Image analysis for probing cell collective movements during embryo morphogenesis.

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The recent development of imaging and image processing tools, such as 4D nonlinear microscopy or 3D cell tracking, allows to follow the dynamics of a large population of cells within a developing embryo. It makes possible to investigate the fascinating and highly regulated choreography of cell movements involved in embryo morphogenesis. By using quantitative description inspired by statistical physics, we further developed movement analysis to investigate the cell kinetic ordering within a large number of cells. An order parameter is defined, allowing to follow the correlations of cell movements and to describe the spatial and temporal propagation of these correlations. This approach aims at identifying specific cell collective behaviors leading to tissue and organ morphogenesis and assessing questions, such as the spatio-temporal scale and the nature of cell-cell interactions involved in morphogenesis. The final goal of this analysis is to study the emergence of shape during embryo development. We illustrate this approach by analyzing *Drosophila* embryo gastrulation. This early stage of development exhibits the first morphogenetic movements, including the mesoderm formation, which is both a tractable model of invagination and a beautiful example of cell collective motion.