopes to the xenotransplantation field which has been stagnated for a dozen years.

This achievement was published on the most prestigious journal, *Science*, as the cover article on September 22, 2017. This is the first report of development of the safe organ-donor pigs for xenotransplantation. Dr. Niu is the leading author of this work. This work reinvigorated xenotransplantation, making it possible to use pig as the organ donor. This achievement was also reported by hundreds of famous foreign media, including *Time*, *BBC*, *New York Times*, *Forbes*, *Fortune*, *Newsweek*, *CBS Nes*, *CNN*, etc. and many domestic media including *People's Daily*, *Xinhua News*, *iFeng*, *The Intellectual* etc.

# Aluminum-Graphene Battery



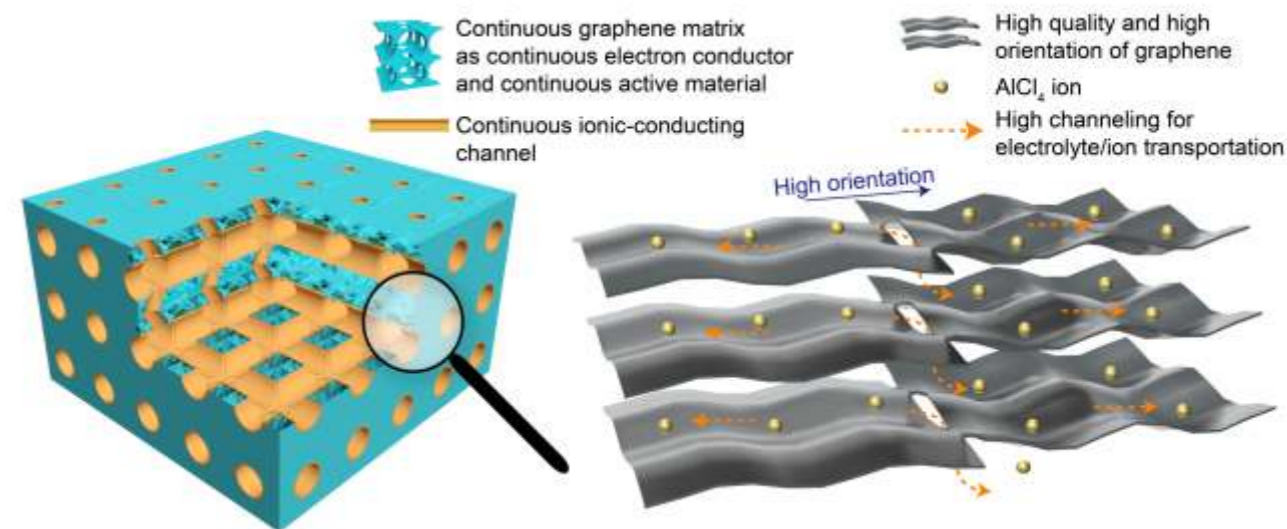
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Raise the concept of aluminum-graphene superbattery; Construct a macroscopically assembled high-performance graphene film cathode; Propose "trihigh tricontinuous" and "defect-free" design principles for cathode; Discover the dendrite phenomenon in aluminum metal anode and suppression mechanism. Build solid foundation for scientific research and practical application of aluminum-ion battery.

## Project Leader: Chao Gao

Renewable clean energy, such as solar energy and wind energy, greatly suffers from critical problems of instability and intermittency, which requires coordination with batteries to continuously offer energy supply. However, there are a lot of problems with existing battery systems. For example, lithium-ion batteries face challenges of scarcity of raw material resources, low-safety, insufficient ratecapability and also many other problems; Lead-acid batteries suffer from short cycle life, low energy density, high toxicity and serious environmental pollution. Therefore, it is in urgent need to develop a new energy storage system that constructs from abundant mineral resource, high performance electrode with high safety. Long cycle life aluminum-ion battery is a novel energy storage system based on aluminum metal anode. This battery possesses unique advantages of high anode capacity, abundant mineral resources, high safety and clean, which shows broad prospect. Nowadays the aluminum-ion battery faces challenges of insufficient electrochemical performance of cathode materials and unclear battery mechanism, leading to its overall performance inferior to traditional high-energy-density lithium-ion batteries and high-power-density supercapacitors. To solve these problems, Gao's group endeavours to find high performance cathode material and find out working mechanism of aluminum-ion battery. After five year's hard work, we successfully constructed a brand new macroscopically assembled graphene film cathode material, propose the design principle, develop the aluminum-graphene superbattery, which build solid foundation for scientific research and industrialized application of aluminum-ion battery.

