智 能 高 维 信 号 处 理

王正 副教授 博导

2025.8

汇报提纲

CONTENTS

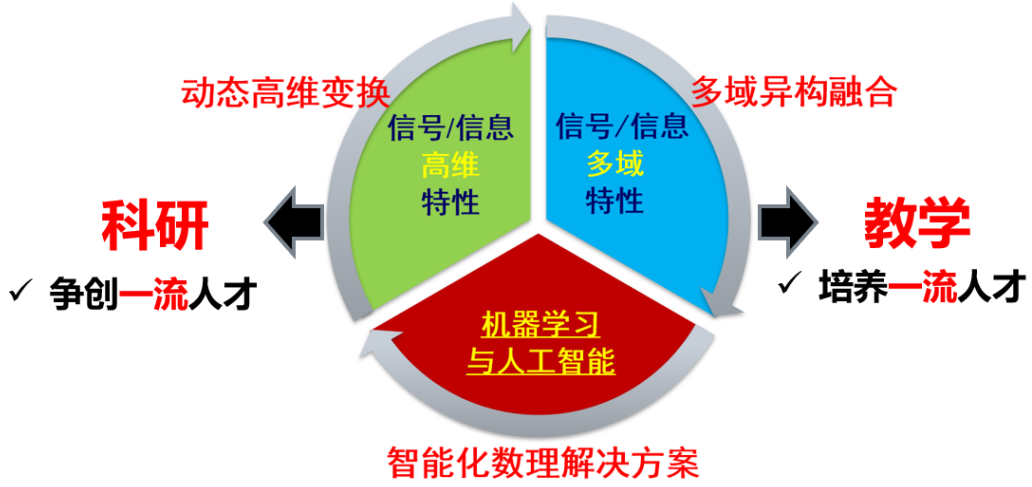
个人简介

https://radio.seu.edu.cn/2023/1025/c19941a469691/page.htm
https://seu-zheng-wang.github.io/ （Github国内网络不稳定，建议电脑端网页刷新打开）

王正

副教授，博士生导师，IEEE高级会员，江苏省双创博士
爱思唯尔中国高被引学者
2021年加入东南大学信息科学与工程学院，移动通信全国重点实验室

- 研究方向：**智能无线通信系统信号传输与检测**
  机器学习与数理统计
  数据深度分析与挖掘



科研
✓ 争创一流人才

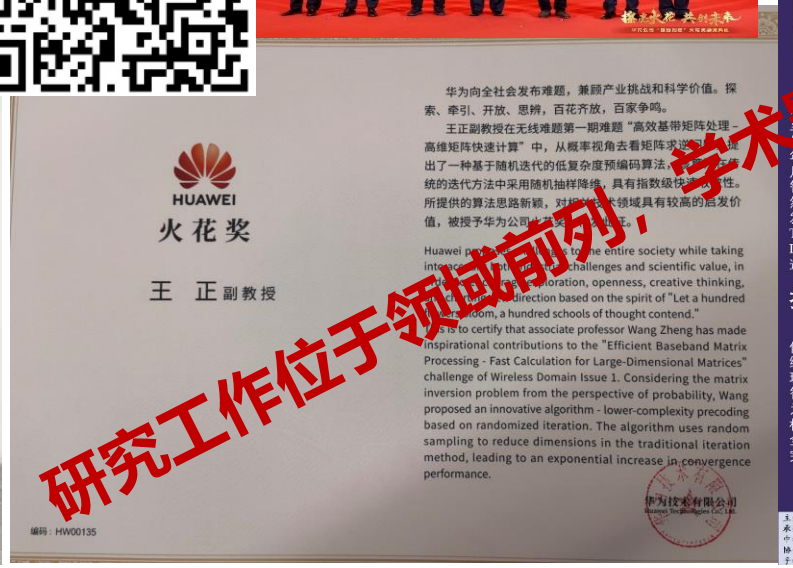
教学
✓ 培养一流人才

研究导向：**理论算法研究+项目**

研究成果：**顶尖学术论文+专利**

- 研究特色：**交叉领域，多学科融合，基础性，普适性**

学术影响力



研究工作位于领域前列，学术影响力持续提升

论文工作 (部分一作&通信作者Trans论文)

