Velocimetry in wide-gap spherical Couette flow

TREND Fair 2004

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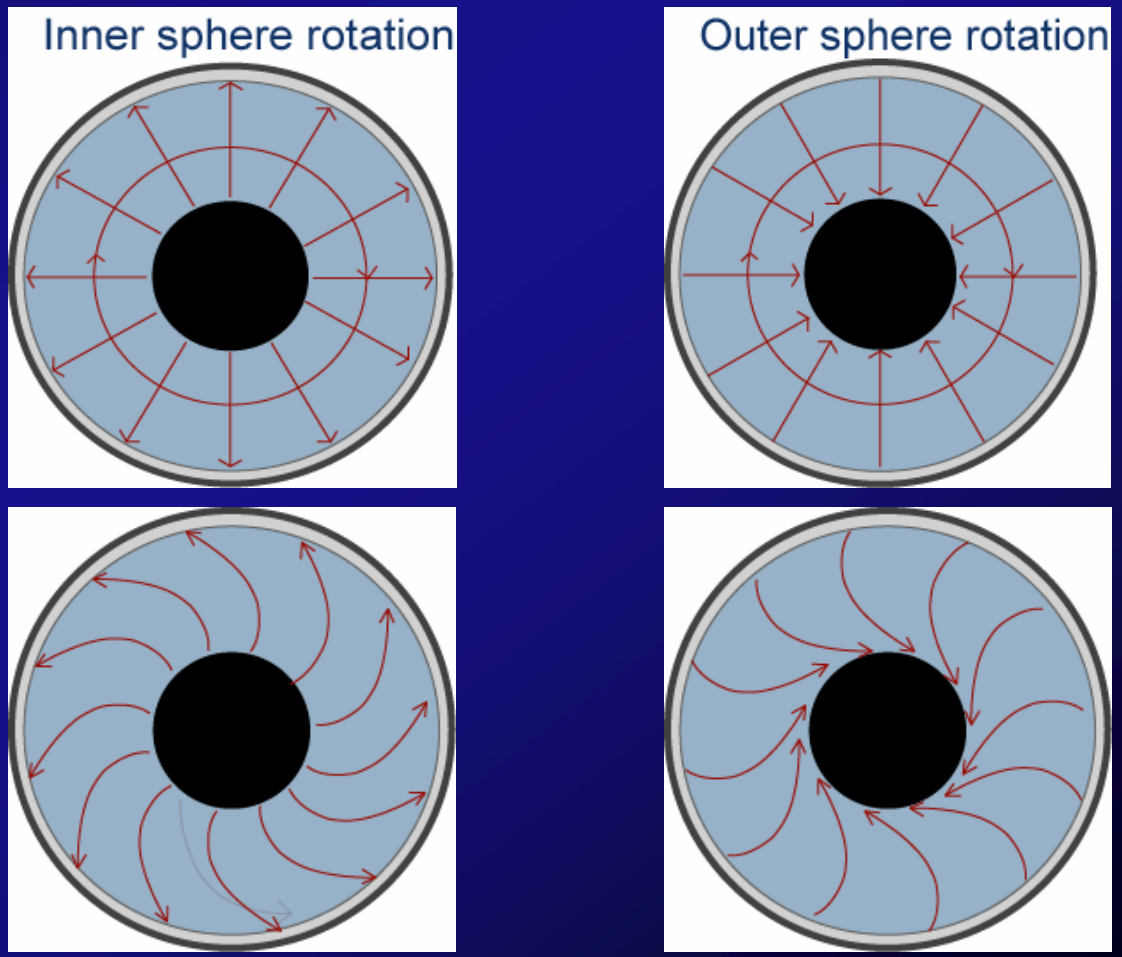
What is spherical Couette flow?

- Two concentric spheres with a fluid-filled gap
- The inner, outer, or both spheres rotate about a single axis.
- Gap width:

