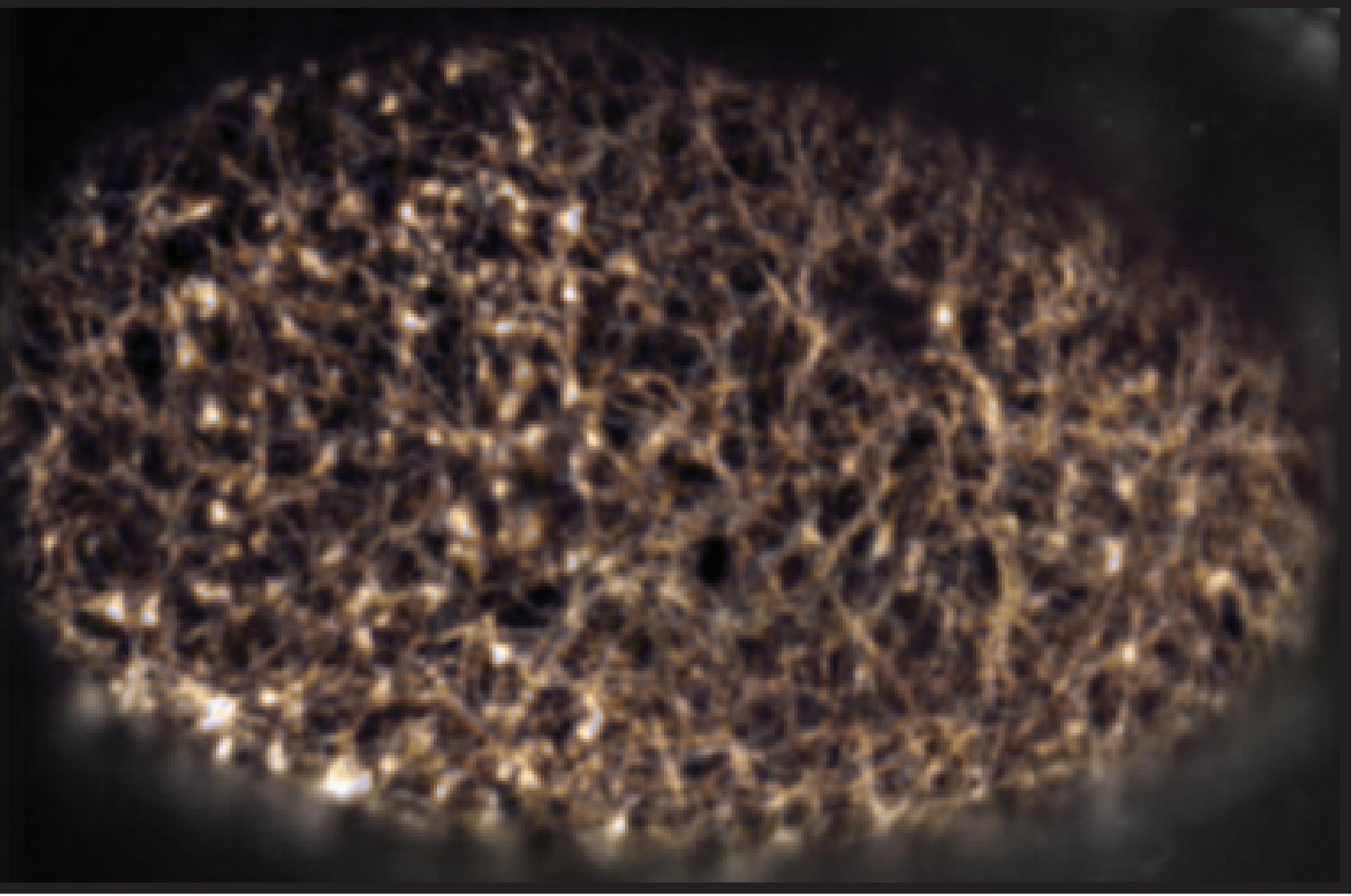


Does filament recycling keep active networks flowing?

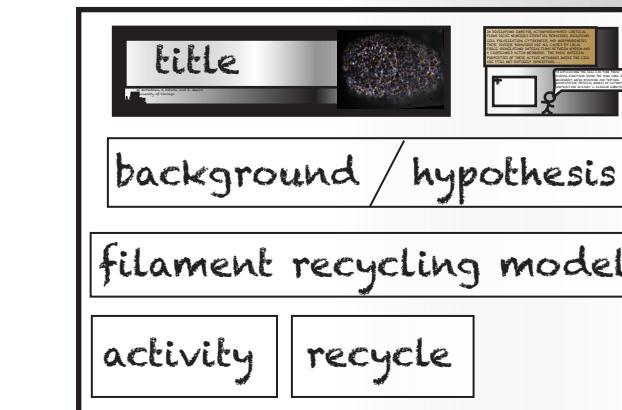
W. McFadden¹ and E. Munro^{1,2}

¹University of Chicago, Biophysical Science

²University of Chicago, Molecular Genetics and Cell Biology, Institute for Biophysical Dynamics, Computation Institute