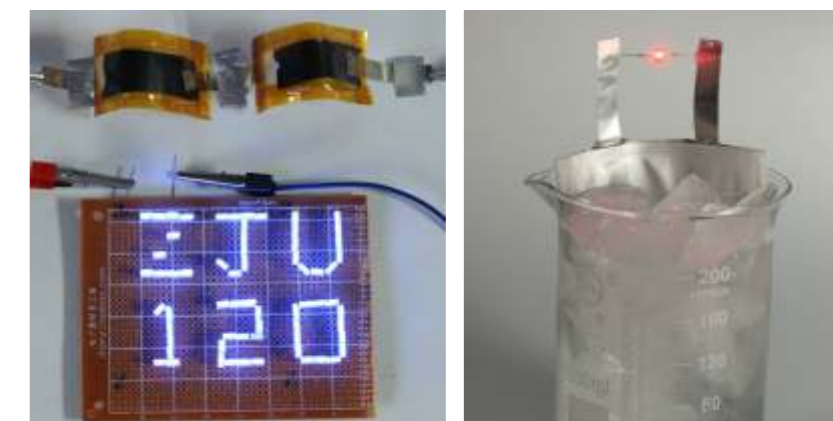
The main feature of this project lies in completely break-away from traditional lithium-ion battery system to build new aluminum battery system. Fabricated from aluminum metal anode, graphene cathode, ionic liquid



electrolyte and glass fiber separator, this new aluminum-graphene battery has six super advantages: 1) ultralong cycle life up to hundred thousands of cycles, which is 100-1000 times higher than traditional batteries; 2) ultrafast charge in seconds, which is 10-100 times faster than traditional batteries; 3) ultrawide operation temperature range from -40 to 120 centigrade degree for working in all-weather conditions; 4) ultrasafety without burning or explosion; 5) ultracheap owing to abundant and cheap aluminum sources; 6) ultrawide application area in energy storage application, power supply, electric devices and military equipments. In addition, this project has the following innovation points:

1) Propose the aluminum-graphene superbattery concept. The previously reported aluminum-ion battery is based on graphite cathode exhibiting insufficient performance. In this project, the cathode active material is totally composed of macroscopically assembled graphene film, which demonstrates a real sense of "graphene battery". Meanwhile the cycle life and rate capability of aluminum-graphene battery in this project are 1-3 orders of magnitude higher than traditional lithium-ion battery; and advantages of both batteries and supercapacitors are achieved simultaneously in this battery, which actually means superbattery.

2) Establish the "trihigh tricontinuous" design



principle of cathode material (trihigh means high quality, orientation, and channeling for local structures, tricontinuous means continuous electron-conducting matrix, ion-diffusion highway, and electroactive mass for the whole electrode) and "defect-free" design principle (the fewer the defects, the better the performance). These provide scientific guidance for cathode design.

3) Explore the aluminum metal anode dendrite phenomenon and suppression mechanism. The previous reports mistakenly declared absence of dendrite in anode that covered up the truth. Our findings uncovered the secret of long cycle life of aluminum-ion battery.

With the development of science and technologies, both power grid, energy supply systems of future cities and buildings, portable electronic devices and electric vehicles are in sharply increasing demand of advanced energy storage batteries. However, the commercial Li-ion battery is greatly restricted by low cathodic capacity and scarcity of lithium sources. Hence developing a new rechargeable battery with higher energy density and more raw material sources is an urgent challenge. The achievement of aluminum-graphene battery paves the way for its scientific research and practical application, which opens the door for developing new green energy storage systems with outstanding performances especially high energy/power densities, long cycle life and wide operation temperature range.