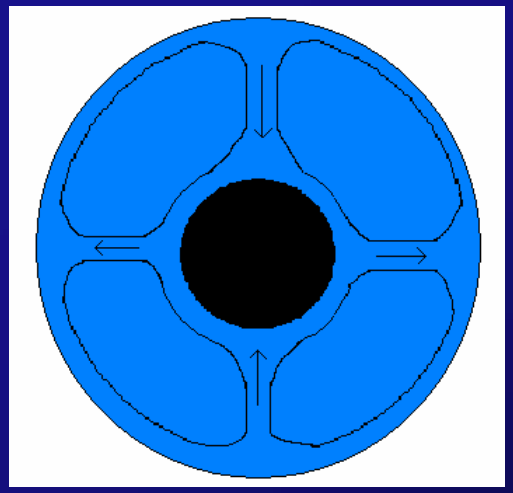
$$\beta = \frac{R_o - R_i}{R_i}$$

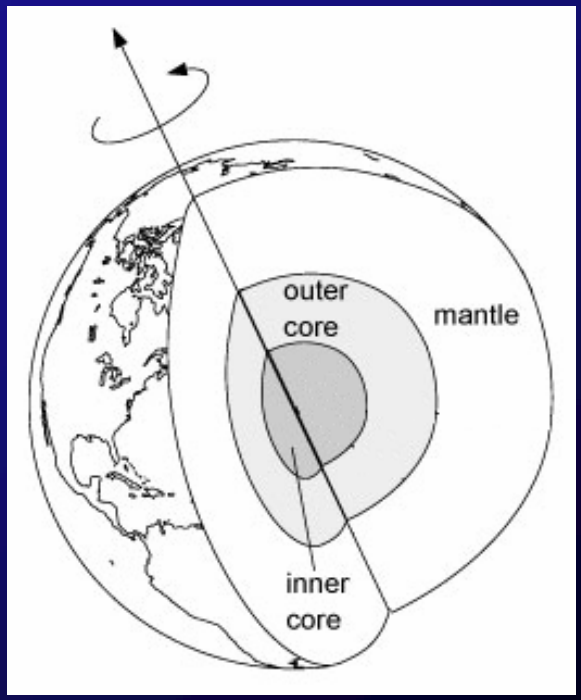
View in equatorial plane of basic flow:



