Sampling the movement phenospace: Towards a biophysics of behavior in the wiggling of *C. elegans*.

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We apply a low-dimensional yet complete representation of body shape (eigenworms, [1]) to construct a principled parameterization of the 2D movement behavior of the nematode *C. elegans*. Despite it's simplicity, we show that a linear dynamical system of the eigenworm projections captures long-range temporal correlations and reveals two periodic dynamics, the primary body wave and and an oscillation between the head and body curvature which underlies long arcs in the organism's trajectory. We parameterize the movement phenospace by reconstructing equations locally in time and show that variation within this space is restrained; with increasing window size, a single behavioral mode dominates the variance and represents the coupled control of speed and turning. The distribution of this primary mode is bimodal, suggesting a correspondence with empirical behavioral states of roaming and dwelling. Finally, we apply our behavioral parameterization to show that the worm's response to a strong impulsive heat shock includes a Hopf-like bifurcation corresponding to an early-time growth of the amplitude of the crawling wave.

References

1. Stephens, G.J., Johnson-Kerner, B., Bialek, W., Ryu, W.S. (2008). Dimensionality and dynamics in the behavior of C. elegans. *PloS Comp Bio* e1000028.

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