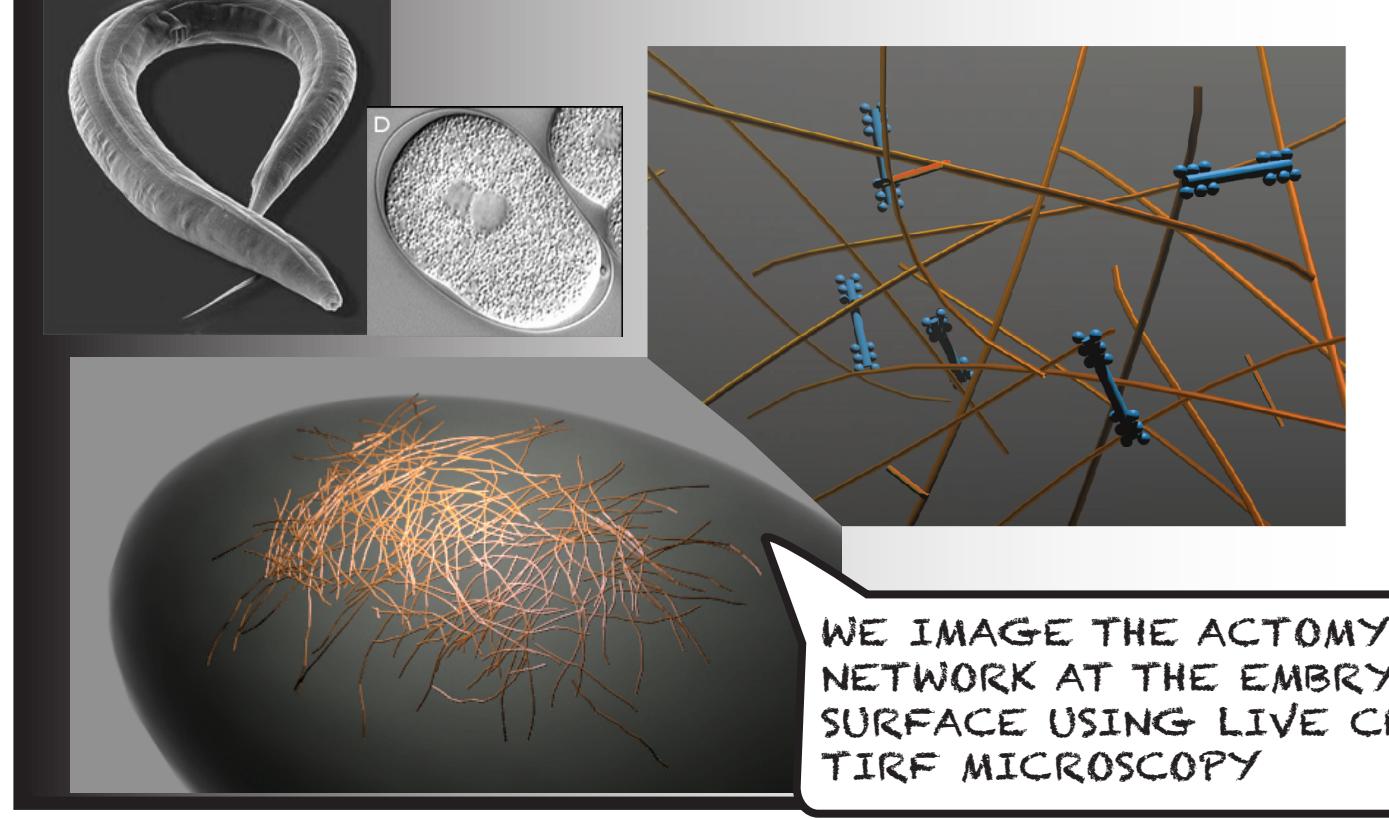


WHEN PRODUCING DIFFERENTIATED CELLS, EARLY *C. ELEGANS* EMBRYOS HAVE TO RELOCATE CELL SPECIFICATION FACTORS FROM ONE END OF THE CELL TO ANOTHER. THE CELL ACCOMPLISHES THIS BY GENERATING PERSISTENT, LONG DISTANCE FLOWS OF ACTOMYOSIN THAT CARRY PARTICULAR ACTIN BINDING PROTEINS TO THE CORRECT POLE. IT TURNS OUT, MAINTAINING THESE FLOWS DEPENDS ON THE CELL'S ABILITY TO REMODEL IT'S ACTOMYOSIN NETWORK BY CONSTANTLY RECYCLING ACTIN FILAMENTS, BUT IT WASN'T CLEAR WHY....