1. **Z. Wang*** and C. Ling, "Lattice Gaussian sampling by Markov chain Monte Carlo: Bounded distance decoding and trapdoor sampling, " ***IEEE Transactions on Information Theory***, vol. 65, no.6, pp. 3630-3645, June, 2019.
2. **Z. Wang*** and C. Ling, "On the geometric ergodicity of Metropolis-Hastings algorithms for lattice Gaussian sampling," ***IEEE Transactions on Information Theory***, vol. 64, no. 2, pp. 738-751, Feb, 2018.
3. **Z. Wang***, Y. Huang and S. Lyu, "Lattice-Reduction-Aided Gibbs Algorithm for Lattice Gaussian Sampling: Convergence Enhancement and Decoding Optimization," ***IEEE Transactions on Signal Processing***, vol. 67, no. 16, pp. 4342-4356, Aug, 2019.
4. **Z. Wang***, R. M. Gower, C. Zhang, S. Lyu, Y. Xia and Y. Huang, "A Statistical Linear Precoding Scheme Based On Random Iterative Method For Massive MIMO Systems," ***IEEE Transactions on Wireless Communications***, vol. 21, no. 12, pp. 10115-10129, Dec. 2022.
5. **Z. Wang***, S. Lyu, L. Liu and Y. Xia, "Learning-Aided Markov Chain Monte Carlo Scheme for Spectrum Sensing in Cognitive Radio," ***IEEE Transactions on Vehicular Technology***, vol. 71, no.10, pp. 11301-11305, Oct. 2022.
6. **Z. Wang***, R. M. Gower, Y. Xia, L. He and Y. Huang, "Randomized Iterative Methods for Low-Complexity Large-Scale MIMO Detection," ***IEEE Transactions on Signal Processing***, vol. 70, pp. 2934-2949, 2022.
7. **Z. Wang***, "Markov chain Monte Carlo Methods for Lattice Gaussian Sampling: Convergence Analysis and Enhancement," ***IEEE Transactions on Communications***, vol. 67, no. 16, pp. 67116724, Oct, 2019.
8. **Z. Wang***, L. Liu and C. Ling, "Sliced Lattice Gaussian Sampling: Convergence Enhancement and Decoding Optimization," ***IEEE Transactions on Communications***, vol. 69, no. 4, pp. 2599-2612, April 2021.
9. **Z. Wang***, S. Lyu, Y. Xia and Q. Wu, "Expectation Propagation-based Sampling Decoding: Enhancement and Optimization," ***IEEE Transactions on Signal Processing***, vol. 69, pp. 195-209, 2021.
10. **Z. Wang***, Y. Xia, J. Li and Q. Wu, "A New Method of Integer Parameter Estimation in Linear Models with Applications to GNSS High Precision Positioning," ***IEEE Transactions on Signal Processing***, vol. 69, pp. 4567-4579, 2021.
11. **Z. Wang***, S. Liu and C. Ling, "Decoding by sampling part II: Derandomization and soft-output decoding," ***IEEE Transactions on Communications***, vol. 61, no. 11, pp. 4630-4639, Nov, 2013.
12. **Z. Wang***, W. Xu, Y. Xia, Q. Shi and Y. Huang, "A New Randomized Iterative Detection Algorithm For Uplink Large-scale MIMO Systems," ***IEEE Transactions on Communications***, vol. 71, no. 9, pp. 5093-5107, Sept, 2023.
13. **Z. Wang***, J. Wang, Z. Gao, Y. Huang, D. W. K. Ng and L. Hanzo*, "Rapidly Converging Low-Complexity Iterative Transmit Precoders for Massive MIMO Downlink," ***IEEE Transactions on Communications***, vol. 71, no. 12, pp. 7228-7243, Dec. 2023.
14. **Z. Wang***, C. Ling, S. Jin, Y. Huang and F. Gao, "Probabilistic Searching For MIMO Detection Based On Lattice Gaussian Distribution," ***IEEE Transactions on Communications***, vol. 72, no. 1, pp. 85-100, Jan. 2024.
15. **Z. Wang***, Y. Xia, C. Ling and Y. Huang, "Randomized Iterative Sampling Decoding Algorithm For Large-Scale MIMO Detection," ***IEEE Transactions on Signal Processing***, vol. 72, pp. 580-593, 2024.
16. **Z. Wang***, L. Liang, S. Lyu, Y. Xia, Y. Huang* and D. W. K. Ng, "Efficient Statistical Linear Precoding for Downlink Massive MIMO Systems," ***IEEE Transactions on Wireless Communications***, Early Access, July. 2024.
17. **Z. Wang***, C. Pan, Y. Huang, S. Jin and G. Caire, "Randomized Iterative Algorithms for Distributed Massive MIMO Detection," ***IEEE Transactions on Signal Processing***, vol. 73, pp. 2304-

