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Quasi-Linkage Equilibrium in spatially separated populations and in diploid genetics

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Quasi-Linkage Equilibrium (QLE) is a theory developed by Kimura (1965) and Neher & Shraiman (2009:2011) to explain the emergency of distributions of genotypes in a population akin to the canonical ensemble in statistical physics, referred to as a QLE state. Recombination (exchange of genetic material between individuals) acts analogously to molecular collisions in kinetic gas theory, and leads, if strong enough, to relaxation to an equilibrium-like state, for a review, see [1].

Geographic isolation is important in evolution, it is a driving force behind speciation. I will discuss how recombination interacts with migration between spatially isolated sub-populations, and if the QLE state can coexist with migration. I will also consider the setting where different sub-populations live in different environments with different fitness landscapes, and if one can infer those landscapes from the population structures if individuals can move between the populations [2]. I will also discuss the conceptual issue if the assumption of haploid genomes usually made in the literature is only a simplification or if the evolution of diploid populations is qualitatively different and can lead to other phases than QLE.

[1] "Statistical genetics in and out of quasi-linkage equilibrium", V Dichio, HL Zeng, E Aurell, Reports on Progress in Physics 86 (5), 052601 (2023)
[2] "Fitness Inference in Presence of Migrations between Coupled Evolving Populations", YH Huang, B Dumont, HL Zeng, J Barton, E Aurell (2026), arXiv preprint arXiv:2605.22665

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