

# YANG ZHAO

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## 🏛 EDUCATION

### Imperial College London · PhD in Wireless Communications

2020 – 2024

- Modules: **Artificial intelligence** (machine learning, deep learning, pattern recognition, large-dimensional data processing, computational optimization), **data science** (hypothesis testing, regression modeling, data visualization, R, Pandas, Mathematica, SPSS), **research computing** (Linux, HPC, Docker, Julia, Fortran)
- Supervisor: Prof. Bruno Clerckx, IEEE Fellow, Head of Communications and Signal Processing Group
- Thesis: [Reconfigurable intelligent surface: beamforming, modulation, and channel shaping \[slides\]](#)

### Imperial College London · MSc in Communications and Signal Processing

2018 – 2019

- Modules: **Communications** (wireless communications, information theory, coding theory, advanced communication theory), **signal processing** (DSP & filters, adaptive signal processing, wavelets, labs), **artificial intelligence** (probability & stochastic processes, computer vision)
- Grade: 78%, Distinction
- Thesis: [Signal optimization for wireless information and power transmission \[poster\]](#)

### University of Liverpool & XJTLU · BEng in Communications and Electronics

2014 – 2018

- Modules: **RF** (antennas, circuits, electronics, electromagnetism, microwave engineering, EMC), **communications** (signal & systems, communication systems, digital & wireless communications), **signal processing** (DSP & filters, instrumentation & control), **programming** (C++, MATLAB, Python)
- Grade: 83%, Distinction
- Thesis: [Cross-layer optimization for 4G broadband wireless communication networks \[poster\]](#)

## 👍 EXPERTISE

- Focus: **Reconfigurable intelligent surface, ambient backscatter communications, wireless power transfer**
- Interests: Power/code-domain NOMA, multi-antenna techniques (hybrid beamforming, interference alignment, generalized spatial modulation, space-time coding), multiplicative interference channel, OTFS, semantic communications
- Skills: **Optimization** (surrogate, fractional, geometric, dynamic, manifold, ADMM), **signal processing** (estimation, detection, waveform design), **information theory** (modulation, coding, capacity), machine learning, compressed sensing, matrix analysis, tensor methods, system modeling, algorithms & simulations

## 🚀 PROJECTS

1. **Channel Shaping Using Beyond-Diagonal RIS:** We investigate the capability of different RIS to redistribute MIMO channel singular values for achieving power and rate gains. Results show that BD-RIS can help to attain full DoF at much lower SNR than conventional RIS thanks to its higher signal processing flexibility.
2. **Capacity Region of RIS-Aided Broadcast Channel:** We derive an accurate and tractable expression to approximate the entropy of Gaussian mixture, which helps to characterize the achievable rate of generalized spatial modulation. Results show that RIS can significantly enlarge the capacity region by switching between different patterns to ride additional information.
3. **RIScatter:** We propose a batteryless cognitive radio that unifies backscatter communication and RIS from an input distribution perspective. It allows RFID tags to function as RIS elements with minimal hardware modifications at legacy receivers. Results show that active and passive transmission can share the same energy, spectrum, and infrastructure while still benefiting each other.
4. **RIS-Aided Wireless Information and Power Transfer:** We optimize waveform and beamforming to enlarge the rate-energy region under practical harvester model and receiver architectures. Results show that RIS beamforming provides a second-order array gain and fourth-order harvested power, both double than transmit beamforming.

## PUBLICATIONS

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- **Y. Zhao**, H. Li, M. Franceschetti, and B. Clerckx, “Channel Shaping Using Beyond-Diagonal Reconfigurable Intelligent Surface: Analysis, Optimization, and Implications,” to be submitted to *IEEE Transactions on Signal Processing*. [[code](#)]
- **Y. Zhao** and B. Clerckx, “**RIScatter: Unifying Backscatter Communication and Reconfigurable Intelligent Surface**,” in *IEEE Journal on Selected Areas in Communications*, vol. 42, no. 6, pp. 1642-1655, Jun. 2024. [[code](#), [poster](#), [blog](#)]
- **Y. Zhao**, B. Clerckx and Z. Feng, “**IRS-Aided SWIPT: Joint Waveform, Active and Passive Beamforming Design Under Nonlinear Harvester Model**,” in *IEEE Transactions on Communications*, vol. 70, no. 2, pp. 1345-1359, Feb. 2022. [[code](#)]
- **Y. Zhao** and B. Clerckx, “**Reconfigurable Intelligent Surfaces in Wireless Information and Power Transfer**,” in *Intelligent Surfaces Empowered 6G Wireless Network*. Hoboken, NJ, USA: Wiley, 2023, pp. 271-295.
- Z. Feng, B. Clerckx, and **Y. Zhao**, “**Waveform and Beamforming Design for Intelligent Reflecting Surface Aided Wireless Power Transfer: Single-User and Multi-User Solutions**,” *IEEE Transactions on Wireless Communications*, vol. 21, no. 7, pp. 5346-5361, Jul. 2022.

## PRESENTATIONS

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- **RIScatter: Unifying backscatter communication and reconfigurable intelligent surface** @ SAL Symposium on 6G, Nov. 2023.
- **Semantic communications: An introduction** @ internal group meeting, Dec. 2022.
- **Symbiotic radio: Towards energy and spectrum efficient transmission** @ internal group meeting, Dec. 2020.

## EXPERIENCE

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### Imperial College London · Teaching Assistant

2020 – 2024

- **Wireless communications and optimization** (4th year and MSc): Tutorial delivery, coursework design & marking, oral examination
- **Communications & signal processing lab** (MSc): Material design & delivery, lab supervision, note & report marking
- **Communications** (2nd year): Slides & graphics making, tutorial delivery, forum Q&A, exam marking
- **Mathematics for engineers** (2nd year): Tutorial delivery, exam marking
- Final-year project (4th year and MSc): Research supervision, progress tracking, feedback & advice, viva examination

### China Mobile Group (Guangzhou) · Summer Intern

2017 – 2018

- **Operations engineer** @ Optimization department: Network monitoring, outage identification, base station repair & upgrade, emergency communication vehicle deployment, MRO statistics analysis, network adjustment planning
- **Data analyst** @ Design institute: Commercial product (BBU, RRU, antenna, AAU, microcell, PSU) evaluation, 4G upgrade solution (GSM/TD → NB-IoT/FDD) summarization, site database management, network statistics (RSRP, SINR, CSFB) measurement, radio tower coverage simulation, press release writing, anniversary event organization

## TRAINING

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- ComSoc courses: [OTFS and delay-doppler communications](#), [introduction to deep learning for the physical layer](#), [principles of satellite location and navigation](#), [introduction to quantum communications](#), [building the road to 6G](#)
- Public lectures: [Statistical detection and estimation](#) by Peyman Milanfar, [Information theory and network coding](#) by Raymond Yeung, [Lean for scientists and engineers](#) by Tyler Josephson (in progress)

## REFEREES

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- **Prof. Bruno Clerckx**, IEEE Fellow, Head of Communications and Signal Processing Group, Imperial College London [[email](#)]
- **Prof. Geoffrey Ye Li**, IEEE Fellow, Chair Professor of Wireless Systems, Imperial College London [[email](#)]

## AWARDS

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- **Featured Article** @ IEEE Journal on Selected Areas in Communications, Jun. 2024
- **IET Student Prize** @ University of Liverpool, 2018
- **Undergraduate Scholarship** @ University of Liverpool, 2017
- **University Achievement Award** @ Xi'an Jiaotong-Liverpool University, 2016