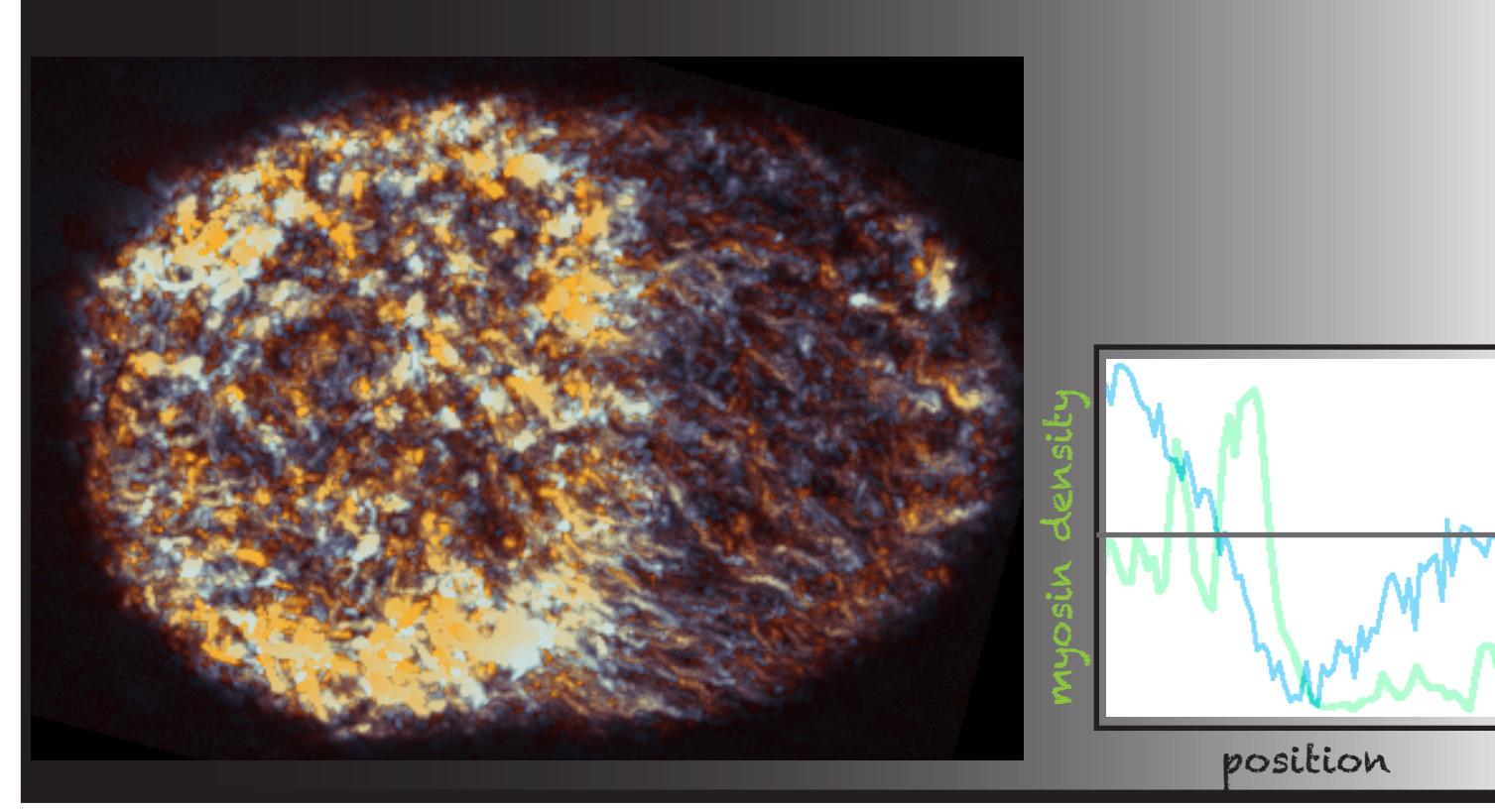


I WANTED TO SHOW WHY FILAMENT RECYCLING WOULD BE SO IMPORTANT TO GENERATING SUSTAINED FLOWS IN AN ACTOMYOSIN NETWORK.

ACTOMYOSIN FLOWS IN *C. ELEGANS* EMBRYOS COME FROM MYOSIN MOTORS DRIVING THE MOTION OF A LAYER OF CROSS-LINKED ACTIN JUST UNDER THE CELL MEMBRANE



ON THE SCALE OF THE WHOLE EMBRYO, THE INTERACTION OF MYOSIN WITH ACTIN FILAMENTS PRODUCES A STEADY FLOW OF MATERIAL THAT PATTERNS A STABLY POLARIZED CELL