高度与质量是工作前提，特色与原创是工作希望

项目工作

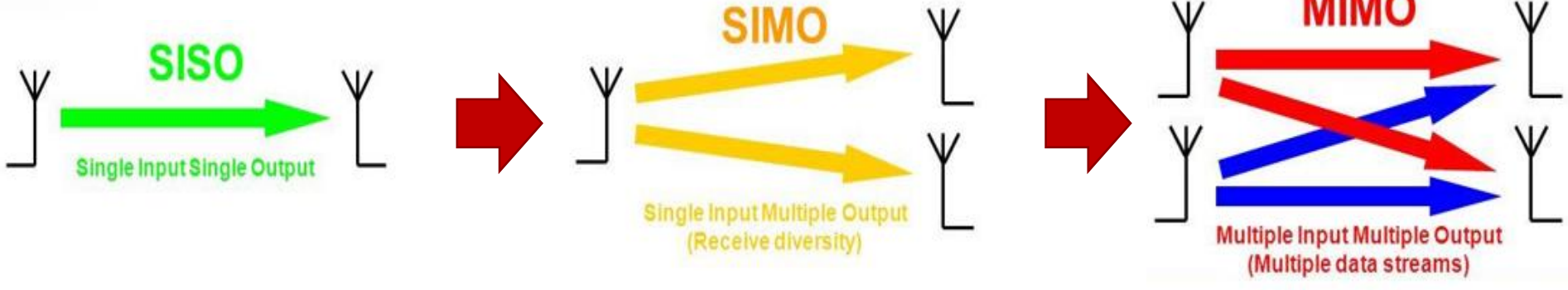
- 国家自然科学基金重点项目子课题(National Natural Science Foundation of China, 主持)
- 国家自然科学基金面上项目(National Natural Science Foundation of China, 主持)
- 国家青年自然科学基金(National Natural Science Foundation of China, 主持)
- 江苏省青年自然科学基金(National Natural Science Foundation of Jiangsu Province, 主持)
- 江苏省双创博士(Jiangsu Province, China, 主持)
- 东南大学无线通信国家重点实验室开放课题基金(主持)
- 电磁频谱工信部重点实验室开放课题基金(主持)
- 西电综合业务网理论及关键技术国家重点实验室开放课题基金(主持)
- 电子信息系统复杂电磁环境效应国家重点实验室课题项目A(主持)
- 电子信息系统复杂电磁环境效应国家重点实验室课题项目B(主持)
- 中国航天科工集团八五一一研究所项目(CASIC, 主持)
- 中国电子科技集团三十六所项目A(CECT, 主持)
- 中国电子科技集团三十六所项目B(CECT, 主持)
- 华为技术有限公司火花奖项目(Huawei, 主持)
- 华为技术有限公司技术研究项目(Huawei, 主持)
- 中兴通讯联合实验室重点项目A(ZTE, 主持)
- 中兴通讯联合实验室重点项目B(ZTE, 主持)
- 展讯通信企业研究项目(Spreadtrum Communications, 主持)

项目服务于研究，在明确研究价值的同时反哺研究工作

汇报提纲

CONTENTS

MIMO

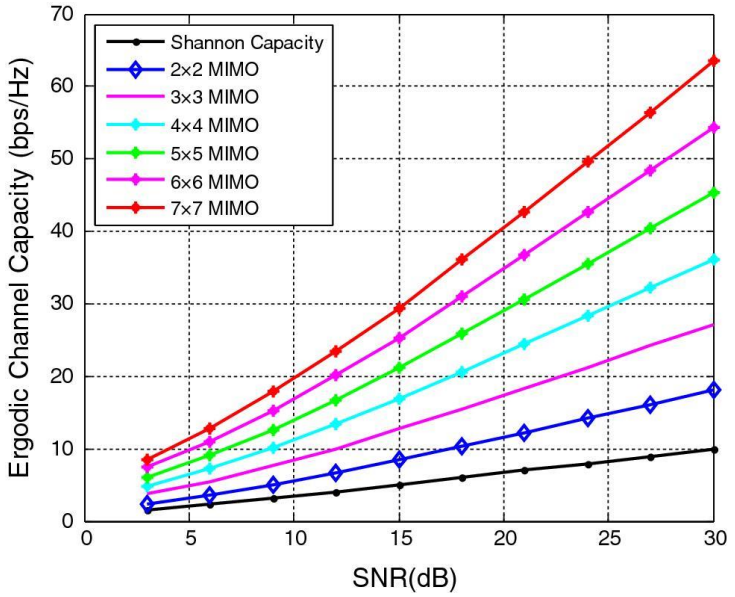


$$C_{\text{sum}} \Leftrightarrow \sum_{\text{Cells}} \sum_{\text{Channels}} B_i \log_2\left(1+\frac{P_i}{I_i+N_i}\right)$$

增加覆盖　增加信道　增加带宽　增加SINR

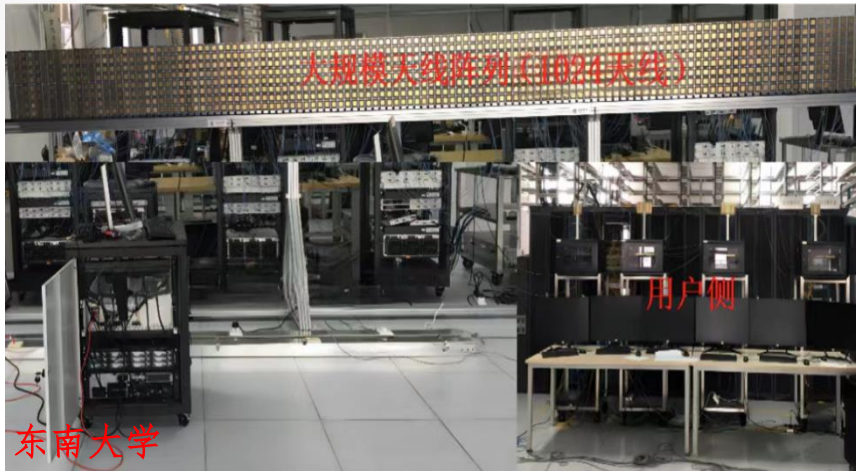
覆盖增强技术	频效提升技术	频谱拓展技术	能效提升技术
超密异构组网 D2D、M2M	大规模MIMO、 FBMC、空间调制	认知无线电、 毫米波、可见光	绿色通信 干扰管理