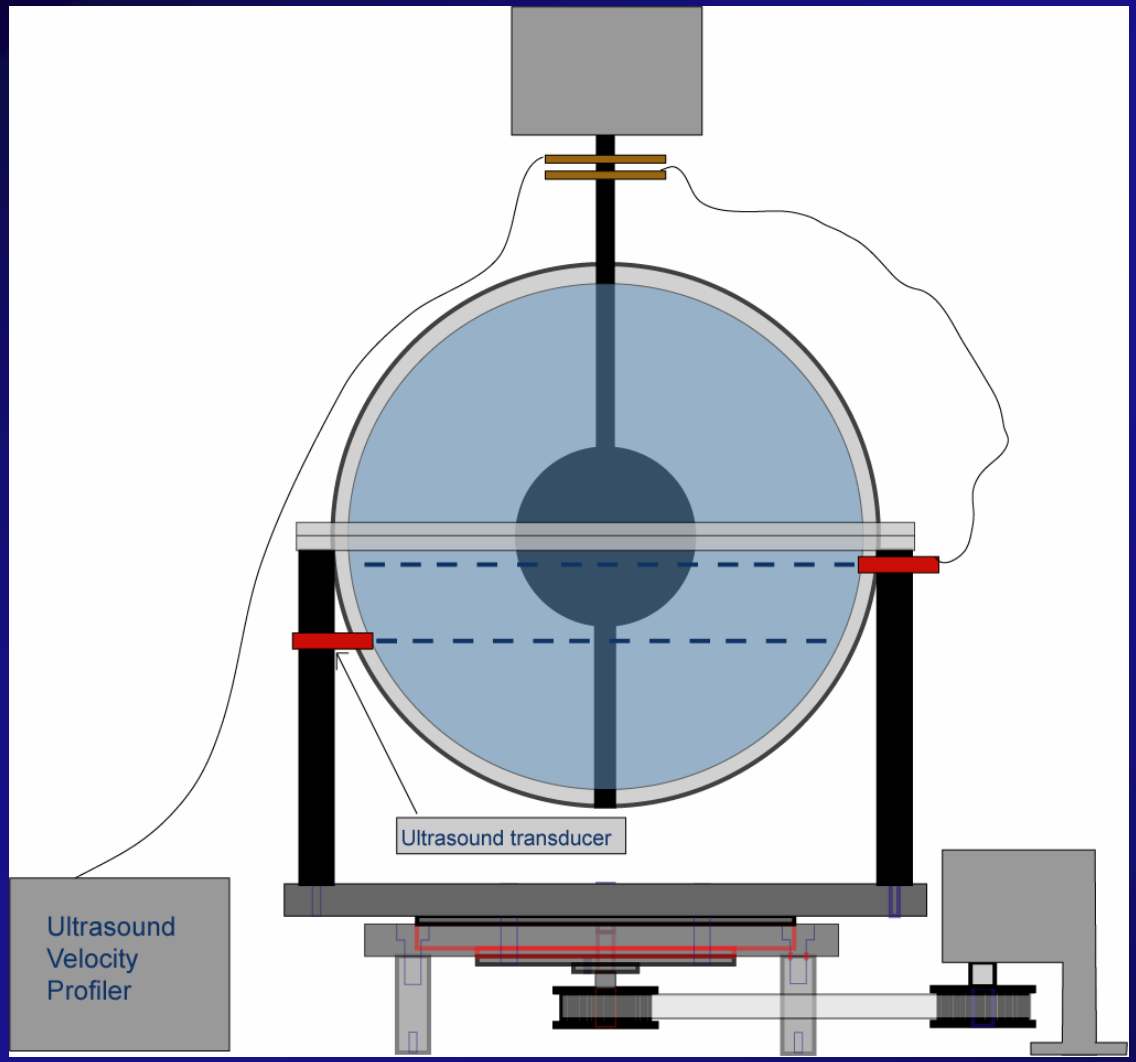
Motivation behind the research

- Magnetic field of the earth is generated via liquid dynamo.
- pol: tor ~ 1 is ideal for magnetic field self-generation





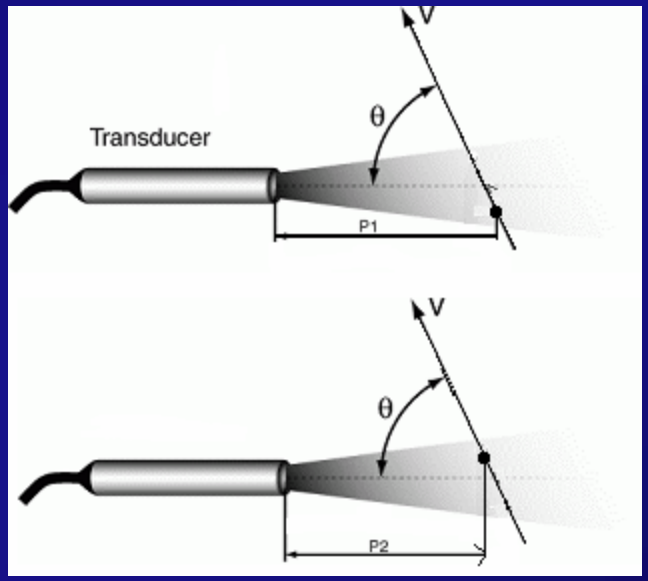
Experimental Apparatus



- $\Re = 2.1$
- Modifications made in order to independently rotate outer sphere this summer.

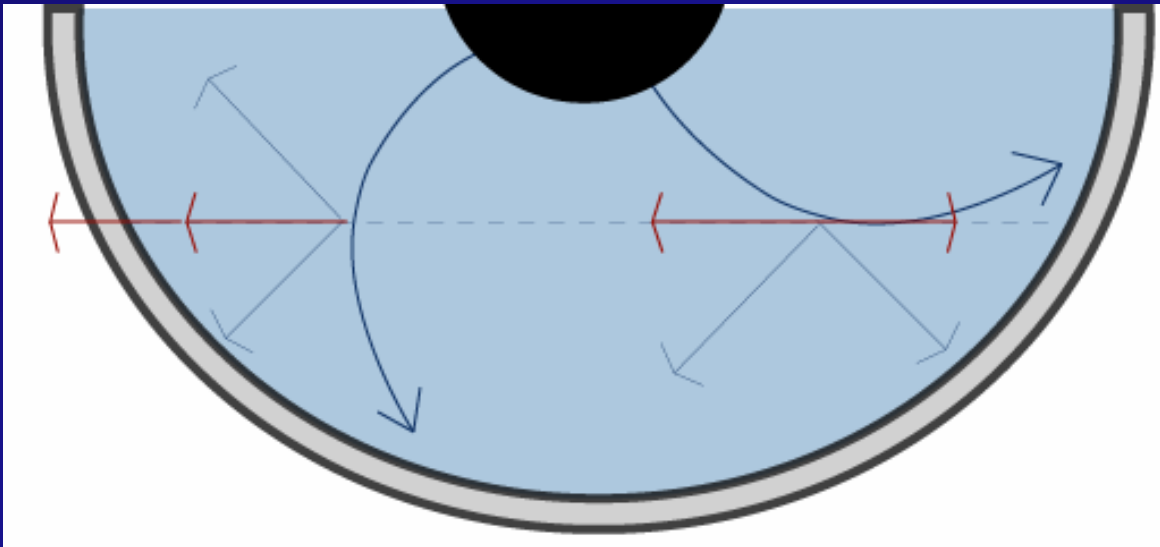
Ultrasound Doppler Velocimetry

- Doppler shifts determine velocity profile and particle location.
- 1024 profiles taken per file



