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Forces, waves and emergent dynamics during collective cell migration

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A broad range of biological processes such as morphogenesis, tissue regeneration, and cancer invasion depend on the collective motion of cell groups. For a group of cells to migrate cohesively, it has long been suspected that each constituent cell must exert physical forces not only upon its extracellular matrix but also upon neighboring cells. I will present novel techniques to measure these distinct force components. Using these techniques, we unveiled an unexpectedly rich physical picture in which the distribution of physical forces is dominated by heterogeneity, cooperativity, and jamming. I will show, moreover, that these essential features of inter-cellular force transmission enable the propagation of a new type of mechanical wave during tissue growth. Finally, I will demonstrate that both in epithelial and endothelial cell sheets, forces and waves are mechanically linked to cell velocities through a newly discovered emergent mechanism of innately collective cell guidance: plithotaxis.