多址技术、用户调度、资源分配、用户/网络协作

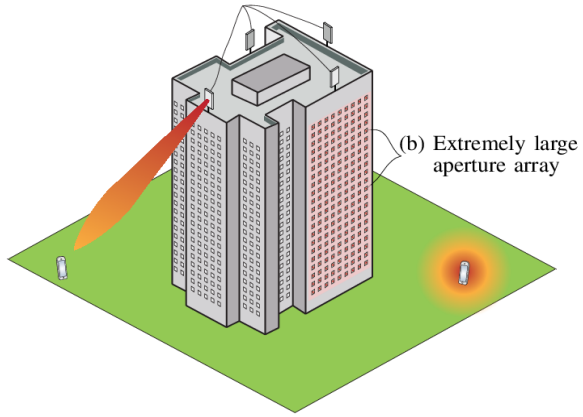


MIMO系统信道容量随着基站天线数或用户侧天线数二者中的最小数而呈现线性增长

MIMO发展趋势

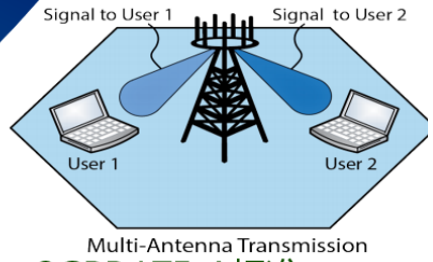


-6G 超大规模MIMO:
上千根天线

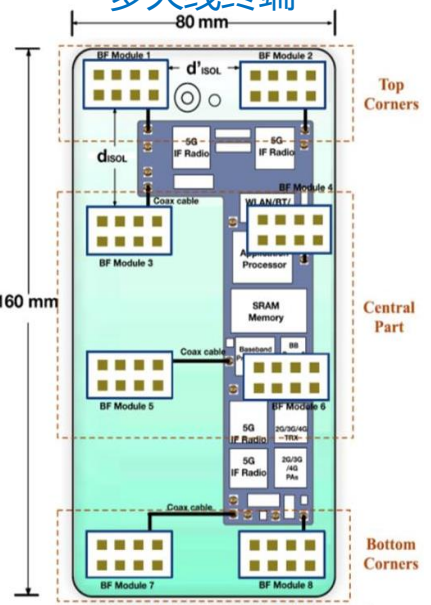


-5G

-大规模天线：基站使用大规模天线阵列（几十甚至上百根天线）



多天线终端



-4G：3GPP LTE标准

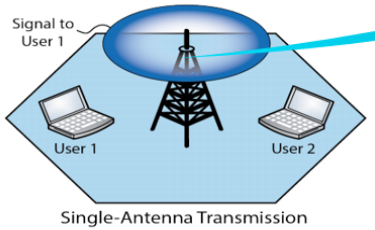
-支持SISO，2×2MIMO，4×4MIMO。下行峰值速率100Mb/s。

-4G：3GPP LTE-A标准

-最多支持8×8MIMO，下行峰值速率1Gb/s

-3G：WCDMA HSPA标准

-只能使用SISO，下行峰值速率7.2Mb/s

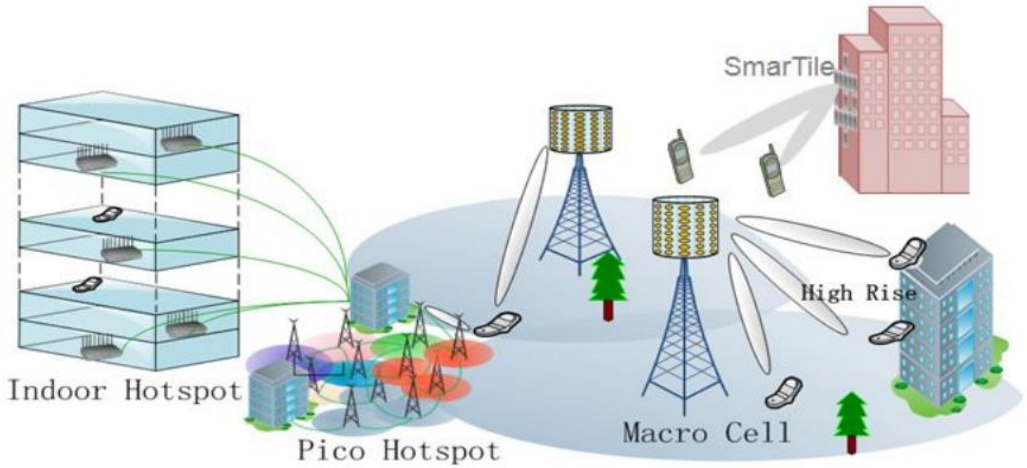