# History of winning remodels thalamo-PFC circuit to reinforce social dominance



Selected as The TOP 10 Academic Advances of The Year

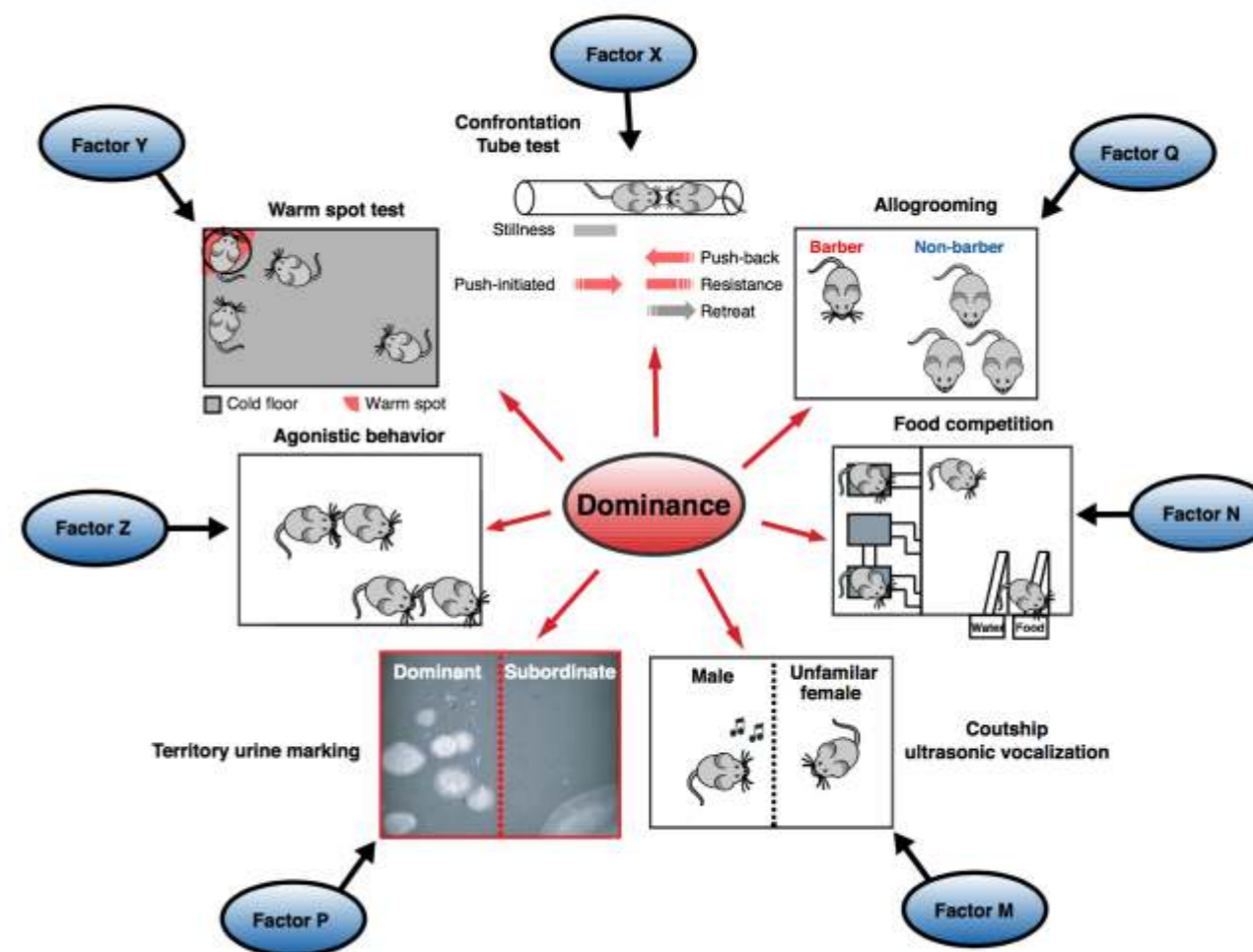
Professor Hailan Hu and her team for the first time decoded neural mechanism of the "winner effect" in the mammalian brain. They reported that repeated victory experiences selectively enhanced the synaptic connection of thalamo-PFC circuit which increase possibility of winning in the following competition.

Project Leader: Hailan Hu

Social hierarchy is a form of ranking system in many animal societies. For a group, a stable hierarchical structure can reduce unnecessary conflicts and energy waste, and promote social harmony. For individuals, social hierarchy plays an important role in the survival and reproduction. According to behavioral studies, dominance status of animals extensively affects their hormone levels as well as behaviors including fighting, mating and so on. However, the neural mechanism underlying social hierarchy remains unclear.



For the first time, Hailan Hu and her team from Zhejiang University established the tube test, a behavioral paradigm for measuring social dominance in rodents. This paradigm has the advantages of clear and quantifiable results, and has been well validated as a reliable measure of social hierarchy by its transitivity, stability over time, and consistency with results of other dominance measures. In 2011, the team first revealed the role of medial prefrontal cortex (mPFC) in social



behaviors. After comparing neurons activity of high- and low-rank mice, they found that social status is positively correlated with the neurons activity of mPFC. This series of results established the relationship between mPFC and social hierarchy (Wang et al., Science, 2011), which published in Science magazine in 2011 September. Science highlighted this work at the home page. The Discover Magazine and the French Le Monde newspaper also published special articles about this work.

In 2017, the team revealed for the first time brain circuit of the "winner effect" (Zhou et al., Science, 2017). The winner effect, that is, the previous winning experience increases the likelihood of the individual winning afterwards. It is important for social hierarchy formation. In the research paper of Science magazine, Hailan Hu and her team reported that repeated winning

experiences enhanced the synaptic connection of thalamo-PFC circuit which increase possibility of winning in the following competition. It is the first time to decode neural mechanism of the "winner effect" in the mammalian brain, and it is the second Science paper about social hierarchy in the team. This finding opens up new ideas and research methods for studying social competitive behavior and development of social hierarchy. It also provides a new target brain area for research on neuroeconomics and social ethology. At the same time, it provides an important theoretical basis for the reform of educational methods and lays out a theoretical framework for studying social behavior-related diseases.

