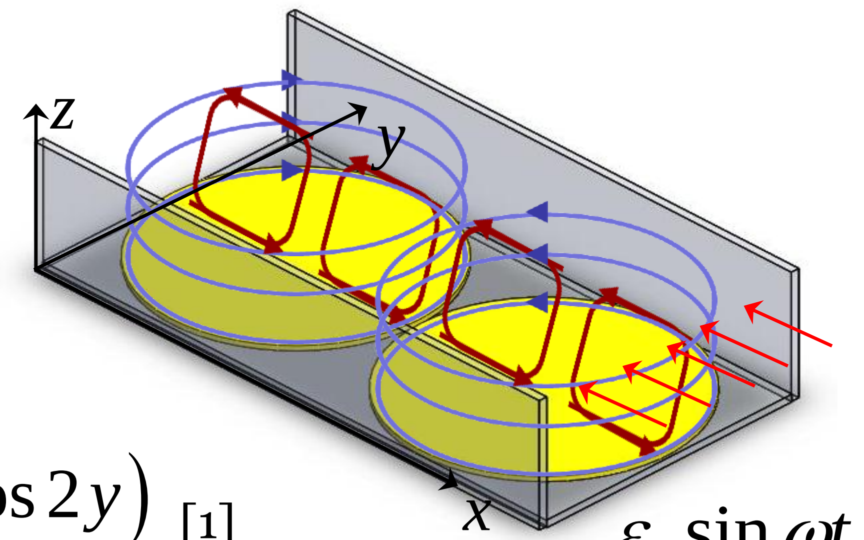
Physical/Dynamical System

- Dynamics of an Advected Particle

$$\dot{x} = \cos\left(x + \varepsilon_0 \sin \omega t\right)\sin y$$
$$+\varepsilon_1 \sin\left(2x + 2\varepsilon_0 \sin \omega t\right)\sin z$$
$$\dot{y} = -\sin\left(x + \varepsilon_0 \sin \omega t\right)\cos y$$
$$+\varepsilon_1 \sin 2y \sin z$$
$$\dot{z} = 2\varepsilon_1 \cos z\left(\cos\left(x + \varepsilon_0 \sin \omega t\right) + \cos 2y\right)$$ [1]

- Flow Structure

[1]



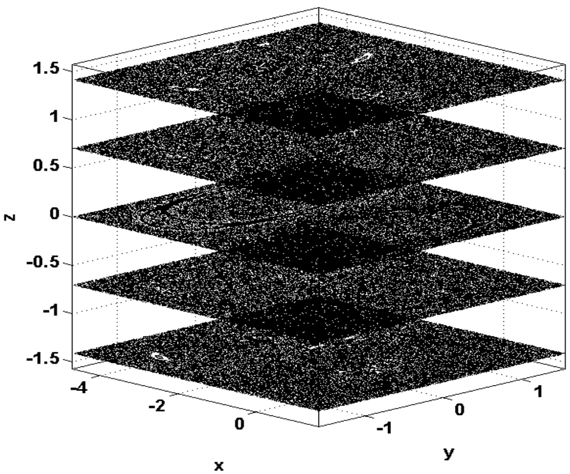
$\varepsilon_0 \sin \omega t$

- ***Rayleigh-Bénard Convection Roll***
- ***Time Dependent Oscillation***
- ***3-D Ekman Pumping***

[1] T.H. Solomon and I. Mezic, Nature **425**, 376-380 (2003)

