Graduate School Event

Thesis Defense: How epistasis and purifying selection shape genetic diversity

Ksenia Khudiakova (Barton and Maas Groups)
Barton and Maas Groups

Host: Mikhail Lemeshko

This Ph.D. thesis investigates how different forms of selection shape genetic diversity in a constant environment that has led to evolutionary equilibrium. We progress from a non-epistatic case to increasingly complex models of epistasis and rely on stochastic and deterministic theory together with simulations.We first show that in the non-epistatic case, and in an asexual population, weak purifying selection leads to multiple-merger genealogies, and that the transition in genealogical properties coincides with the onset of Muller's ratchet.Then, we apply a result from discrete Morse theory to prove that adding each next fitness peak to the landscape requires at least one additional special pairwise interaction between loci, called reciprocal sign epistasis.We then show that reciprocal sign epistasis can extend the diversity-promoting effects of balancing selection and delineate the parameter conditions under which this effect is expected to occur.Finally, we demonstrate how epistasis that arises under stabilizing selection amplifies the effects of random genetic drift by causing the selection coefficients of mutations to fluctuate through interactions with the changing genetic background.Together, these results show that non-epistatic purifying selection reduces genetic diversity relative to neutrality, and that once Muller's ratchet starts operating, this reduction cannot be captured by any simple rescaling of Kingman's coalescent. On an epistatic fitness landscape, reciprocal sign epistasis is a key ingredient for generating multiple fitness peaks, and it substantially alters within-population dynamics at evolutionary equilibrium by extending the diversity-maintaining effects of balancing selection and driving temporal changes in selection coefficients. This Ph.D. thesis thus advances our understanding of how epistasis shapes genetic diversity and evolutionary dynamics in populations at equilibrium.

Monday, April 13, 2026 02:00pm - 03:00pm
Sunstone Bldg / Ground floor / Big Seminar Room B (I23.EG.102) and Zoom

This invitation is valid as a ticket for the ISTA Shuttle from and to Heiligenstadt Station. Please find a schedule of the ISTA Shuttle on our webpage: https://ista.ac.at/en/campus/how-to-get-here/ The ISTA Shuttle bus is marked ISTA Shuttle (#142) and has the Institute Logo printed on the side.