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# THE OUTSTANDING ACHIEVEMENTS OF ZHEJIANG UNIVERSITY IN 2017

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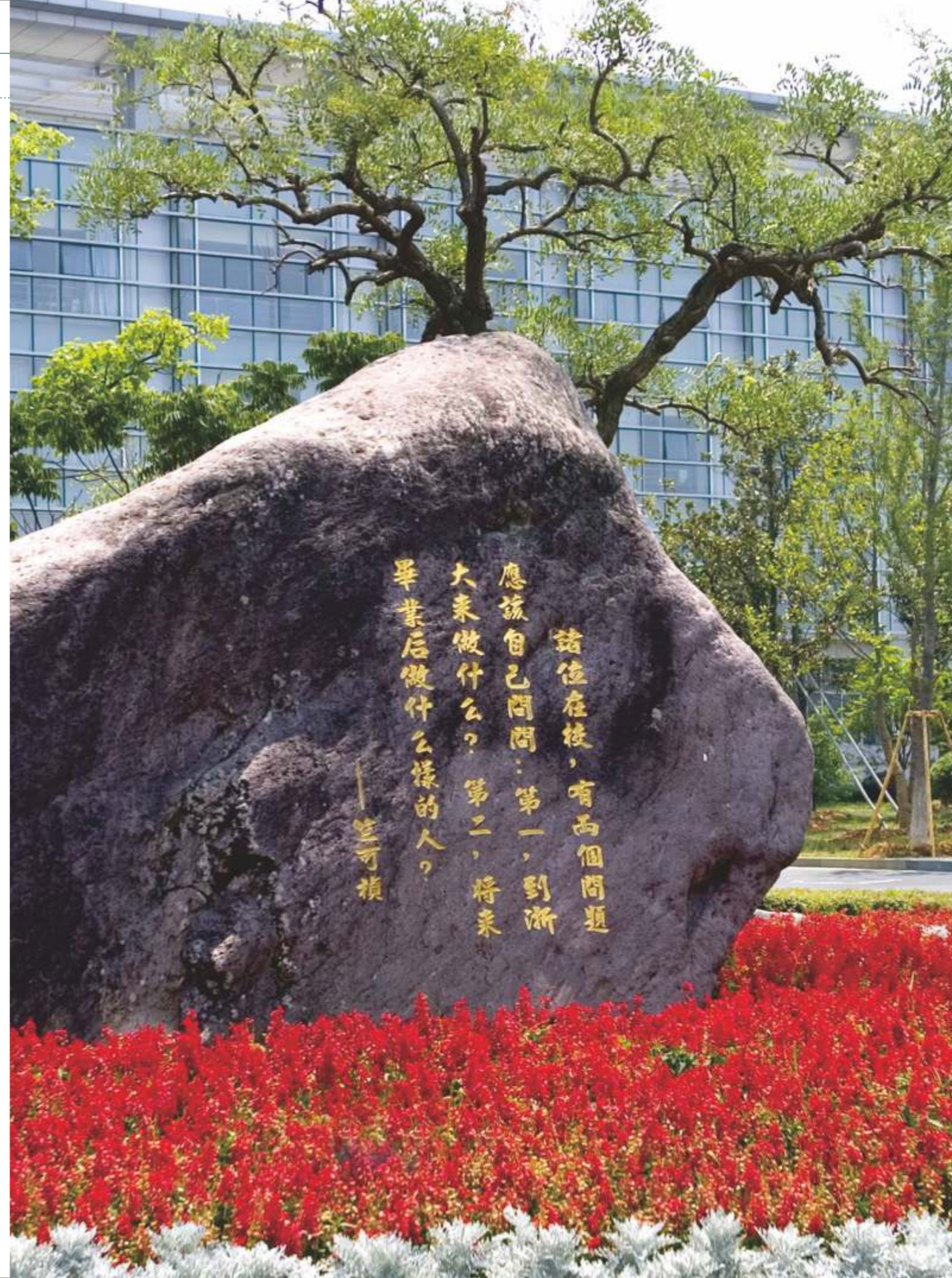
THE ACADEMIC COMMITTEE  
OF ZHEJIANG UNIVERSITY

and secretary general were selected and the *Statutes of the Academic Committee of Zhejiang University (Revised)* were approved. Further, the documents concerning the eligibility requirements of the members and the formation and major duties of the work committee of the Academic Committee were recognized.

Setting up the mechanism for publicizing academic issues: The website of the Academic Committee has been revised, and the *Academic Release* is broadcast once a week. With narration in popular science terms, images and videos, the academic progress at Zhejiang University is put on display, and the Science Cover of the ZJU homepage updated.

The *Detailed Rules for the Investigation and Treatment of Academic Misconduct at Zhejiang University (Trial)* [No.32 by ZJU (2017)] has been formally issued. Thirty-three rules in 7 chapters define the working mechanisms for treating academic misconduct, including categories, investigation, identification, treatment, reconsideration, and supervision.

The period ahead is crucial as it will provide opportunities for ZJU to become a truly world-class university with Chinese characteristics. ZJU can take the lead by cultivating talent morally and ethically. The university will continue its efforts towards first-class development, driven by a comprehensive deepening of reforms. ZJU is committed to opening up, cooperation with other institutions, and optimization of its inner organization.



諸位在校，有兩個問題  
應該自己問問：第一，到浙  
大來做什麼？第二，將來  
畢業後做什麼樣的人？  
——竺可楨

Achieving substantial results in admission and employment: ZJU has innovated multiple admission modes. It has enlarged the coverage of the application-review system for the admission of doctoral students and continued the reforms in the area of overall planning and admission of full-time and part-time postgraduates. In 2017, the ranking of the new students in their respective provinces and cities ticked up. In addition, employment of 2017 graduates ranked at the forefront among domestic universities.

