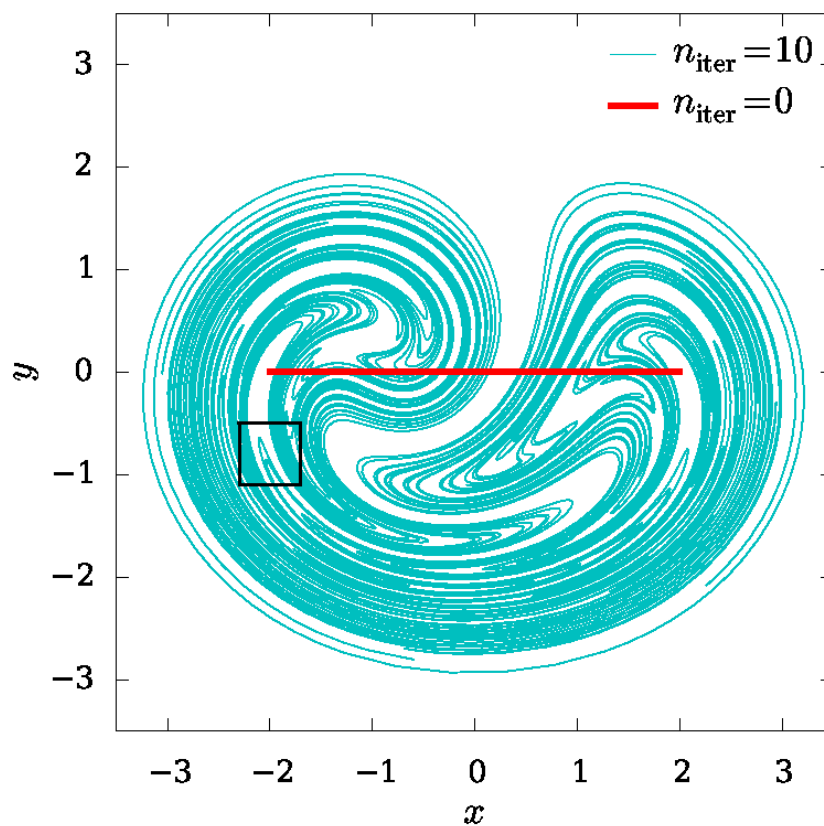


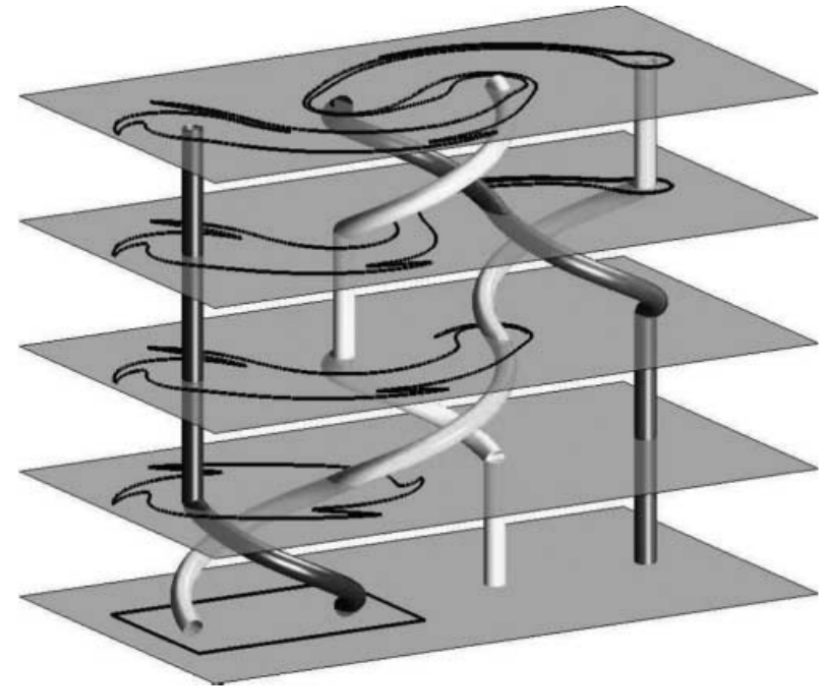
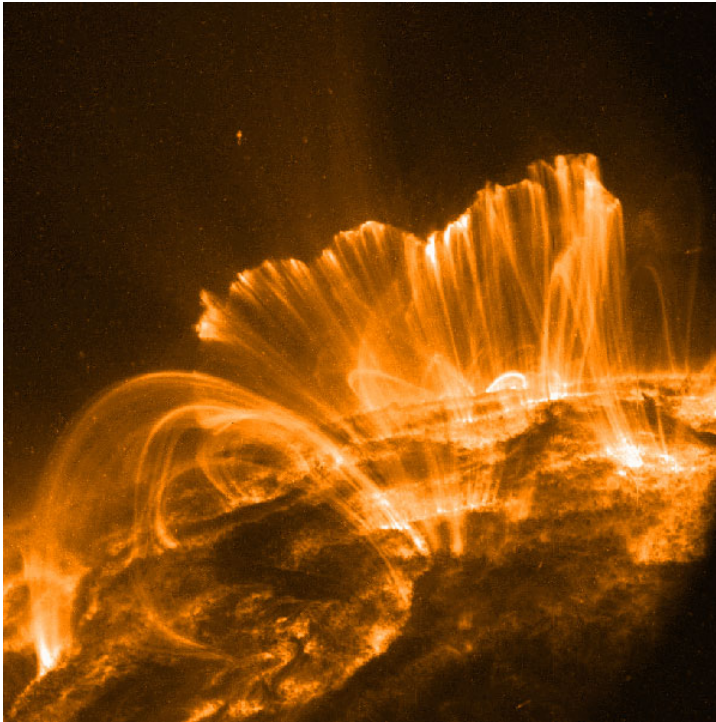
# Magnetic Field Line Tangling and Topological Entropy

Simon