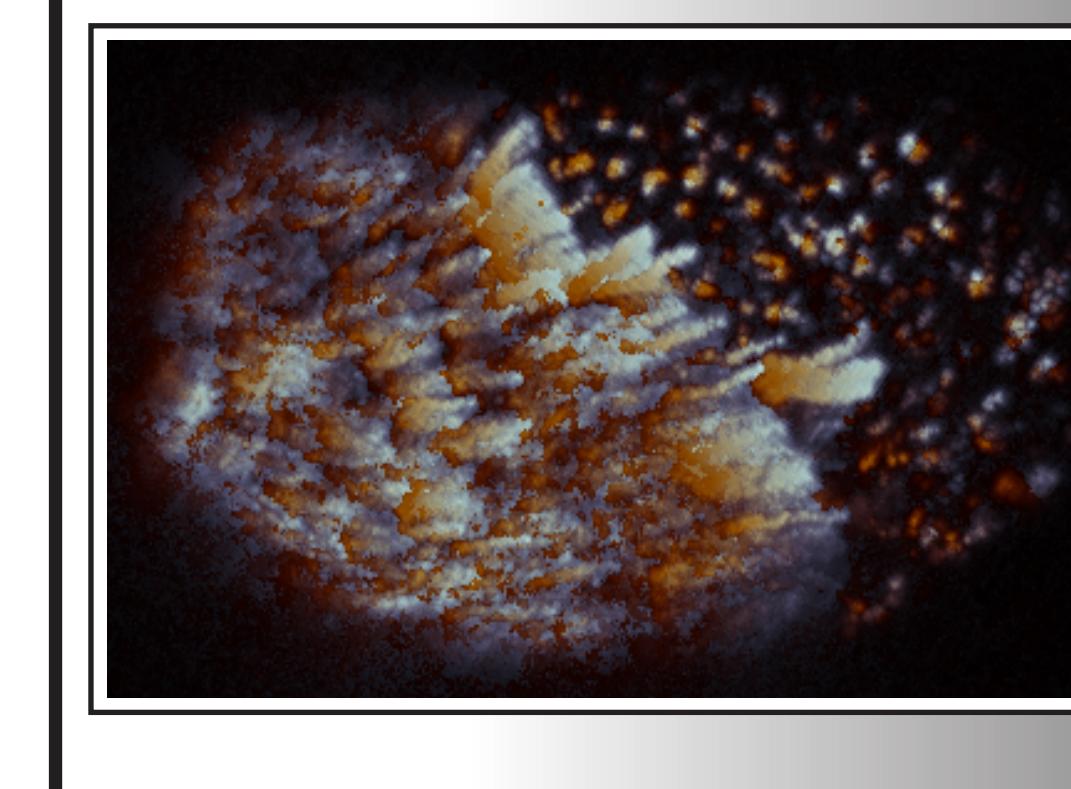


IN CONTRAST, IN VITRO NETWORKS IRREVERSIBLY BREAK DOWN AND NEVER PRODUCE SUSTAINED FLOWS



SO I WAS WONDERING WHAT'S THE BIG DIFFERENCE BETWEEN IN VITRO NETWORKS AND THE ONES I SEE IN CELLS

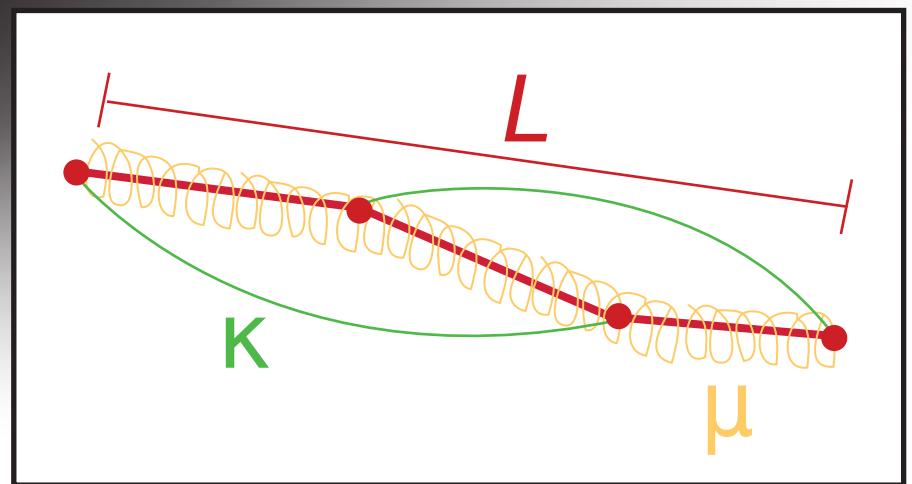
STOPPING ACTIN FILAMENT DEPOLYMERIZATION AND REPOLYMERIZATION (RECYCLING) CAUSED TEARING MUCH LIKE IN VITRO NETWORKS



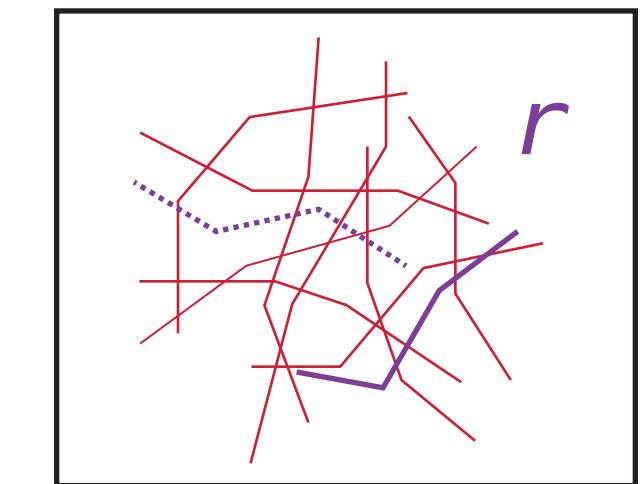
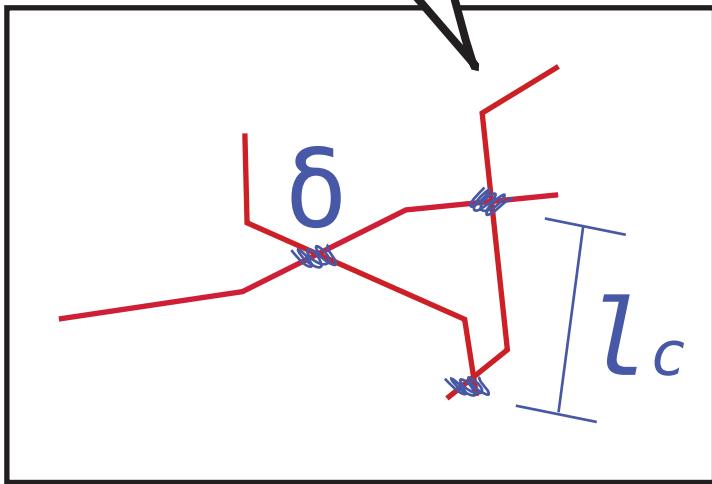
I ALSO MEASURED THE AVERAGE LIFETIME OF AN ACTIN MONOMER TO BE ~10s -- WAY SHORTER THAN IN VITRO ACTIN NETWORKS

