Abstract Submitted
for the DFD09 Meeting of
The American Physical Society

Affine transformations capture beak shape variation in Darwin's Finches MICHAEL BRENNER, OTGER CAMPAS, School of Engineering and Applied Sciences, Harvard University, RICCARDO MALLARINO, ARHAT ABZHANOV, Department of Organismic and Evolutionary Biology, Harvard University — Evolution by natural selection has resulted in extraordinary morphological complexity of living organisms, whose description has thus far defied any precise mathematical characterization linked to the underlying developmental genetics. Here we demonstrate that the morphological diversity of the beaks of Darwin's finches, the classical example of adaptive morphological radiation, is quantitatively accounted for through the mathematical group of affine transformations. Specifically, we show that all beak shapes of Ground Finches (genus *Geospiza*) are related by scaling transformations (a subgroup of the affine group), and the same scheme occurs for all the beak shapes of Tree and Warbler finches. This analysis shows that the beak shapes within each of these groups differ only by their scales, such as length and depth, each of which is knownto be under genetic control.The complete morphological variability within the beaks of Darwin's finches can be explained by extending the scaling transformations to the entire affine group, by including shear transformations. Altogether our results suggest that the mathematical theory of groups can help decode morphological variability, and points to a potentially hierarchical structure of morphological diversity and the underlying developmental processes.

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Date submitted: 06 Aug 2009 Electronic form version 1.4