## Abstract Submitted for the MAR14 Meeting of The American Physical Society

Universality in legged locomotion on low-resistance ground FEIFEI QIAN, School of Electrical and Computer Engineering, Georgia Institute of Technology, WYATT KORFF, Department of Integrative Biology, University of California at Berkeley, PAUL UMBANHOWAR, Department of Mechanical Engineering, Northwestern University, ROBERT FULL, Department of Integrative Biology, University of California at Berkeley, DANIEL GOLDMAN, School of physics, Georgia Institute of Technology — Natural substrates like sand, snow, leaf litter and soil vary widely in penetration resistance, but little is known about how legged locomotors respond to this variation. To address this deficit, we built an air-fluidized trackway filled with granular material to control ground resistance. Resistance can be reduced to zero by increasing the upward flow of air through the bed. Using a hexapedal robot as our model locomotor, we systematically study how locomotion performance varies with penetration resistance, limb kinematics and foot morphology. A universal model, which combines robot kinematics and ground parameters, determines robot speed for all penetration resistances and captures the dependence of performance sensitivity on foot pressure and ground resistance. Expanding the scope of locomotors to include five organisms, we find that their performance on lowresistance ground is also well captured by the universal model. The model suggests that both increasing foot size and decreasing gait frequency reduce the performance loss as ground resistance decreases. Organisms may minimize the inertial effects of the granular media by maintaining maximum foot impact shear stresses through passive structures, e.g. long flexible toes, and active mechanisms, e.g. gait frequency control.

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