TO SEE WHETHER FILAMENT RECYCLING WOULD PRODUCE FLOWS IN ACTIVE NETWORK, I BUILT A MODEL...

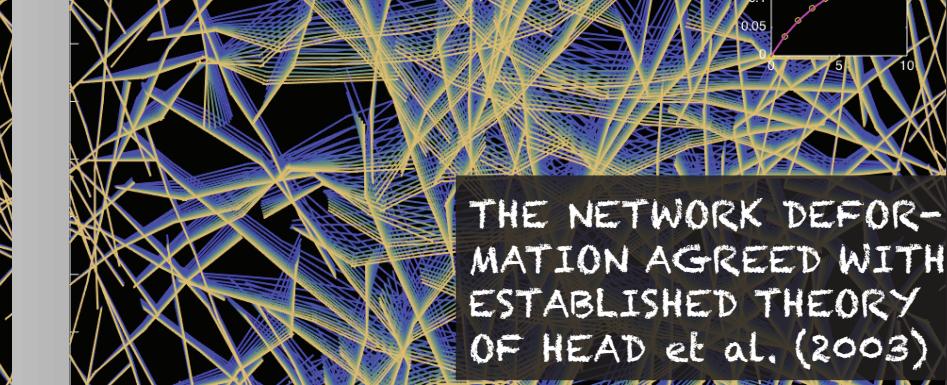
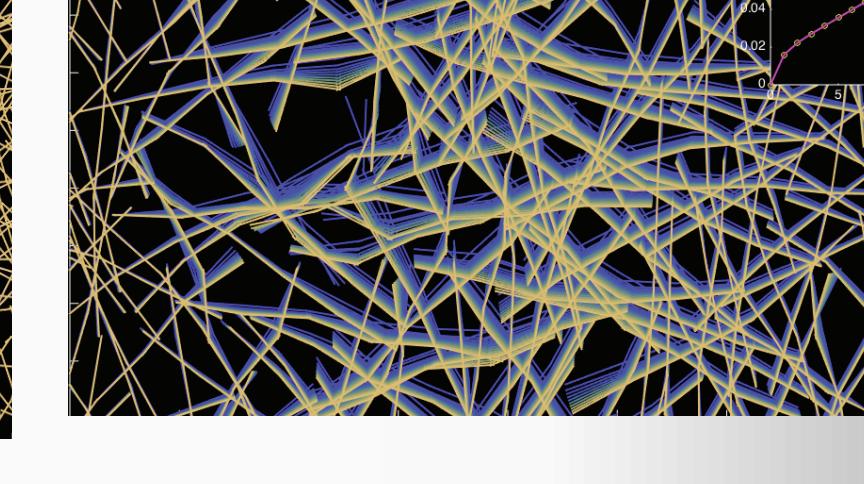
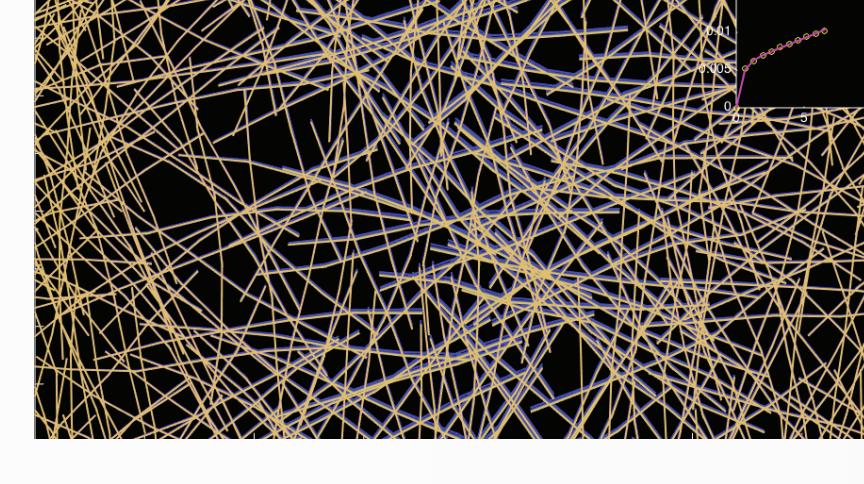
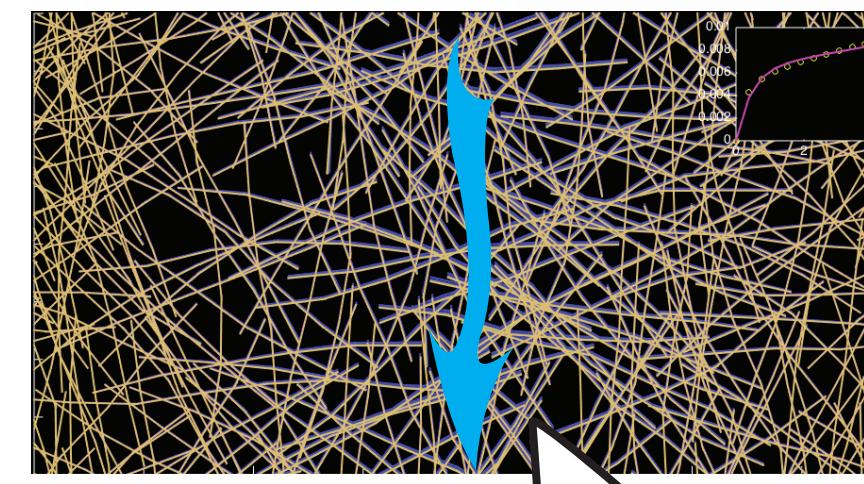
MY MODEL COMBINED WELL-UNDERSTOOD PHYSICS OF ACTIN WITH SIMPLE MODELS OF CROSSTALK AND FILAMENT RECYCLING



