Time-resolved evolution of the wall-bounded vorticity cascade

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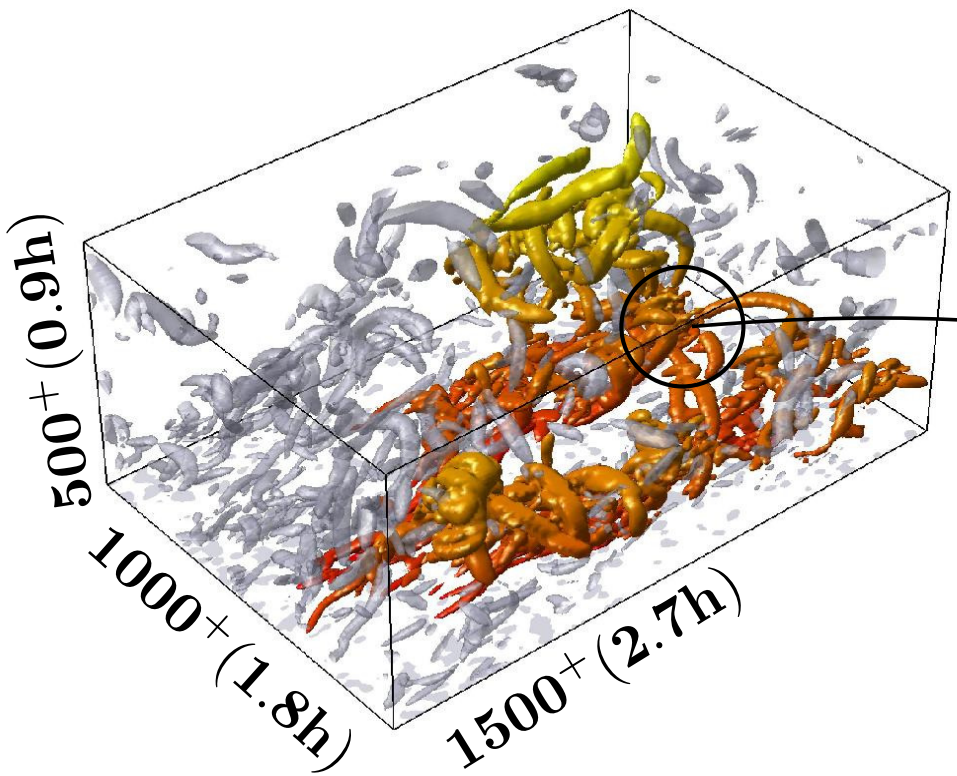
Numerical Experiments & Vortex Clusters

$\mathbf{Re_\tau}$	$\mathbf{L_x/h}$	$\mathbf{L_z/h}$	$\mathbf{N_F}$	$\mathbf{T}$
950	π	$\pi/2$	$\mathbf{10^4}$	**10**