Candelaresi, David Pontin, Gunnar Hornig



# Magnetic Fields

NASA



*(Thiffeault et al. 2006)*

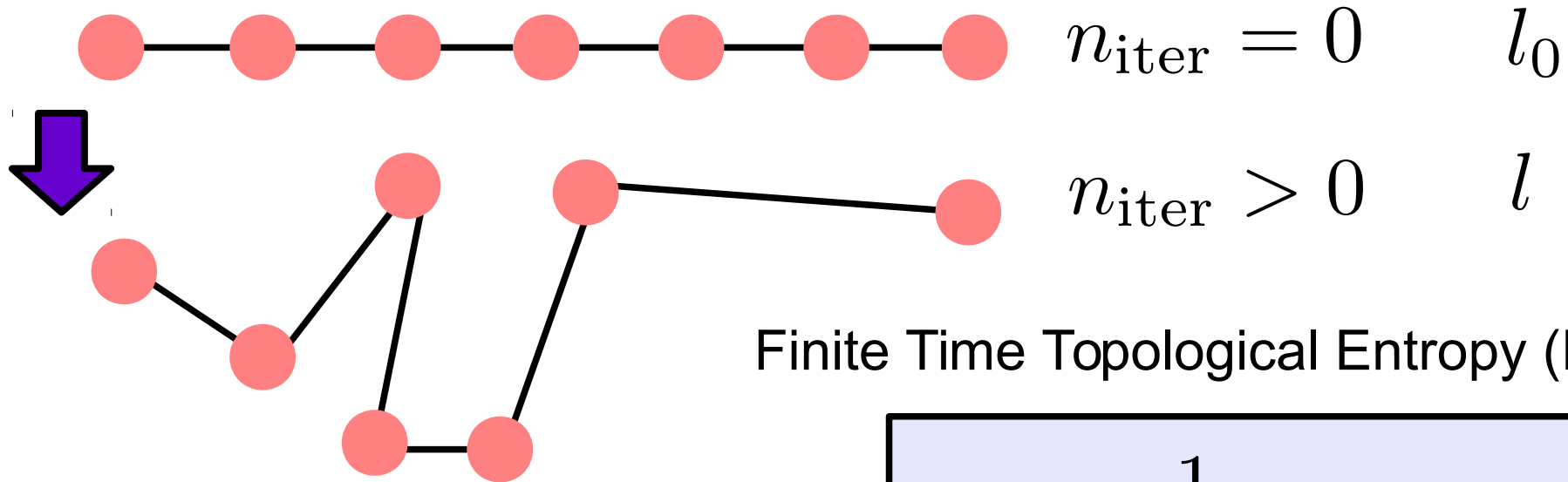


Field line tangling in solar and laboratory magnetic fields.



