Soft Living Active and Adaptive Matter

The finch beak: growth, form and function.

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Abstract:

Darwin's finches are a classic example of adaptive radiation, exemplified by their adaptive and functional beak morphologies. Using 3D scans of skulls in this group, we perform an evolutionary morphometric analysis of the three-dimensional beak shapes and find that they can be fit by a simple functional form: the transverse sections of the beaks are parabolas with a curvature that decreases linearly with distance away from the tip of the beak. Guided by our morphometric analysis of finch beaks and earlier observations of the development of the zebra finch beak, we propose a minimal biophysical model for beak morphogenesis in the form of a local geometric growth law that is related to curvature-driven flow. We show that our model captures the range of observed shapes of the finch beak in terms of a morphospace set by the relative size and shape of the developing beak primordium. Finally, we consider the functional role of size, shape and orientation by treating the beak as an elementary machine, and show how its mechanical advantage relates to the variable.

Date: 2/15/2021

Time: 9:00 AM-10:15 AM

About the speaker:

Salem Al Mosleh is a postdoctoral fellow at the Center of Mathematical Sciences and Applications, Harvard University. As a soft condensed matter physicist, he aims to gain insights into the emergent behavior of real complex systems. He is currently working on the physical and mathematical aspects of morphogenesis with L. Mahadevan at Harvard University.

Salem received his Ph. D. from the University of Massachusetts Amherst in 2018. He has presented his research in several professional meetings including the Soft Matter GRC and the Aspen Center for Physics working group. At UMass Amherst, he has won the seed pitch competition through his proposal for the development of educational physics games.

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