Advancing innovation and education in entrepreneurship: In the cultivation program of undergraduate majors, the courses on innovation and entrepreneurship were new to compulsory general education. The program now has a work system for the full-chain promotion of curriculum teaching, training, competition, practical training, incubation and practice and has set up innovation and entrepreneurship practice platforms. The College of Innovation and Entrepreneurship was selected as a national model, and ZJU has been honored as one of the first *National Model Universities in Deepening the Reforms on Innovation and Entrepreneurship Education*. The university has incorporated the *Idea Bank Maker Space* into the national incubator management service system. In 2017, ZJU students performed well in domestic and international innovation competitions, winning 6 grand prizes and 45 first prizes in international competitions, 8 grand prizes and 17 first prizes in national competitions, including the Grand Champion of the 3<sup>rd</sup> China College Students' Internet+ Innovation and Entrepreneurship Competition and the Grand Champion of the China Youth Internet Entrepreneurship Contest.

### III Research Capacity

Research funds at ZJU exceeded 4 billion yuan, achieving sustained growth at a high level in 2017. ZJU received research funds totaling 4.017 billion yuan (an increase of 499 million yuan over 2016). Funding from the government was 2.916 billion yuan (72.59%) and funding from companies was 1.101 billion yuan (27.41%).

Steadily increasing the capacity of major research projects: ZJU obtained in 2017 18 new national key R & D projects, 11 national major special projects, 1 major project of national fund, and 19 key projects of national fund.

Steadily improving the layout of scientific research: ZJU has strong infrastructure for science and research, with 24 state-level research bases, including 10 national key laboratories, 4 national engineering technology research centers, 2 national engineering research centers, and 8 national (local collaboration) engineering laboratories. In addition, the university has 136 bases at ministerial or provincial levels, 13 research academies, and 39 research centers. 176 research institutes have been established exclusively by ZJU. The Zhejiang Lab has been operating smoothly. The Super-gravity Centrifugal Simulation and Experimental Device, a national key science and

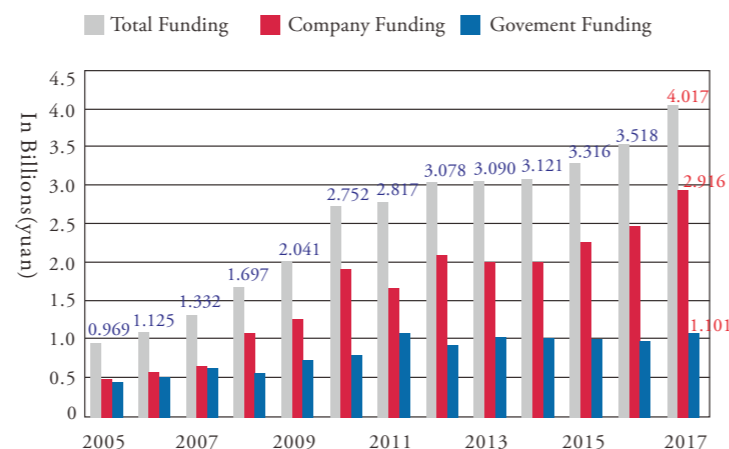
technology infrastructure project with a total investment of more than 2 billion yuan, has been approved by the National Development and Reform Commission. The 16+X research alliance and collaborative innovation centers are also being developed further.

### IV. Academic Impact

Publishing papers with international impact: According to the data released by the Institute of Scientific and Technical Information of China in October 2017, ZJU ranked first among domestic universities with 6,231 papers listed in the Science Citation Index (SCI), the number growing from 2016. 48,595 papers were cited 571,022 times in the time period from 2007 through 2016. 4,008 papers are listed among China's excellent scientific and technological papers, and 1,489 co-authored papers with ZJU staff as the first author are listed in SCI. The SCI statistics from January 15, 2018, list 208 papers with ZJU staff as the first author that have an impact factor above 10, 1 published in *Science*, 1 in *Cells*, 10 in PNAS, 25 in the series of *Nature*, and 6 in the series of *Cell*.

Historical breakthroughs in national science and technology awards: In 2017, ZJU won 4 National Science and Technology Awards in the first completion unit, and 3 first and 6 second National Science and Technology Awards as a participating unit. In addition, ZJU won 1 item in the *Top 10 Science and Technology Progress at Chinese Universities*, 8 first and 8 second *Excellent Achievement Awards in Scientific Research (Science and Technology) of Higher Schools* as the first completion unit and 13 first *Zhejiang Science and Technology Awards* as the first completion unit.

Figure 2 Research Funding of ZJU in Past Years



A system for transferring scientific and technological achievements: The Industrial Technology Research Institute of ZJU and the University National Science Park of Zhejiang Province have been collaborating to promote comprehensive science and technology services for the university national science parks. The Park was

appraised as an A-class national science and technology business incubator and as the only *National College Student Entrepreneurship Model Park* in Zhejiang Province. ZJU ranked first consecutively among domestic universities in the number of patents, a total of 1,979 patents for invention among 2,357 major patents granted, and 14 patents applied through the PCT. Furthermore, ZJU ranked high in the number of intellectual property transactions: 2,934 new technology contracts worth 1.4 billion yuan from companies were signed, among which there were 41 technology transfer contracts worth 31.48 million yuan.