Study the tangling of magnetic field lines.

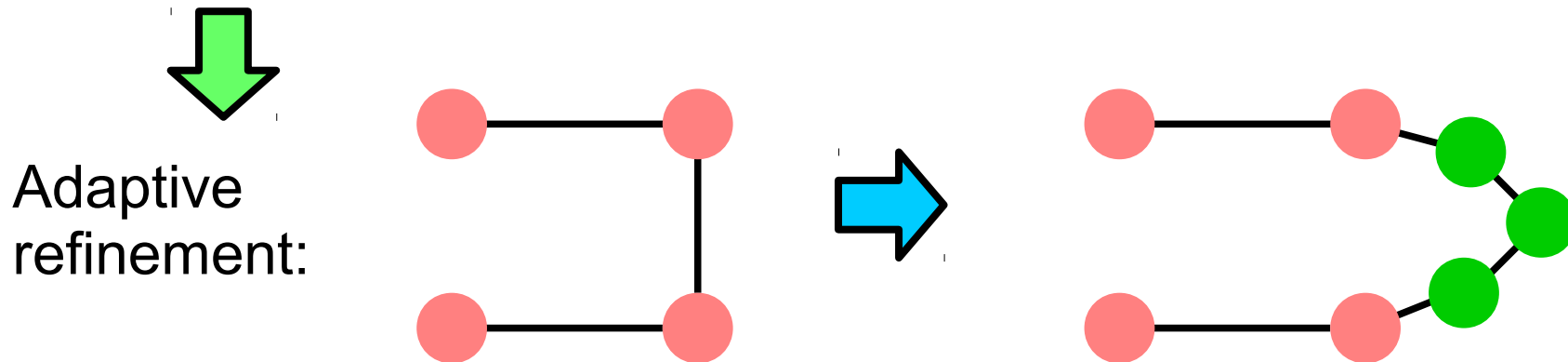
# Topological Entropy



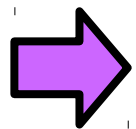
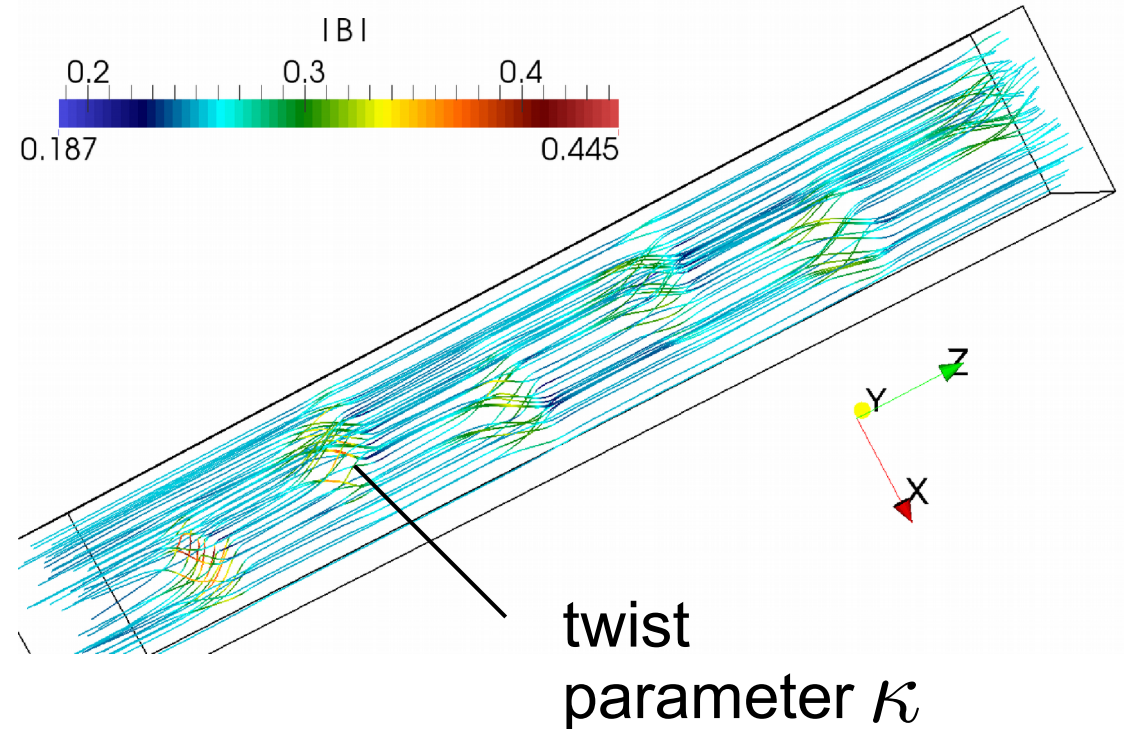