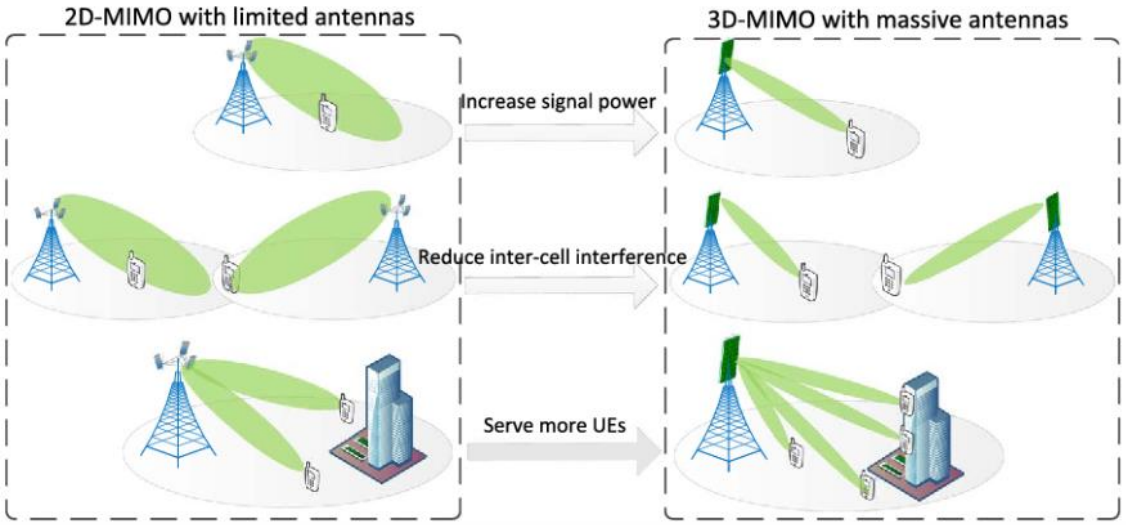
-3G：WCDMA HSPA+标准

-支持2×2MIMO，下行峰值速率42Mb/s

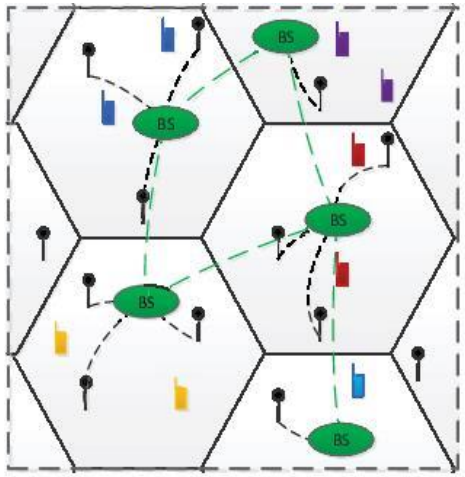
MIMO系统作为一种基础性的通信核心技术，将会一直延续下去，4G,5G,6G,7G……

MIMO演进历程

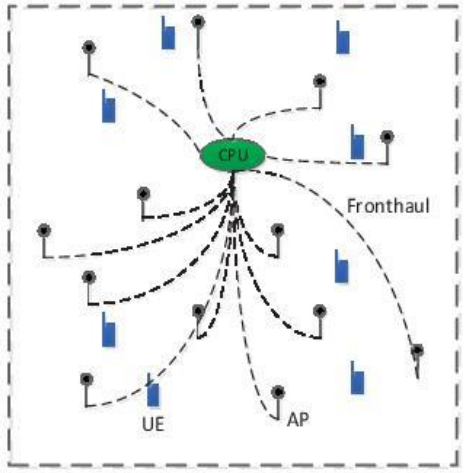




Distributed Antenna　　Centralized Antenna

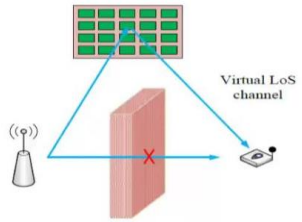


(a) Network MIMO

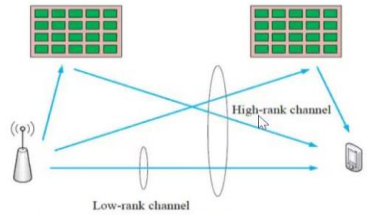


(b) CF massive MIMO

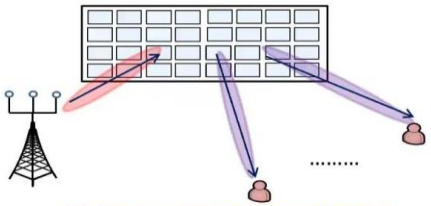
IRS Applications for Wireless Communications