Parameter Values for actin-like networks:
 $\mu = 1 \text{ nN}$ $K = 0.0001 \text{ nN} \cdot \mu\text{m}^2$ $L = 1-10 \mu\text{m}$
 $\delta = 1000$ $l_c = 0.05-0.2 \mu\text{m}$
 $r = 0-1000 \mu\text{m/s}$ $\zeta = 0.001 \text{ nN} \cdot \text{s}/\mu\text{m}$



BEFORE INTRODUCING FILAMENT RECYCLING I MADE SURE THAT THE NETWORK RESPONDED CORRECTLY TO DIFFERENT NETWORK PARAMETERS

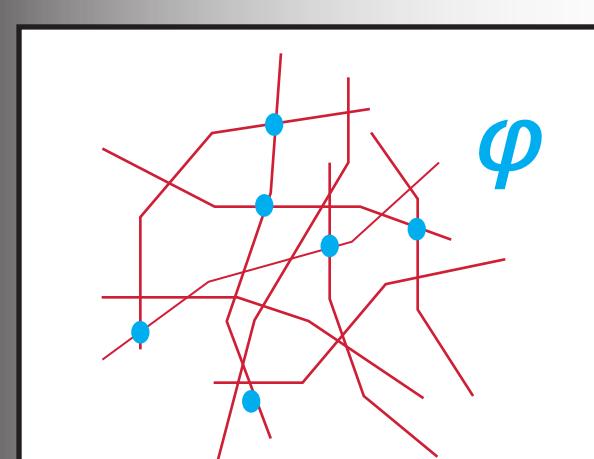
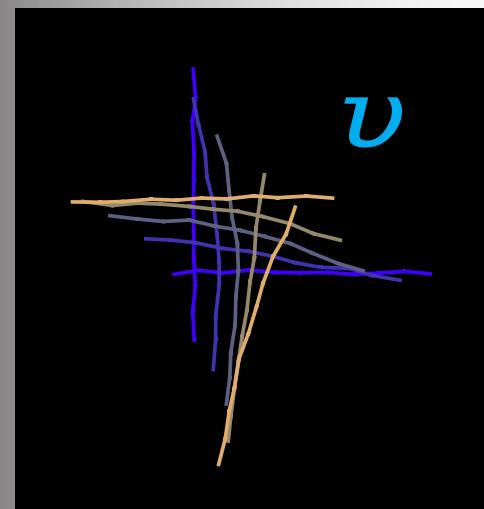