Method of Data Analysis

Visualization of the flow on a chord axis in terms of its toroidal (odd) and poloidal (even) components

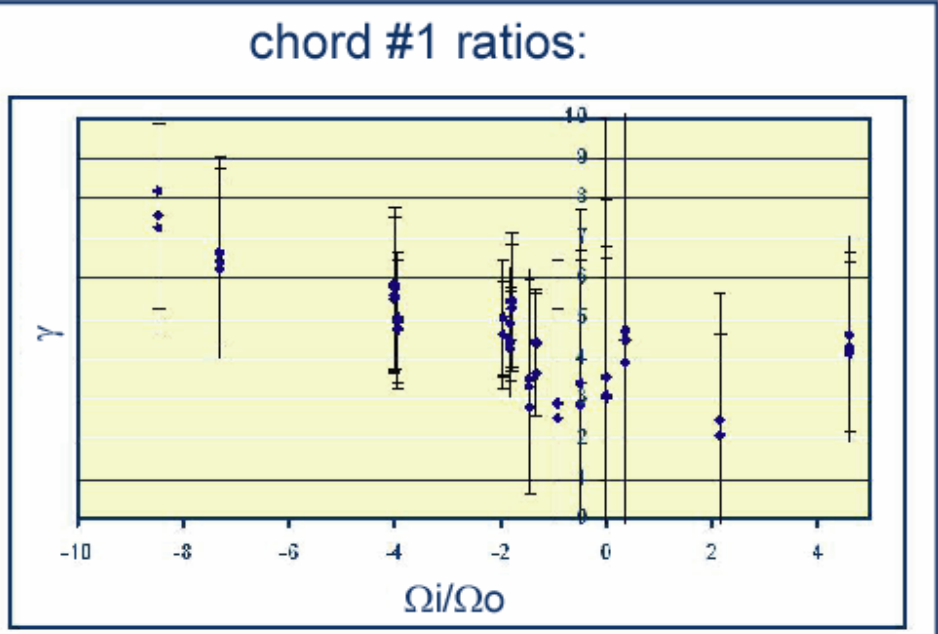


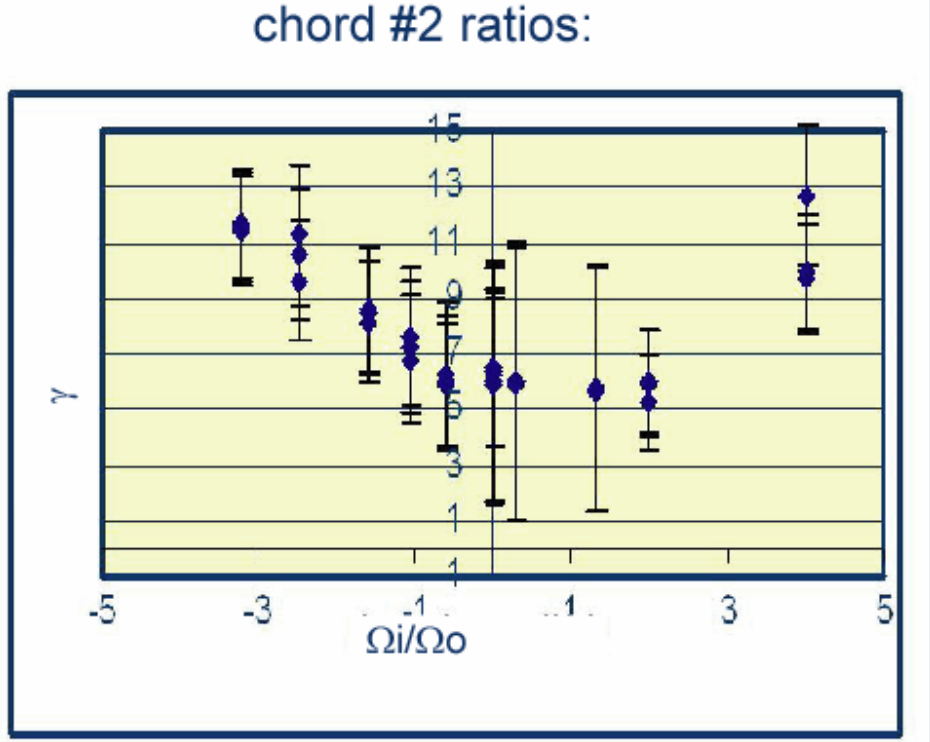
$$tor : pol \equiv \gamma = \frac{\| v_{tor} \|_2}{\| v_{pol} \|_2}$$