### V. Development of Philosophy and Social Sciences

Exploring and constructing the ideological and cultural highlands and improving the systems and platforms for cultural heritage and innovation: The Development Alliance of Cultural Heritage Disciplines, the Art and Archaeology Library, the Chinese Academy of Translation and Translation Studies, and the Academy of Ma Yifu were established. *The Complete Collections of the Paintings Through the Ages* was listed in the *National Major Publishing Project*. The compilation and research of the *History of Zhejiang University* was initiated, and the Research Center of Zhejiang University History was set up for a systematic review and scientific summary of the history and evolution of ZJU. Special funds were allocated to philosophy and the social sciences, and efforts continued concerning *big data* + inter-disciplinary innovation teams in the humanities and social sciences.

ZJU finalized the methods for the recognition of think tank results and for the construction of high-end think tanks. It developed plans for the promotion of the Publicity Department of the Zhejiang Provincial CPC Committee, the College of Media, the International Culture School, and the School of Marxism.

In 2017, ZJU maintained its lead among domestic universities in research funds in liberal arts, worth a total of 265 million yuan. 540 papers were included in SSCI, an increase of 44% over 2016; 39 papers were included in A&HCI, ranking second. ZJU ranked first in the number of National Social Science Fund projects and in the number of achievements included in the *National Philosophy and Social Sciences Achievements Library*.

### VI. International Cooperation and Exchange

Catering to the *First-class Discipline Partnership Promotion Plan* and the *Top University Cooperation Plan*, ZJU is increasing its cooperation with top universities, e.g. Harvard University, Yale University, University of Chicago, Stanford University and Oxford University, in order to expand its global cooperation links.

The International Campus in Haining and the optimization of the personnel cultivation model: More and better exchange channels have been opened for students. 61.97% of ZJU undergraduates went for further study at home and abroad, among whom about 800 went to the

top 100 universities in the world, accounting for 56.82% of those studying abroad. Undergraduates went on exchange for 3,250 person-times, a year-on-year increase of 26.64%. Postgraduates went on exchange for 2,440 person-times, a year-on-year increase of 10.5%. Among those students going on exchange, 72.77% were doctoral students.

Table 2 List of Research Institutes and Achievements

National Key Laboratories	10
National (Local Collaboration) Engineering Laboratories / Research Centers	9
National Engineering (Technological) Research Centers	6
Key Humanities and Social Sciences Research Bases of Higher Schools	3
Total Research Funds (2017)	4.017 billion yuan
National Natural Science Fund (2017)	0.57 billion yuan
2017 National Awards for Science and Technology (The first completion unit)	4
Papers included in SCI (2017)	6327
Patents for Invention (2017)	1979

Constructing a global management team: The first group of staff members for global communication and exchange have been trained. *The Plan for Upgrading Overseas Work Organizations* has been drafted, and internet publicity, reputation assessment and ability for international relations, and high-level portals in foreign languages have been strengthened. Further, the liaison and cooperation with overseas media, liaison agencies, and universities are being explored. Moreover, a series of academic exchange activities with Stanford University, University of Chicago, Yale University and other world-famous universities are occurring. The research achievements of 7 faculties were reported in *Nature* in 8 periodicals.

Supported by the projects *Lectures of Overseas Masters*, *The Tour of Nobel Prize Winners on Chinese Campuses*, *Special Funds for Academic Masters*, and *Lectures of Distinguished Zhu Kezhen Scholars*, ZJU has invited 57 prestigious overseas experts to give public lectures, including 15 Nobel Prize Winners.

### VII. Academic System

Reelecting the members of Academic Committee and organizing a new Academic Committee: In April of 2017, the reelection and first plenary session of the Academic Committee of Zhejiang University was held. Jin Deshui, Secretary of the CPC Committee, and Wu Zhaohui, President of ZJU, granted letters of appointment to the members of the new Academic Committee. In addition, the director, deputy director

# Academic Achievements of Zhejiang University in 2017



2017 witnessed strong momentum at Zhejiang University (ZJU), as ZJU deepened its *Six Strategies for Comprehensive Strength* and strategic thinking. ZJU is building a world-class university with Chinese characteristics in the new era. This effort is continuing by advocating the overall objectives and fundamental tasks outlined in the *Double First-Class Plan* (first-class disciplines and universities in the world) and the *Thirteenth Five-year Plan for Economic and Social Development*.

## I. Discipline Progress

There has been progress with talent teams. These teams are being optimized in terms of various plans: *Convergence Plan of Academic Masters, Hundred-Talents Program, Thousand Postdoctoral Program, and Interim Measures for the Employment of Foreign Teachers to Zhejiang University*.