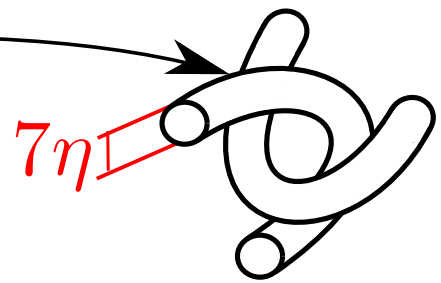
Numerical Experiments

DNS in Channel



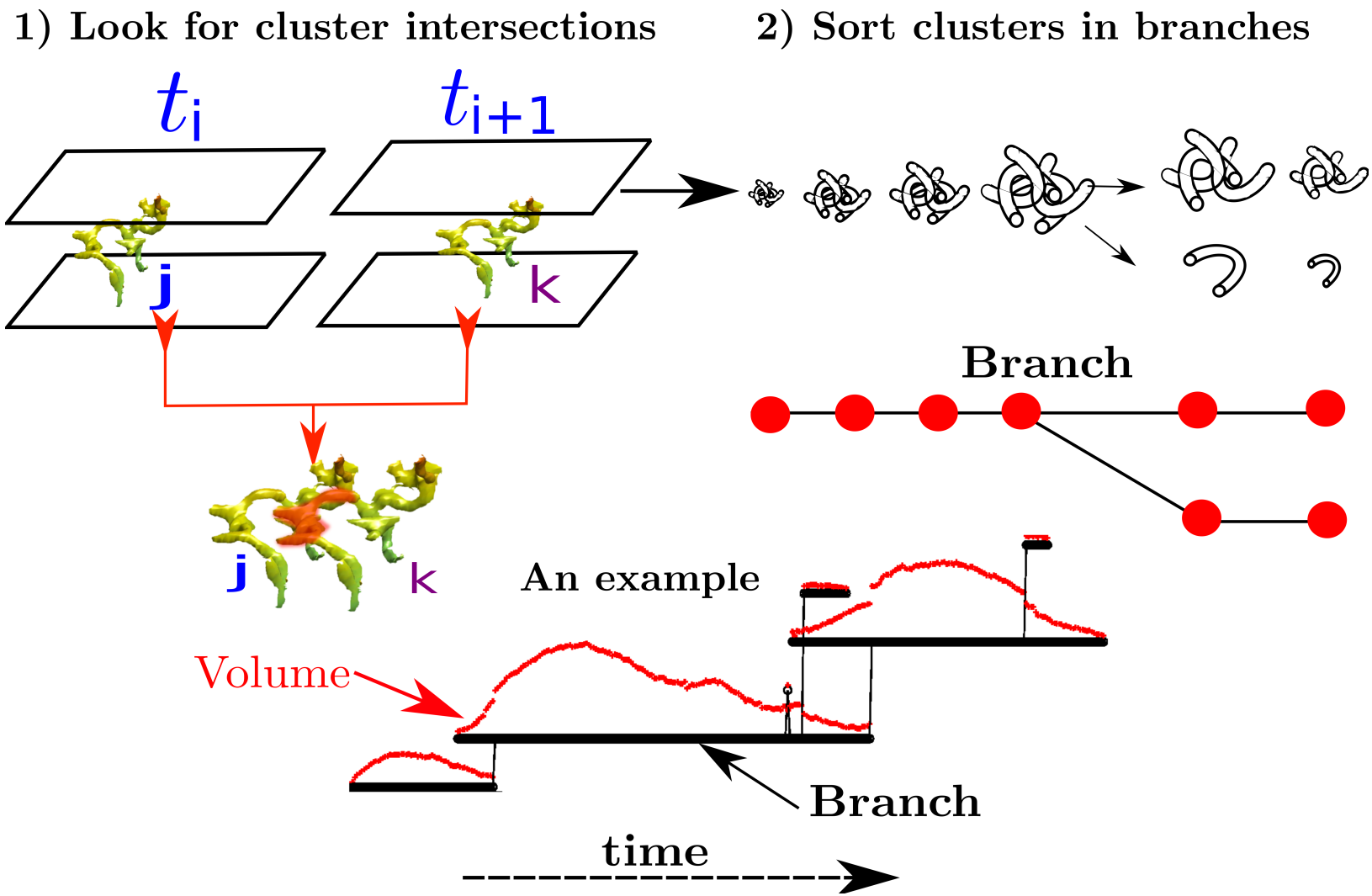
Vortex Clusters

$$\mathbf{D(x) > \alpha D'(y)}$$

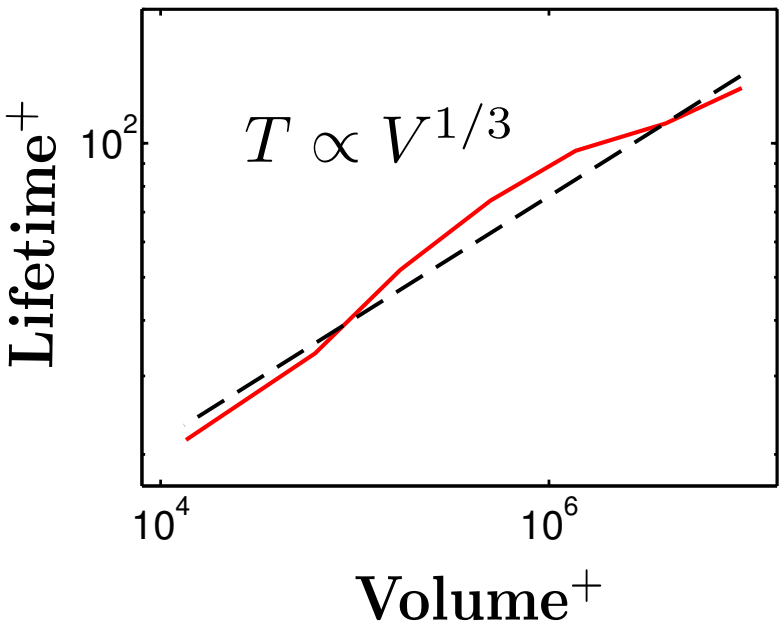


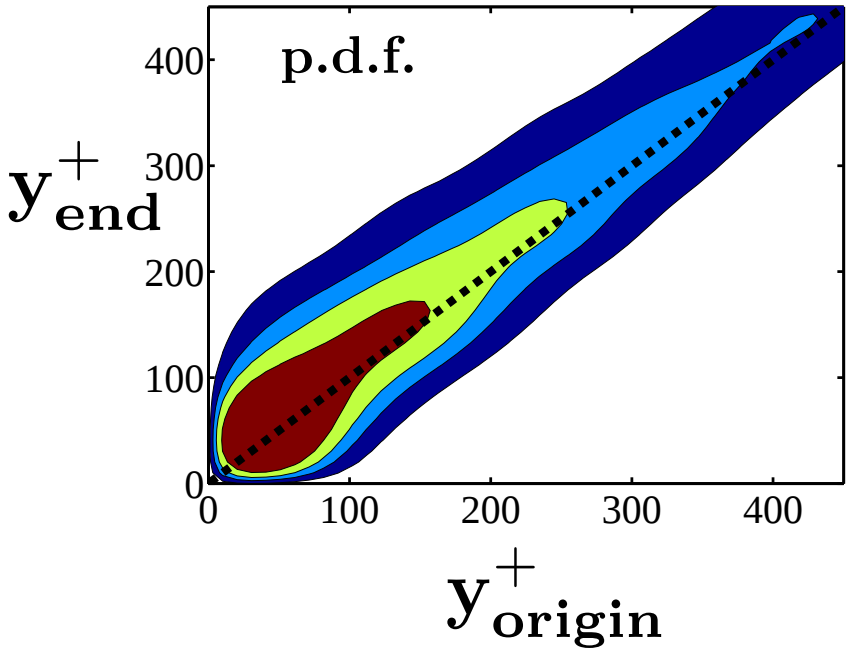
sponge of strings

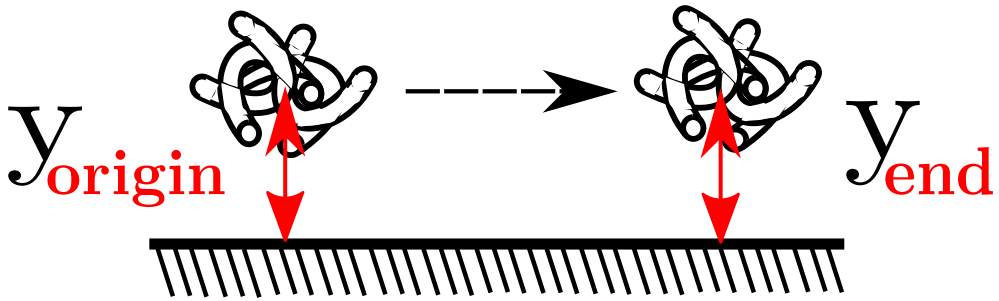