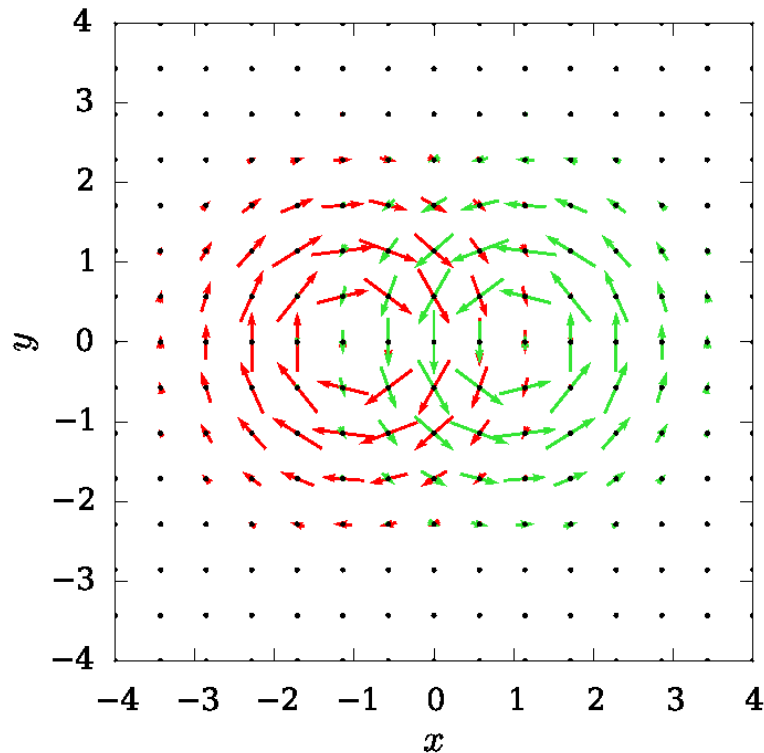
Finite Time Topological Entropy (FTTE):

$$h = \frac{1}{n_{\text{iter}}} \ln(l/l_0)$$

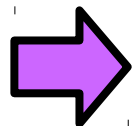
 Number of necessary points large!