As of Dec. 2017, ZJU had 8,657 teaching and administrative staff members (3,611 full-time teachers). ZJU ranks at the forefront among domestic universities, with 21 academicians of the Chinese Academy of Sciences, 20 academicians of the Chinese Academy of Engineering, 9 Distinguished Professors of Humanities and Social Sciences, 237 State 1000-elite Program (Young) Experts, 101 (young) professors of the *Cheung Kong Scholar's Program*, 129 recipients of the *State Science Fund for Distinguished Young Scholars*, 109 recipients of the *State Science Fund for Excellent Young Scholars*, 63 leading talents of the *Ten Thousand*

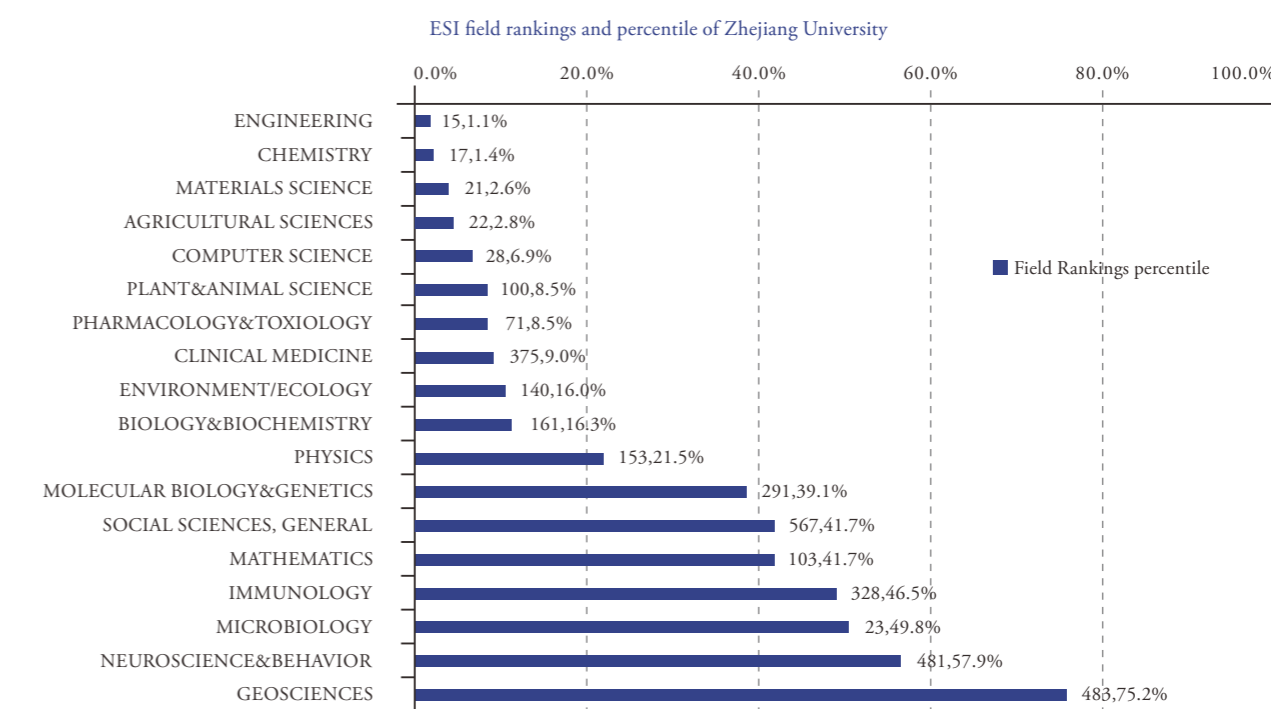
**Table 1 A List of High-level Talents and Teams atof ZJU**

High-level Talents and Teams	Numbers / Team Numbers
Academicians of Chinese Academy of Sciences	21
Academicians of Chinese Academy of Engineering	20
Distinguished Professor of Humanities and Social Sciences	9
State 1000-Elite Program (Young) Experts	237
Cheung Kong Scholar's Program (Young) Professors	101
State Science Fund for Distinguished Young Scholars	129
State Science Fund for Excellent Young Scholars	109
Leading Talents of the Ten Thousand Talent Program and Top-notch Young Talents	63
Distinguished Experts of Zhejiang Province	43
Qjushi Distinguished Experts (including leading talents of humanities and social sciences)	253
Research Teams of State Natural Science Fund Innovation, Innovation Teams of the MOE, Innovation Teams of Key Areas of Talent Promotion Plans of Ministry of Science and Technology	40

*Talents Program and Top-notch Young Talents as well as 43 Distinguished Experts of Zhejiang Province.*

A new level in the strength of disciplines has been reached. According to ESI field rankings, ZJU now ranks second among domestic universities, with 18 disciplines in the top 1% of the world's academic institutions, 7 in the world's top 100 of ESI. In addition, ZJU now ranks first in 8 disciplines in the top 1%, and 5 in the top 50 of ESI. In the fourth round of the national assessment of disciplines at domestic universities, 11 first-class disciplines at ZJU were rated A+, ranking third; 39 first-level disciplines were rated A, ranking first. In addition, the excellent rating of first-class disciplines climbed to 63.93%, ranking second.