Results

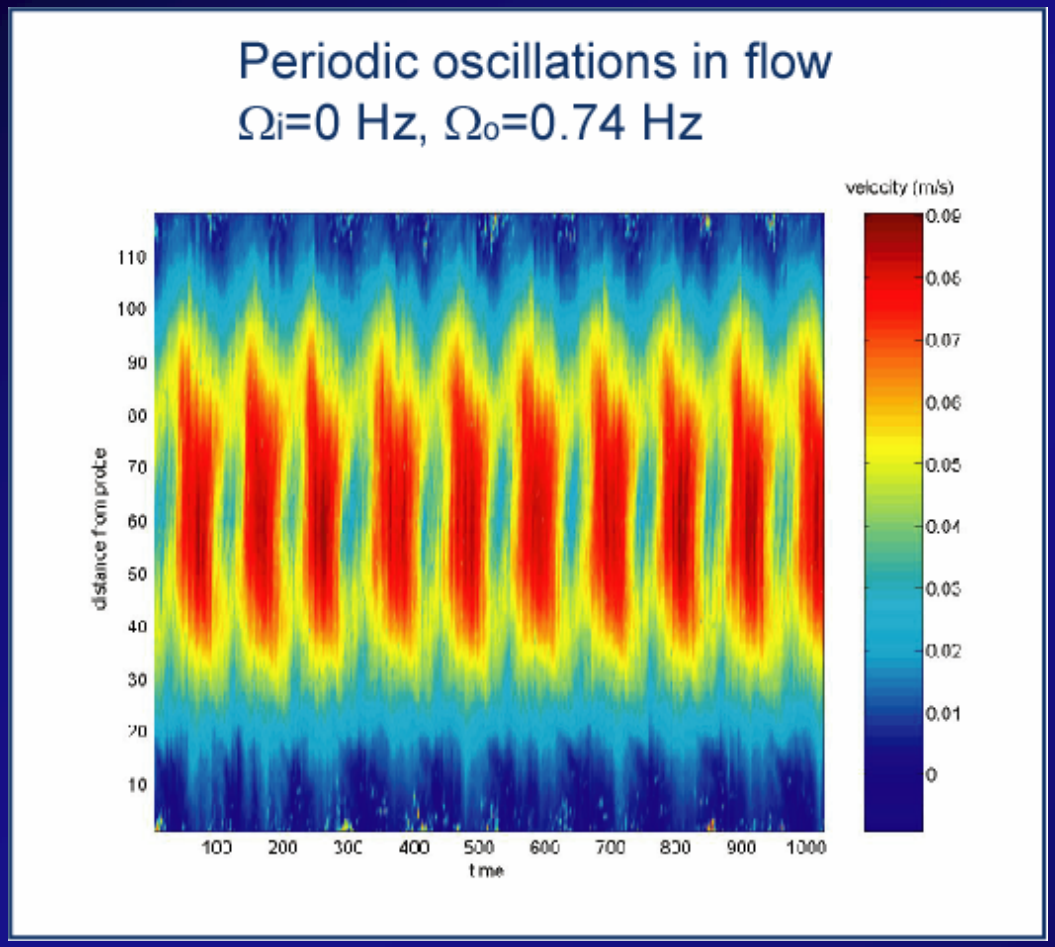
Both chord locations show a general trend toward lower toroidal: poloidal ratios in the case that

$$-2 < \frac{\Omega_i}{\Omega_o} < 2$$





Results



Fluctuations in flow appear throughout most of the data, likely caused by spiral waves. The period of these oscillations is in the vicinity of $T_{osc}/T_o \approx 9.5$

Conclusions and Further Research

- most optimal conditions for self-generation when

$$-2 < \frac{\Omega_i}{\Omega_o} < 2$$

- Further analysis on fluctuations in the data acquired here will provide a better understanding of the oscillatory behavior of the flow

Acknowledgements

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