lowering network stiffness

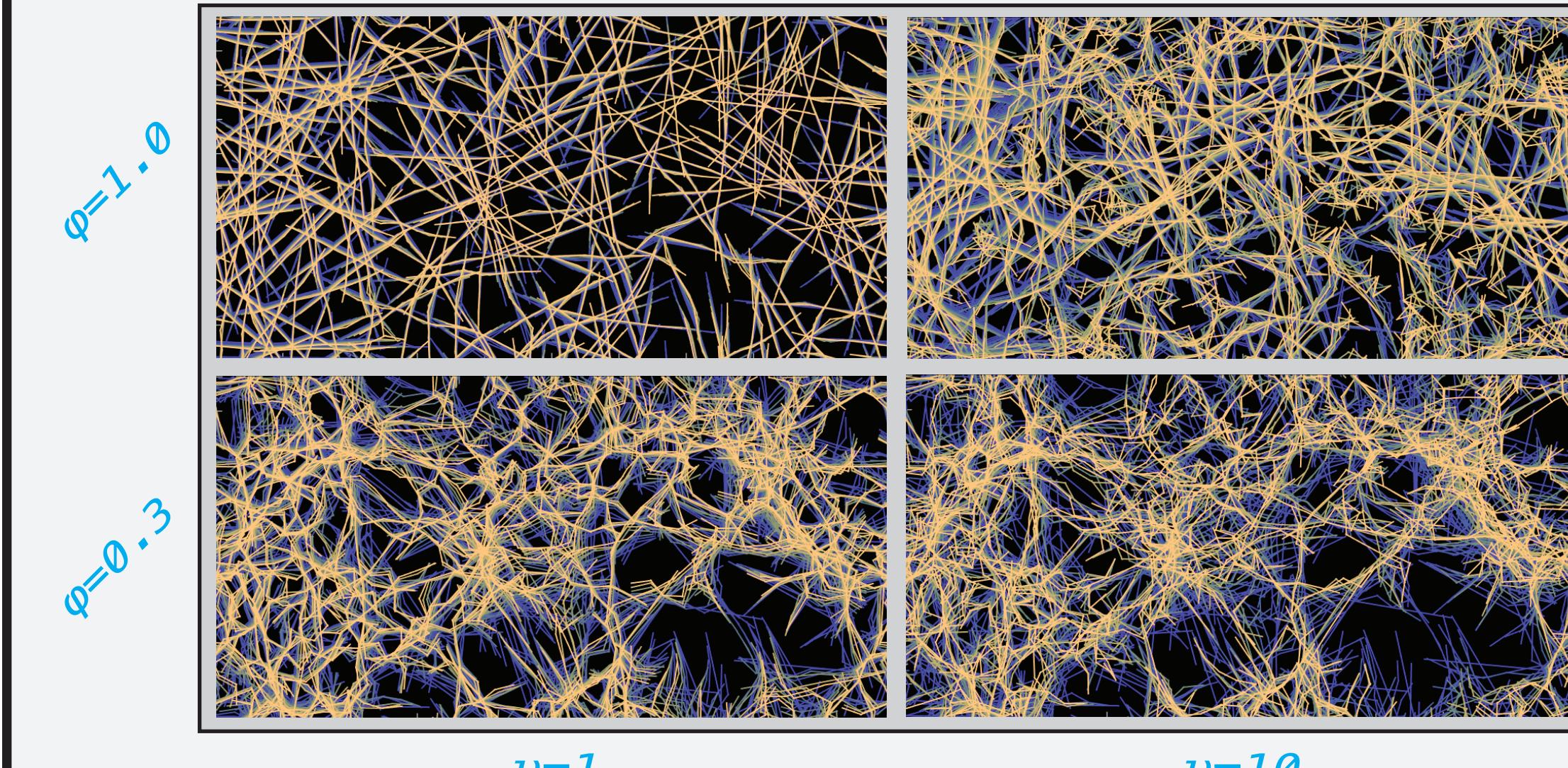
I PROBED THE NETWORKS BY APPLYING A FORCE ALONG CENTER OF THE NETWORK AND PINNING THE OUTSIDE EDGES

NEXT I ADDED ACTIVE FORCES TO THE MODEL TO SEE WHETHER MYOSIN COULD TEAR APART THE NETWORK IN THE ABSENCE OF RECYCLING...

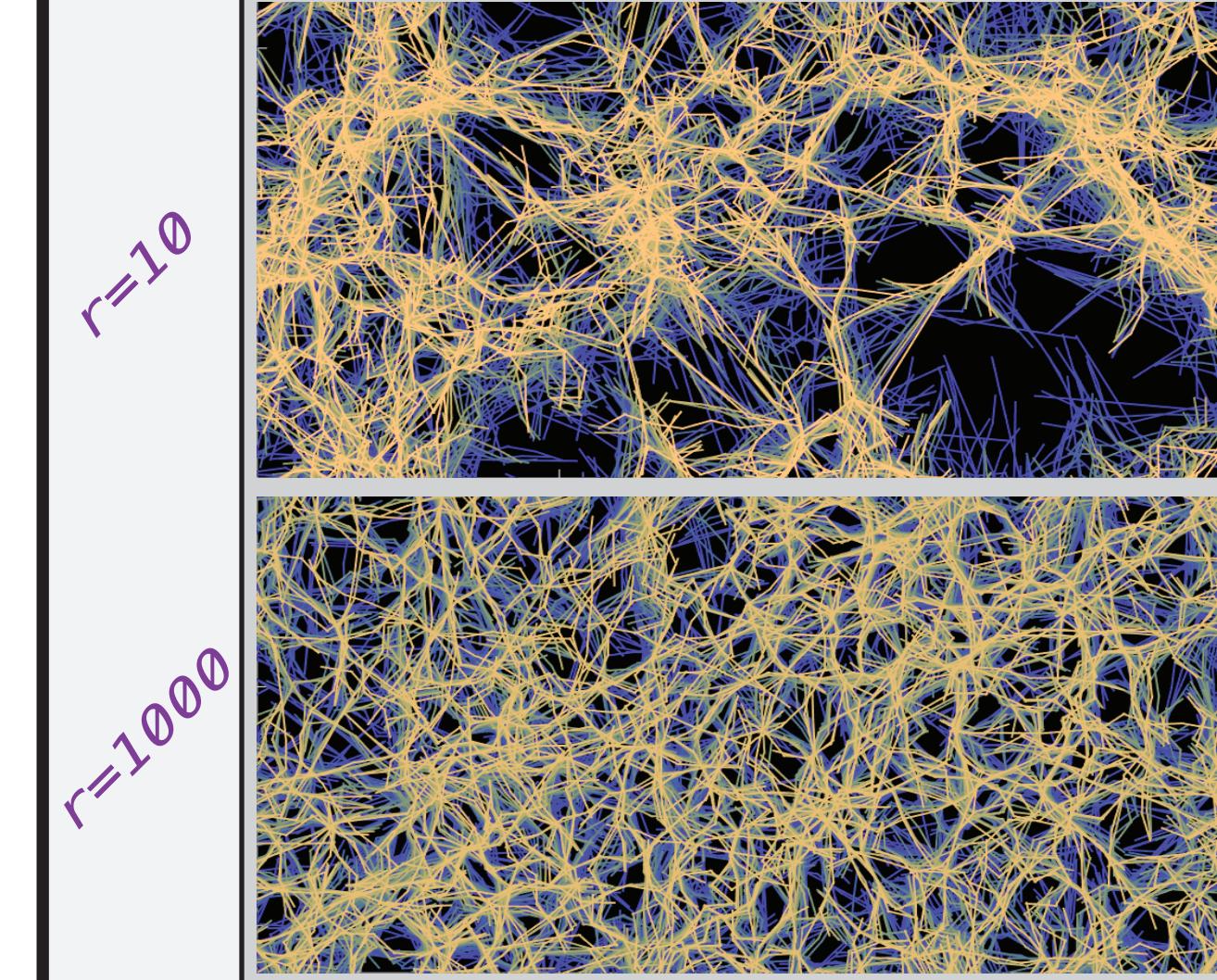
THE ACTIVE NETWORK MODEL ADDS ACTIVE FORCES (v) ALONG FILAMENTS AT A FRACTION (ϕ) OF THE CROSSTALK POINTS