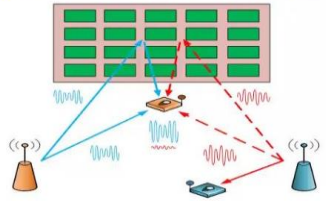
(a) Bypass obstruction



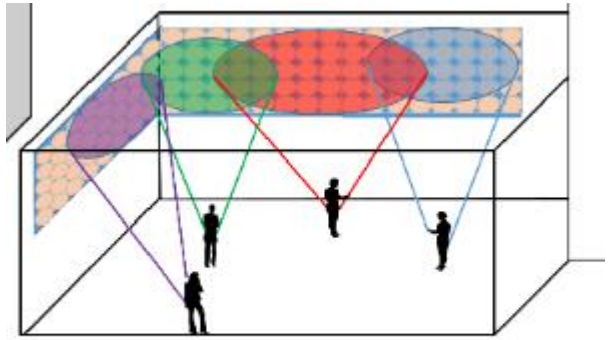
(b) Enhance MIMO channel rank



(c) Passive relaying/beamforming



(d) Passive Interference Cancelation



(a) XL_MIMO
(b) Large intelligent surface

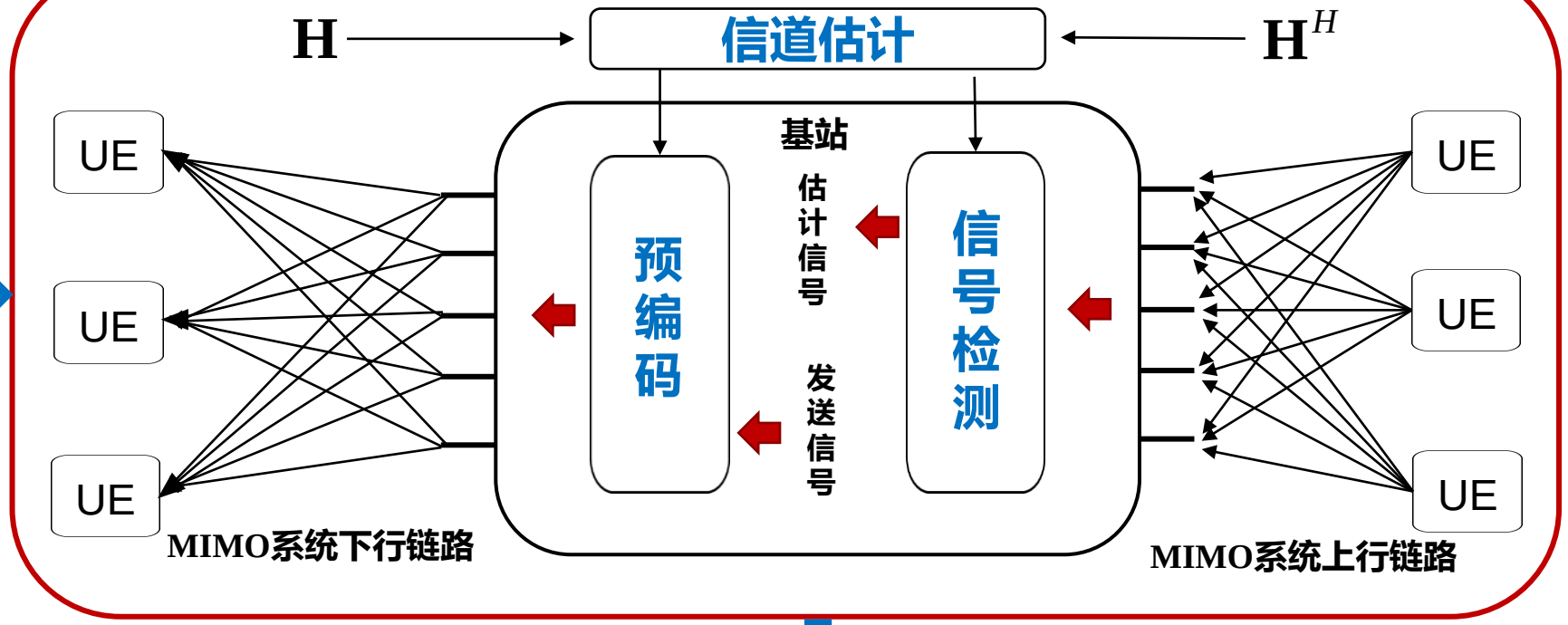
伴随着MIMO系统的不断演进，各种新的场景不断出现，各种新的问题也随之涌现……

MIMO研究框架

数理统计 + 代数格理论 + 采样理论 + 优化理论 + 机器学习人工智能 + ……

相辅相成

面向核心基础问题



适配各种MIMO场景需求

性能 & 复杂度 & 时延 & 普适性 & 灵活性 & 智能化 & ……

MIMO系统→高维信号处理→智能高维信号处理

汇报提纲

CONTENTS

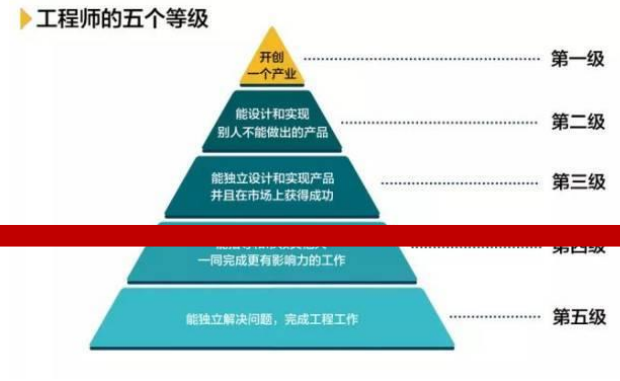
研究风格

始终身处科研一线，和博士硕士的科研是层次不同的平行线

深造
企业
研究所
事业单位
……

更多的选择，更好的就业

更好的科研生态



逐渐锻炼升级

做自己的科研
(五分耕耘一分收获)

同时

指导学生科研
(一分耕耘一分收获)

不停探索，保持自己的学术竞争力

高质量的指导和培养

个人主线

Representative Publications

Journal Articles:

[1] **Z. Wang*** and C. Ling, "Lattice Gaussian sampling by Markov chain Monte Carlo: Bounded distance decoding and trapdoor sampling, " ***IEEE Transact*** [PDF] [Link]

[2] **Z. Wang*** and C. Ling, "On th ***Transactions on Informa***

[3] **Z. Wang***, Y. Huang and S. Ly Enhancement and Decoding (16, pp. 4342-4356, Aug, 2019.

[4] **Z. Wang***, Y. Xia, C. Ling and ***IEEE Transactions on Si***

[5] **Z. Wang***, R. M. Gower, Y. Xi Detection," ***IEEE Transact***

[6] **Z. Wang***, S. Lyu, Y. Xia and ***Transactions on Signal I***

[7] **Z. Wang***, Y. Xia, J. Li and Q High Precision Positioning," [Link] [PDF]

[8] **Z. Wang***, "Markov chain Mo ***Transactions on Commu***

[9] **Z. Wang***, L. Liu and C. Ling, ***Transactions on Commu***

[10] **Z. Wang***, S. Liu and C. Ling ***on Communications*** *(TC*

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[11] **Z. Wang***, W. Xu, Y. Xia, Q. Systems," ***IEEE Transacti*** [PDF]