# Blinking Vortex Experiments

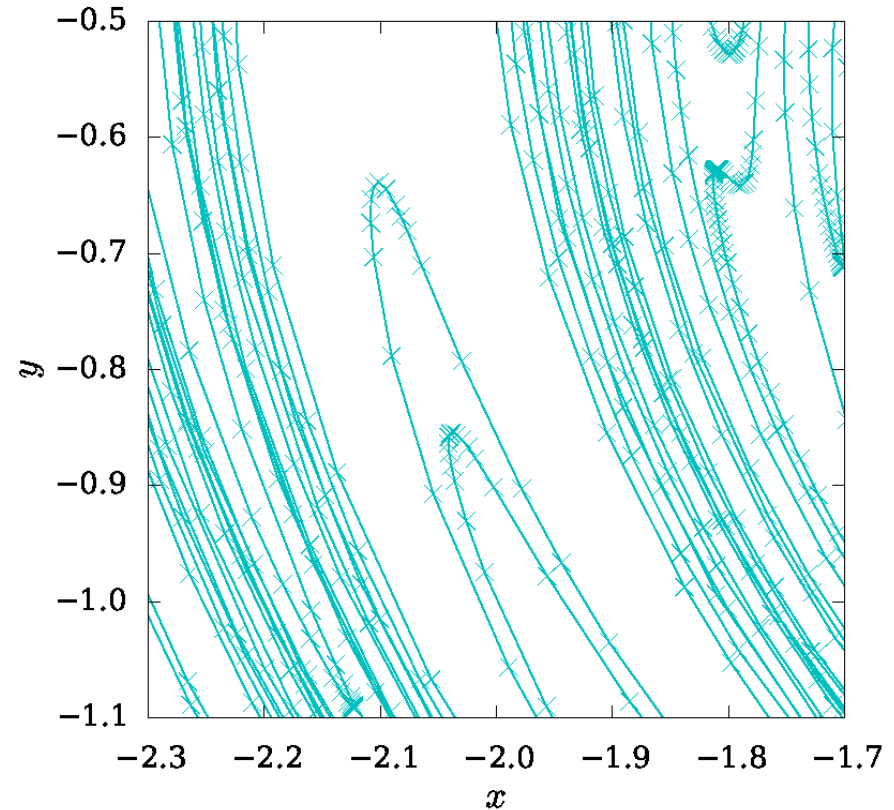
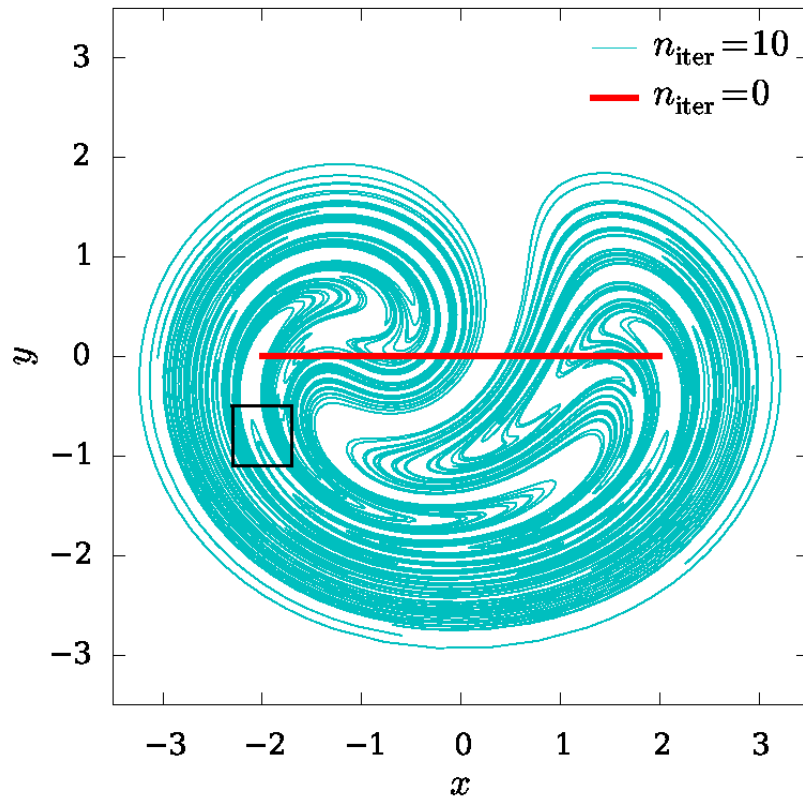


Repeated applications of the blinking vortex motion.



World lines correspond to 3d braided magnetic field.