Tracking Method



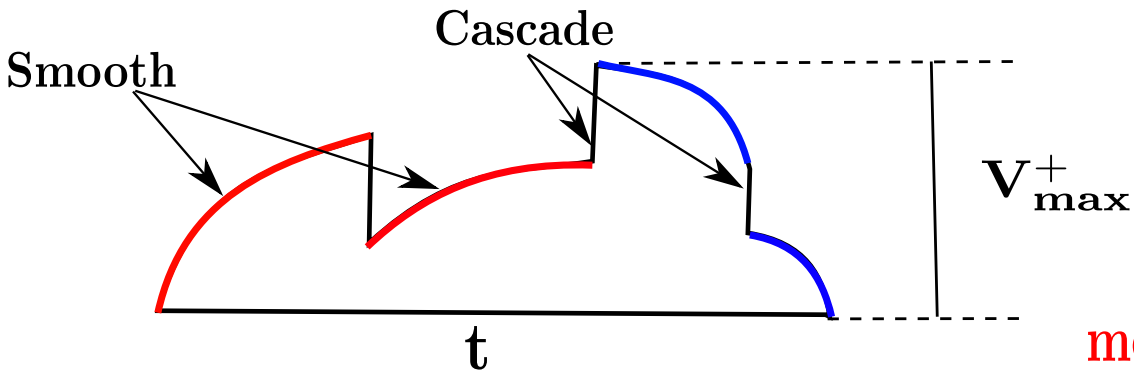
Lifetimes & Wall-normal Displacement

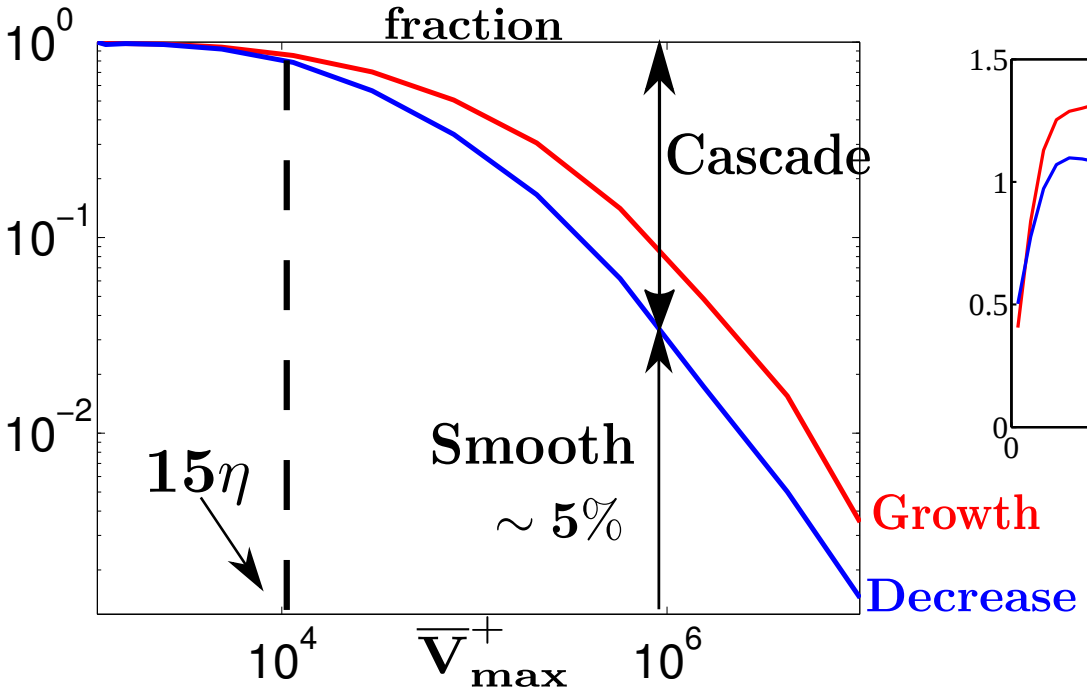


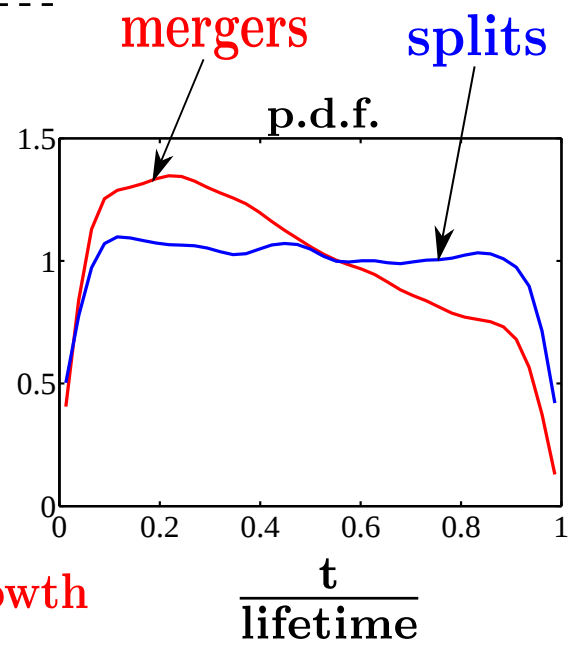




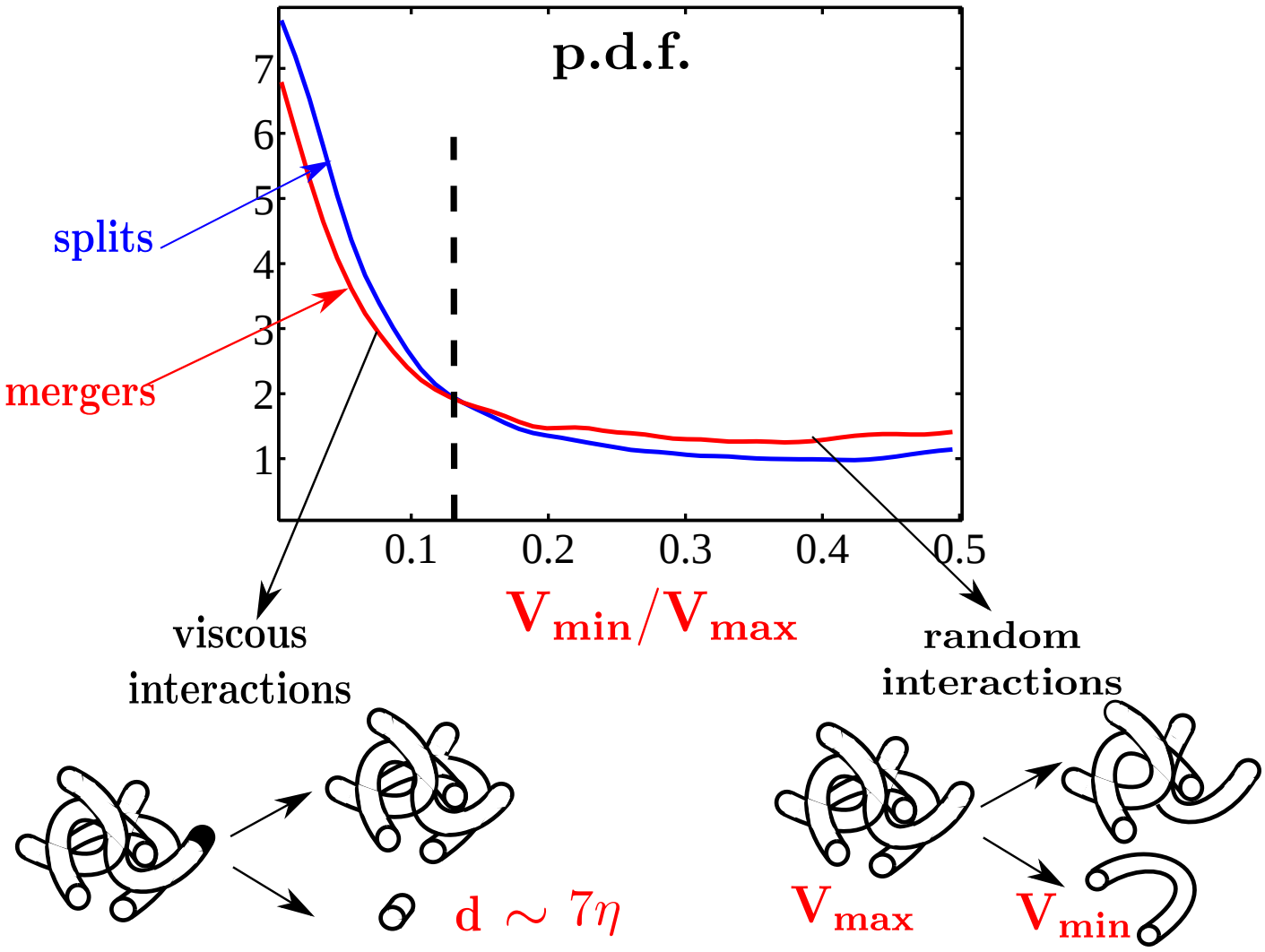
Smooth Growth & Decrease vs. Cascade







Volume Fractions during the Cascade



Conclusions

1. We can track in time 3D coherent structures.
2. Their lifetimes are proportional to the cube root of the maximum volume attained by them.
3. Their probability of moving away from the wall is only slightly higher than that of moving towards it and independent of their inception.
4. Vortex clusters grow and decay mostly by mergers (inverse cascade) and splits (direct cascade) if their size is above 15η.
5. Both mergers and splits look quite similar except for some differences near the viscous scale.
6. Splits happen at all times.
7. Mergers happen most probably at the beginning of the life.