**Figure 1 ESI field rankings and percentile of Zhejiang University**



## II. Talent Cultivation

Upgrading undergraduate education to new heights: A plan for the cultivation of undergraduate education has been geared towards improving students' learning outcomes, and a talent training system called KAQP (knowledge imparting, ability training, quality enhancement, and personality shaping) has been initiated. Course construction has been steadily promoted, teaching quality strictly controlled, new teaching modes innovated, information technology promoted, and education and teaching integrated. Further, the *Measures for Managing the Credits of Second, Third and Fourth Classrooms of Zhejiang University Undergraduate (Trial)* and other documents for the organic integration of the four classrooms have been issued. 57 English-language courses in 25 schools and departments guided by overseas teachers now exist.

Deepening postgraduate cultivation reforms: ZJU has been highlighting collaboration between research and teaching as well as international cooperation. It has formulated a new round of postgraduate training and initiated ability-based curricula. The Polytechnic Institute of Zhejiang University has been established for better postgraduate degree education in engineering majors. ZJU has also initiated the collaboration cultivation model between ZJU and enterprises, with international education programs with leading engineering colleges in Europe and America. The reforms on professional degrees and multidisciplinary studies are pressing ahead. Further, the university has set up the committee for professional degree assessment at the Polytechnic Institute and the committee for degree assessment of the "Medicine + X" Multidisciplinary Talent Development Center of Excellence have been set up.

# ZHEJIANG UNIVERSITY ACADEMIC ANNUAL REPORT 2017

The Academic Annual Report 2017,  
Zhejiang University

**Sponsor:**  
The Academic Committee of Zhejiang University

**Co-Sponsor:**  
Zhejiang University Young Professor Association

**Chief Editor:** Z. Zhang

**Editor:** HR. Li MJ.Zhu

**Acknowledgements:**  
The Sci-Tech Academy of Zhejiang University  
The Social Sciences Academy of Zhejiang University

**Designer:**  
Zhao Jianghui design office



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2016

# ZHEJIANG UNIVERSITY ACADEMIC ANNUAL REPORT

## PREFACE

Located in the historical and picturesque city of Hangzhou, Zhejiang University is a prestigious institution of higher education with a long history. In its 120-year history, Zhejiang University has always been committed to cultivating talent with excellence, advancing science and technology, serving for social development, and promoting culture, with the spirit best manifested in the university motto "Seeking the Truth and Pioneering New Trails". Zhejiang University is a comprehensive, research-oriented and innovative university with distinctive features and a national as well as international impact. Research at Zhejiang University spans 12 academic disciplines, covering science, engineering, agriculture, medicine, management, philosophy, economics, law, education, literature, history, art, and etc. With 7 faculties and 36 colleges/schools/departments, 1 polytechnic institute, 2 sino-foreign cooperation institutions and 7 affiliated hospitals. With seven campuses, namely Zijingang, Yuquan, Xixi, Huajiachi, Zhijiang, Zhoushan and Haining campus, Zhejiang University encompasses an area of 5,739,978 square meters with school buildings covering 2,575,983 square meters of floor space. The university library holds a collection of more than 7.084 million volumes. As of the end 2017, there are a total of 53,673 full-time students enrolled at Zhejiang University, including approximately 18,048 graduate students, 10,747 Ph.D candidates, and 24,878 undergraduates. In addition, there are about 6,843 international students (including non-degree students and 4,116 degree students) currently attending Zhejiang University.

Academic studies are the soul, source and foundation of a university. Therefore, academic construction is of utmost importance, constituting its wisdom, progress and reputation. Zhejiang University, adhering to the academic construction at the core, has advanced and progressed a lot in disciplinary development, talent team, scientific research, talent cultivation, academic exchanges and cooperation, and academic systems.

Embodying the creation, inheritance and accumulation of knowledge, the university aims to increase the understanding and exploration of the objective world and its reality, to nurture an atmosphere of seeking truth, impartiality, democracy and tolerance on the campus and to cultivate the culture of respecting, following, understanding and approaching academic studies, all of which serve as the ultimate source of the endless pursuit of students and faculty towards academic studies.

The compilation of the *Academic Annual Report* is targeted at arousing the attention and interest of students, teachers, researchers and the public towards the academic development of Zhejiang University, creating a strong academic atmosphere and enhancing academic exchanges.

By summing up the academic construction of Zhejiang University in 2017, the *Academic Annual Report* introduces the excellent academic achievements voted by the members of Academic Committee of Zhejiang University, expertise of young scholar and science communication media, as well as lists the main research achievements of Zhejiang University. The *Academic Annual Report* serves as a compilation of the academic contributions of Zhejiang University members for the past year and serves as a record of Zhejiang University's march forward as a first-class university.

It is evident in this report that, by cherishing the philosophy of "seeking truth," innovation and exploration, Zhejiang University members will be better able to conduct academic studies and better serve the nation and the society with their professional knowledge, innovative mind, deliberation and discrimination.

Gratitude is extended to all who have supported and encouraged the compilation and publication of this year's *Academic Annual Report*.

Academic Committee, Zhejiang University