[12] **Z. Wang***, J. Wang, Z. Gao, Precoders for Massive MIMO 7228-7243, Dec. 2023. [Link] [

[13] **Z. Wang***, C. Ling, S. Jin, Y. Distribution," ***IEEE Transa*** [PDF]

[14] **Z. Wang***, L. Liang, S. Lyu, Systems," ***IEEE Transacti***

[15] **Z. Wang***, R. M. Gower, C. Zhang, S. Lyu, Y. Xia and Y. Huang, "A Statistical Linear Precoding Scheme Based On Random Iterative Method For Massive MIMO Systems," ***IEEE Transactions on Wireless Communications*** *(TWC*, 通信权威期刊), vol. 21, no. 12, pp. 10115-10129, Dec. 2022. [Link] [PDF]

Articles of Supervised Students and Cooperation

[1] Q. Chen, **Z. Wang***, C. Qi, Z. Gao, Y. Huang and D. Niyato, "Decentralized Likelihood Ascent Search-Aided Detection For Distributed Large-Scale MIMO Systems, " ***IEEE Transactions on Wireless Communications***, vol. 24, no. 5, pp. 4160-4173, May 2025. [Link]

[2] L. He, **Z. Wang***, S. Yang, Detection, " ***IEEE Trans***

[3] X. Yan, **Z. Wang**, Y. Jia, Z Fractional Programming [Link]

[4] G. Chen, **Z. Wang*** , H. Li Clustering and Beamform 2025, doi: 10.1109/TWC.2

[5] L. He, **Z. Wang***, Z. Gao, Detection," ***IEEE Trans***

[6] Q. Chen, **Z. Wang***, C. Ma MIMO," ***IEEE Transact***

[7] F. Shen, G. Ding, Q. Wu an ***IEEE Transactions on***

[8] G. Chen, **Z. Wang***, Y. Jia Systems," ***IEEE Transa***

[9] F. Shen, **Z. Wang***, G. Din Spectrum-Heterogeneous 2022. [Link]

[10] G. Chen, **Z. Wang***, H. L Cell-Free Systems," ***IEEE***

▼ View More Earlier A

[11] X. Yan, T. Ji, **Z. Wang** an ***IEEE Communication***

[12] C. Yang, L. Tang and **Z. W** Detection," ***2021 IEEE W*** [Link]