Long/Short-Time Transport Structures

- Poincaré Sections



Parameters

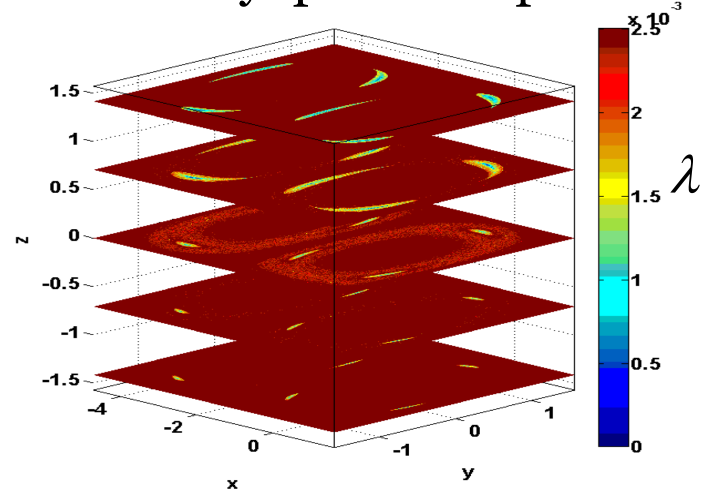
$$\varepsilon_0 = 0.10$$

$$\varepsilon_1 = 0.008$$

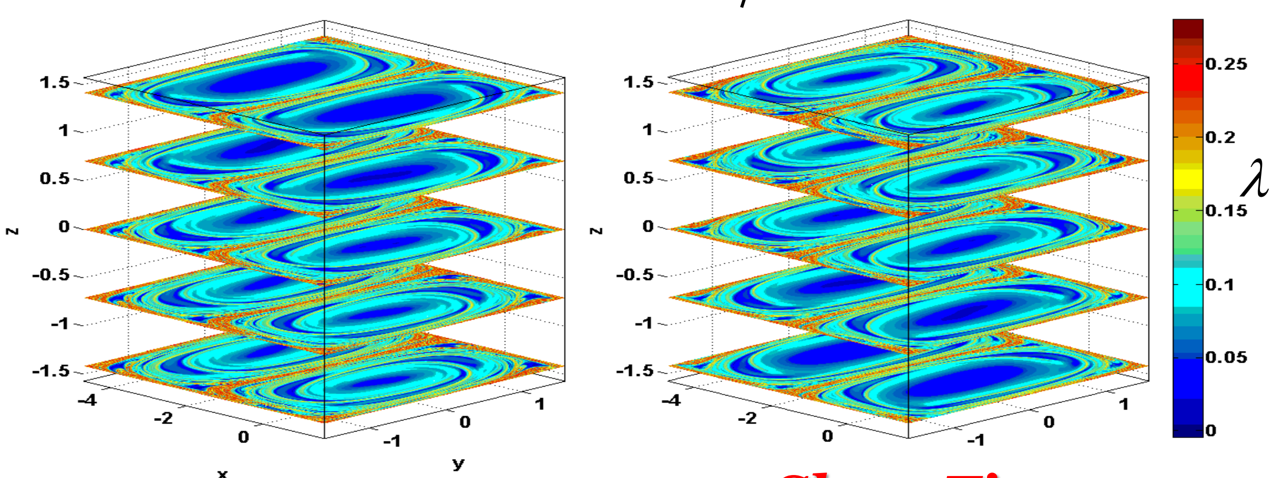
$$\omega = 2.00$$

Long Time

- Lyapunov Exponent

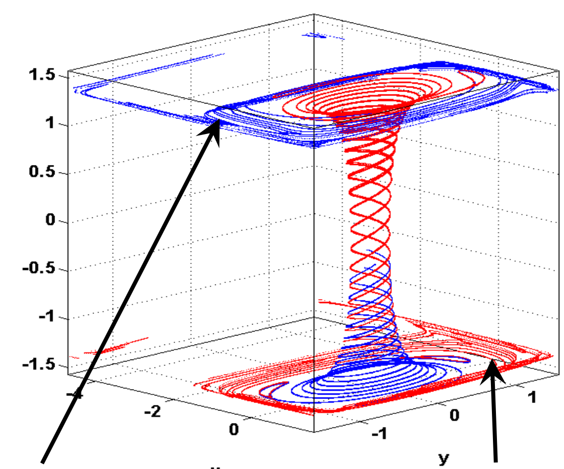


- F.T.L.E. $\tau = \pm 20\pi/\omega$



Short Time

- L.C.S.



Attractive

Repulsive

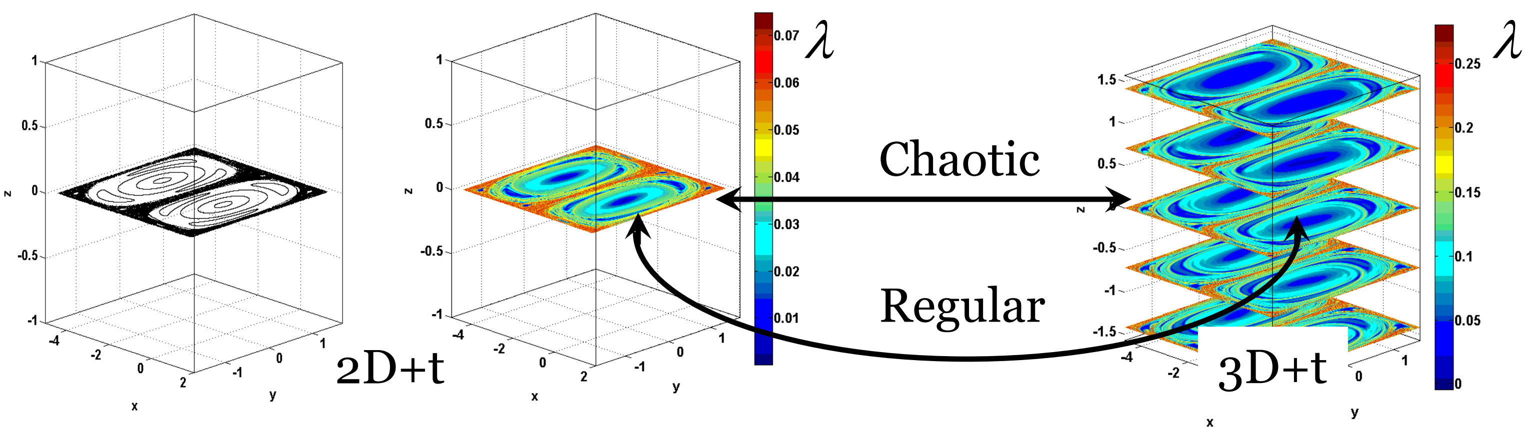
Conclusion

- Different transport structures at short-time & at long-time

Short-time: chaotic transport around half-cell boundaries, "regular" transport in the center

Long-time: chaotic transport well spread throughout the cell

- Similarities between 2D+t and 3D+t at short-time



- Importance of time scale for observations