Guang-Xing Li, Ph.D.

Associate Professor & Principal Investigator | Computational & Theoretical Physics | Scientific ML

AI for Scientific Discovery · multiscale physics · self-supervised learning · computational methods

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Research Summary

Associate Professor and computational/theoretical physicist developing analytical, numerical, and machine-learning methods for extracting structure, dynamics, and physical understanding from complex scientific data. For 15+ years, his work has progressed from physics-based structural diagnostics and multiscale representations, culminating in ScaleAware-JEPA, which extends self-supervised latent representation learning to continuous multiscale scientific fields for ML-assisted scientific discovery.

111 scientific publications · 1,800+ citations · h-index 24 · €280k+ PI-led competitive funding

Selected Research Contributions

ScaleAware-JEPA — *Representation learning for scientific discovery in continuous fields*

2026 · Sole author · arXiv:2606.29723 · Code

- **Research contribution:** opens JEPA-style representation learning to **continuous, intrinsically multiscale scientific fields** by making **physical scale** part of both the **representation and prediction geometry**.
- **Scientific objective:** learns latent structure not merely for predefined prediction tasks, but to expose scientifically meaningful organization before objects, labels, or segmentation rules are specified.
- **Approach:** world-model-inspired latent prediction of hidden structure in representation space; scale-aware multiscale representation and dense latent-field learning.
- **Demonstration:** MHD turbulence, molecular-gas observations, and urban fields; recovered coherent structures and physically distinct scaling relations.

Related work (2026): Scale-Aware Adversarial Analysis — physically constrained multiscale diagnostics for failure modes in generative models.

Adjacent Correlation Analysis — *Hidden regularities in complex spatial data*

2025 · Sole author · arXiv:2506.05759 · Code

- Recovers local correlations obscured by global statistics, representing complex spatial patterns as phase-space vector fields.
- The recovered vectors admit an attracting-manifold interpretation, opening routes to classification, prediction, and forecasting.

Constrained Diffusion Decomposition — *Multiscale representation of continuous fields*

2022 · Sole author · arXiv:2201.05484 · ApJS 259, 59 · Code · PyPI: constrained-diffusion

- Nonlinear-diffusion decomposition producing pixel-registered physical scales without the ringing and negative artifacts of conventional band-limited filtering.
- Provides the explicit physical-scale coordinate later used by ScaleAware-JEPA for scale-aware latent prediction.

G-virial — *Physics-based identification of gravitational structure*

2014–2018 · DFG-funded

- Analytical–numerical framework linking virial theory, simulations, and observables to identify gravitationally significant structure in turbulent media.

Academic Appointments & Research Leadership

Associate Professor & Principal Investigator **2018–Present**
Yunnan University (SWIFAR), China

- Lead theoretical and computational research in multiscale physics and scientific ML, using complex observational and simulation data.
- Supervise PhD/MSc researchers in computational methods, scientific data analysis, and scientific ML.
- Advise collaborators on physical interpretation and computational strategy, translating scientific questions into models, diagnostics, numerical analyses, and ML approaches.
- Led a Max Planck Partner Group for international collaborative research.

DFG Research Fellow **2014–2018**
LMU Munich (Universitäts-Sternwarte), Germany

- Awarded a DFG Research Fellowship to develop computational methods for extracting physical structure and dynamical understanding from observational and simulation data.
- Developed G-virial, combining analytical physics and numerical simulations to identify gravitationally significant structure in turbulent molecular-gas data.

Ph.D. Researcher **2010–2014**
Max Planck Institute for Radio Astronomy, Germany

- Developed robust, scalable algorithms and computational models for multiscale structures in high-dimensional, heterogeneous environments.

Selected Scientific Discoveries

- *Nature Communications* (2025) — kiloparsec-scale, long-lived superbubble; co-corresponding author
- *Nature Astronomy* (2023) — cosmic-ray shielding by dense molecular gas
- *Nature Astronomy* (2022) — flyby-induced spirals in a massive protostellar disk; co-corresponding author; led interpretation/modeling
- *MNRAS Letters* (2022) — coherent velocity wave in the Radcliffe Wave; first author

Funding

- DFG Research Fellowship — €220k, PI
- Max Planck Partner Group — €60k, PI

Education

Ph.D. Astrophysics / Computational Modeling — Max Planck Institute for Radio Astronomy & University of Bonn (2014), *magna cum laude*
M.Sc. Astrophysics — University of Science and Technology of China (2010)
B.Sc. Electronics — Peking University (2007)

Computational & ML Methods

Methods: scientific machine learning · self-supervised learning · PyTorch · GPU/HPC computing · numerical modeling · multiscale analysis · hydrodynamics/MHD