# Blinking Vortex Experiments



(Candelaresi et al. 2017)

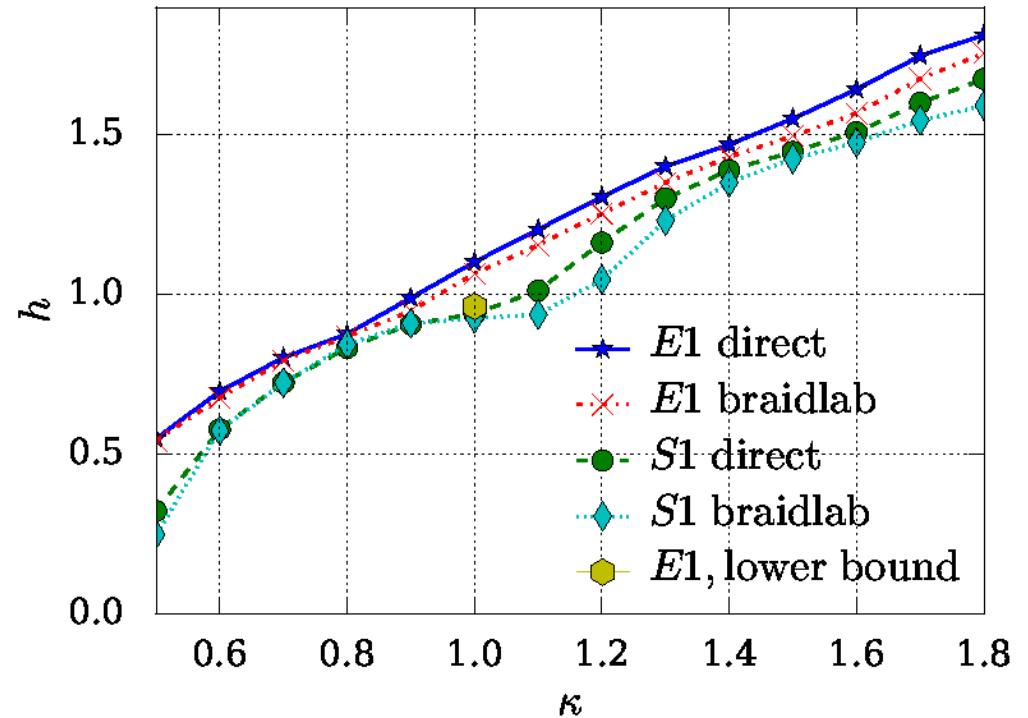
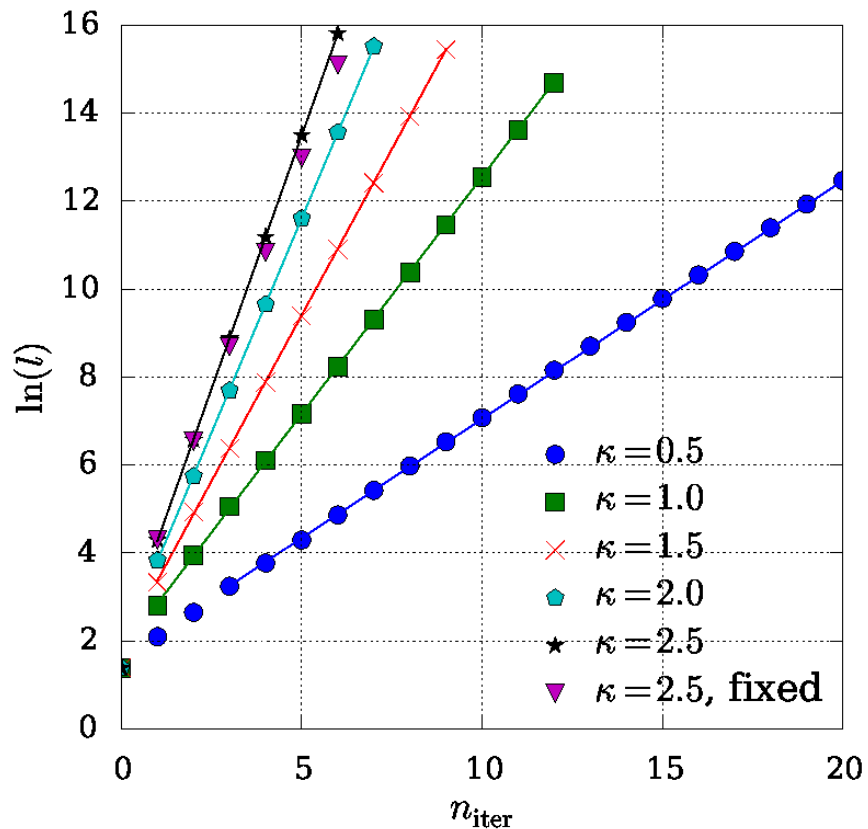


Adaptive refinement successfully increases resolution where needed.