MY PRELIMINARY RESULTS SHOW THAT NETWORKS DO TEAR APART AND THAT THIS BEHAVIOR CAN BE TUNED BY VARYING THE MAGNITUDES OF ACTIVE FORCE AND ACTIVITY FRACTION

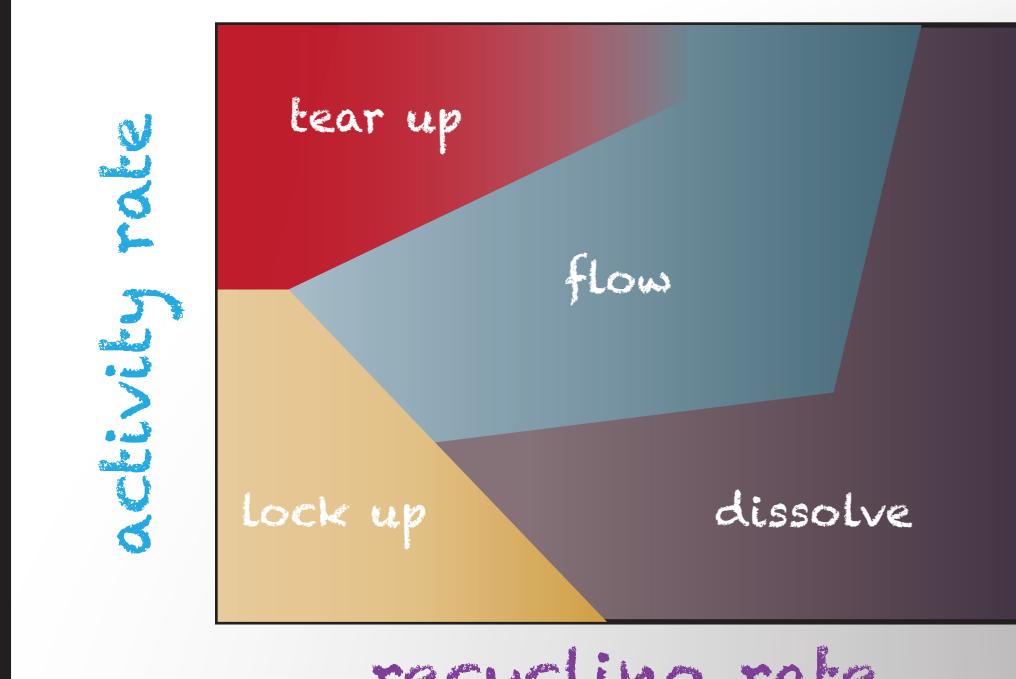


ANOTHER PRELIMINARY RESULT SHOWS THAT JUST BY TURNING UP THE RECYCLING RATE, OPENING TEARS CAN BE HEALED



HMM, THESE ISOTROPIC NETWORKS DON'T ACCURATELY REFLECT OUR SYSTEM'S UNIDIRECTIONAL FLOW

THESE RESULTS HINT AT A GENERAL PHASE DIAGRAM THAT COULD EXPLAIN HOW ACTIVITY AND RECYCLING WORK TOGETHER TO GENERATE FLOWS



BUT YOU'LL HAVE TO WAIT 'TIL NEXT TIME FOR THE CONCLUSION OF THIS PROJECT...