[13] L. He, T. Liu and **Z. Wan** ***2021 IEEE 94th Vehicul***

[14] N. Zhou, **Z. Wang***, L. H ***14th International Co*** pp. 1096-1101. [Link]

[15] X. Yan, **Z. Wang**, Y. Jia, Coherent Cell Free Network, ***2023 IEEE Wireless Communications and Networking Conference (WCNC)***, Glasgow, United Kingdom, 2023, pp. 1-6. [Link]

学生主线

个人特色培养思路

现象观察

- 研一时间紧张，科研投入难以保证
- 起步最难，需要大量时间打基础

↓

- 培养重心后置（不足）

↓

- 真正科研时间略显仓促，对研究领域内容理解不够，试错空间少，且缺乏时间调整方向
- 科研起步需要时间，刚刚上路入门完成一个流程，面临毕业了

↓

- 潜力未充分挖掘，成果数量受限

个人思路

- 保研时间充裕，却往往被忽视
- 专项起步保障+定制化毕设培养+科研流程初探

↓

- **培养重心前置+1对1指导（特色）**

↓

- 利用保研时间完成从无到0，从0到1的过程，需要花费大量导师精力
- 从1到10的过程，学生努力高飞，导师辅助指导，且时间充裕

↓

- 科研工作↑科研成果↑科研潜力↑未来发展↑

➢ 针对保研生（天然优势） ➢ 学生个人成长快，成果好，出路多 ➢ 研三轻松惬意，找工作时间多，就业好

保研学生情况介绍

2020年保研

大四
保研

投稿IEEE VTC国际会议

Conferences > 2021 IEEE 94th Vehicular Tech...

Recurrent Sparse MIMO Detection Network Based on Modified Projected Gradient Descent Method

Publisher: IEEE | Cite This | PDF

Lanxin He ; Tao Liu ; Zheng Wang All Authors

发表

研一

投稿IEEE Trans. on Wireless Communications

Journals & Magazines > IEEE Transactions on Wireless... > Early Access

Generalizing Projected Gradient Descent for Deep-Learning-Aided Massive MIMO Detection

Publisher: IEEE | Cite This | PDF

Lanxin He ; Zheng Wang ; Shaoshi Yang ; Tao Liu ; Yongming Huang All Authors

发表

研二

投稿IEEE Trans. on Vehicular Technology

Journals & Magazines > IEEE Transactions on Vehicula... > Early Access

Favorable-Propagation-Exploited Variational Inference for Massive MIMO Detection

Publisher: IEEE | Cite This | PDF

Lanxin He ; Zheng Wang ; Zhen Gao ; Lei Liu ; Yongming Huang All Authors

发表

研三

Journals & Magazines > IEEE Transactions on Signal P... > Volume: 70

Randomized Iterative Methods for Low-Complexity Large-Scale MIMO Detection

Publisher: IEEE | Cite This | PDF

Zheng Wang ; Robert M. Gower ; Yili Xia ; Lanxin He ; Yongming Huang All Authors

A New Low-Complexity WMMSE Algorithm for Downlink Massive MIMO Systems

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Ningxin Zhou ; Zheng Wang ; Lanxin He

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- 【2024届】贺岚昕，工学硕士（南航期间招收）(Master of Engineering)，跟随王正老师继续读博(东南大学), PhD supervised by Dr Zheng Wang in Southeast University

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- [2025届] 周宁欣，工学硕士(Master of Engineering)，就职于小米(上海) Xiaomi

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校优秀论文

- [2025届] 龚蓓蕾，工学硕士(Master of Engineering)，就职于国家电网(上海) State Grid

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校优秀论文

- [2025届] 高逸群，工学硕士(Master of Engineering)，就职于普源精电(苏州) RIGOL Technologies

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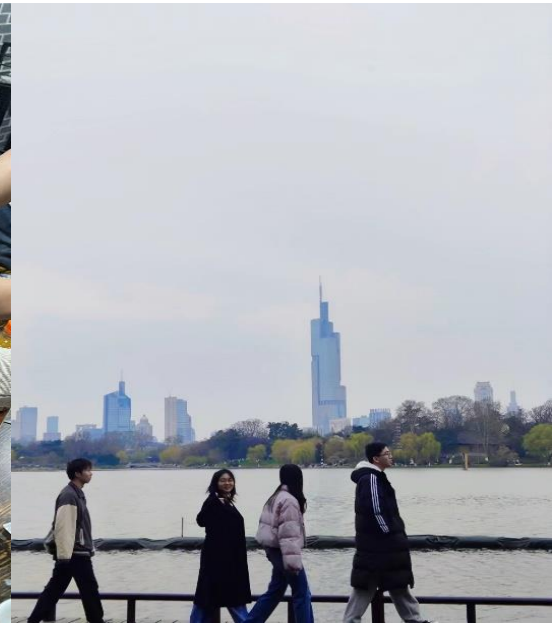

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