Greatly decrease number of points.

# Blinking Vortex Experiments



(Candelaresi et al. 2017)

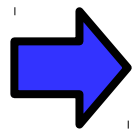
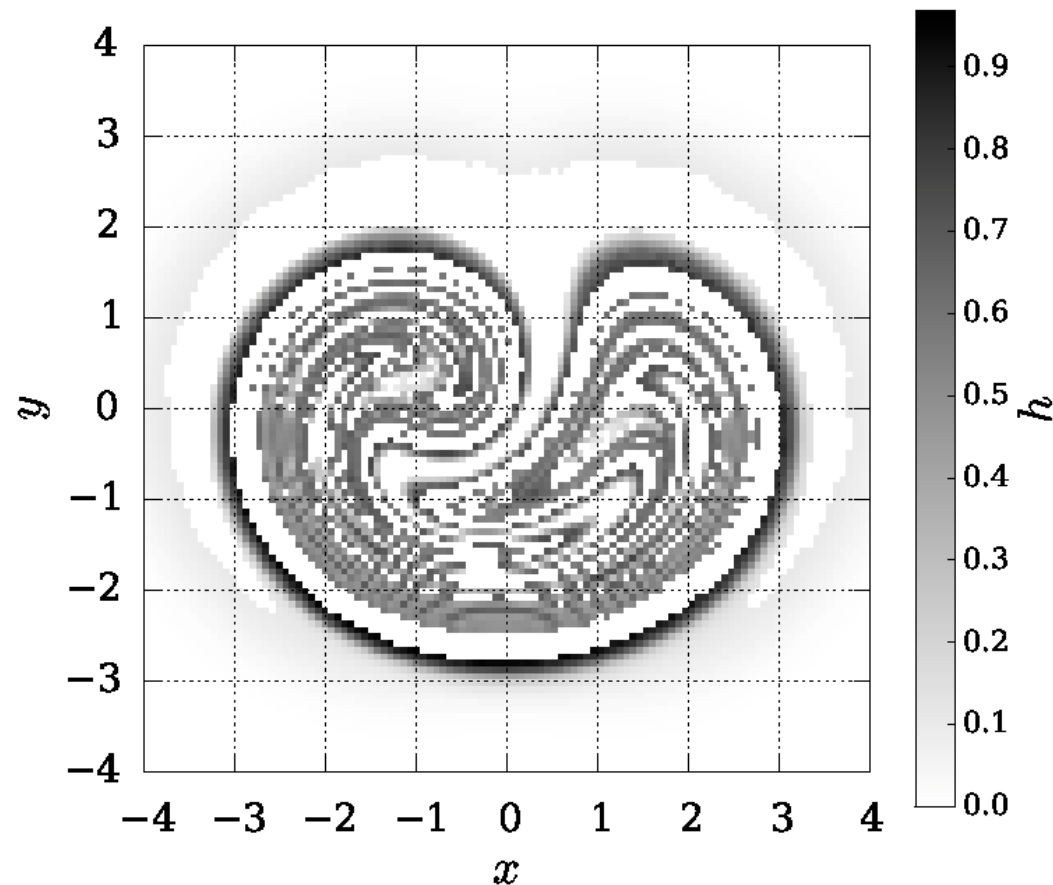


Speed up of 450x compared to previous methods.



Accurately compute the FTTE

# Topological Entropy Distribution



Map circles and measure their exponential stretching.



FTTE distribution shows areas of chaotic behavior.

# Conclusions

- Measure field line tangling through topological entropy.
- Estimate the entropy through material line stretching.
- Adaptively refine calculations.
- Speed up of 450x.
- Spatial topological entropy distribution.