

Decoding emergent patterns in large microbial communities through the prism of disordered systems

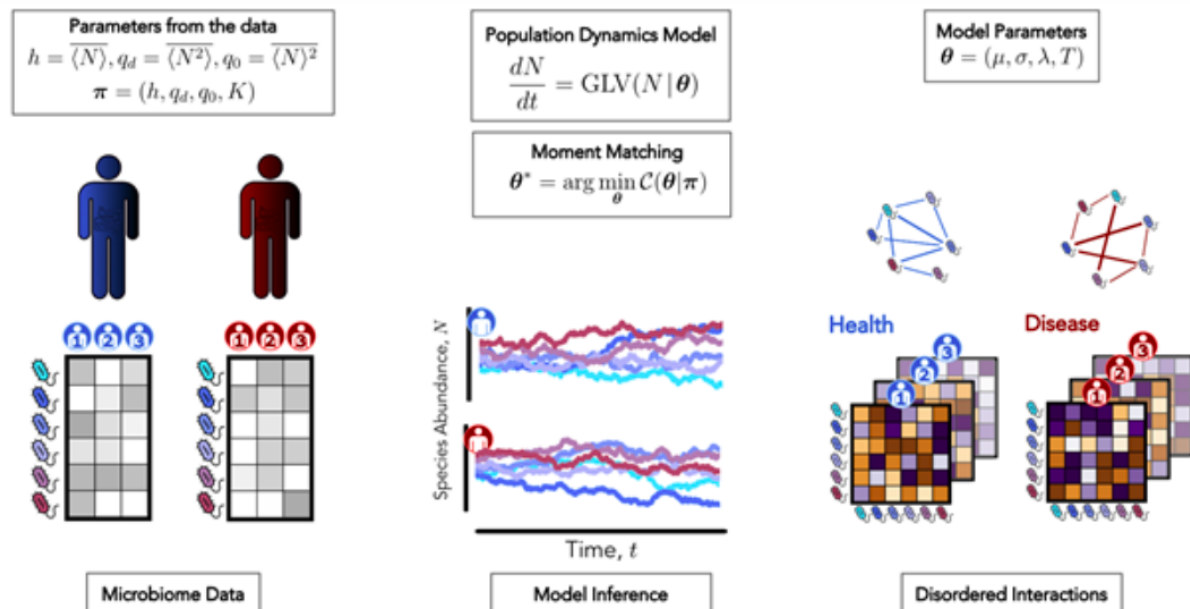
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The remarkable biodiversity of natural ecosystems has attracted growing interest in recent years, not only among ecologists but also within the theoretical physics community.

In this talk, I will present a disordered variant of the Generalized Lotka-Volterra (GLV) model incorporating random species interactions and demographic noise, as a proof of concept for its applicability to the human gut microbiota.

Through the analysis of metagenomic data from both healthy individuals and patients with inflammatory bowel disease, I will show that distinct physiological states of the gut microbiome map onto different noise-driven and disorder-driven regimes of the GLV model [1, 2]. Finally, I will discuss non-logistic growth functions as a generalization of this framework, which we propose as stabilizing mechanisms that remain effective even as species richness increases [3].



References

- [1] A. Altieri et al., Phys. Rev. Lett. 126 (2021).
- [2] J. Pasqualini, A. Maritan, A. Rinaldo, S. Facchin, E. V. Savarino, A. Altieri* & S. Suweis*, eLife14:RP105948 (2026)
- [3] I. Hatton, O. Mazzarisi, A. Altieri, M. Smerlak, Science 383 (2024).