Attractor? I Hardly Know Her!

featuring rotations and ODEs in VR

2016 Spring MEGL Symposium

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This Semester

- Rotations Demo
- Chaotic Attractors ODE Solver

Rotations

- Exploring IUPUI's Daniel Ramras' paper "How efficiently can one untangle a double-twist? Waving is believing!"
- Nullhomotopy in SO(3)
  - Dirac belt trick
  - Philippine candle dance

More formally…

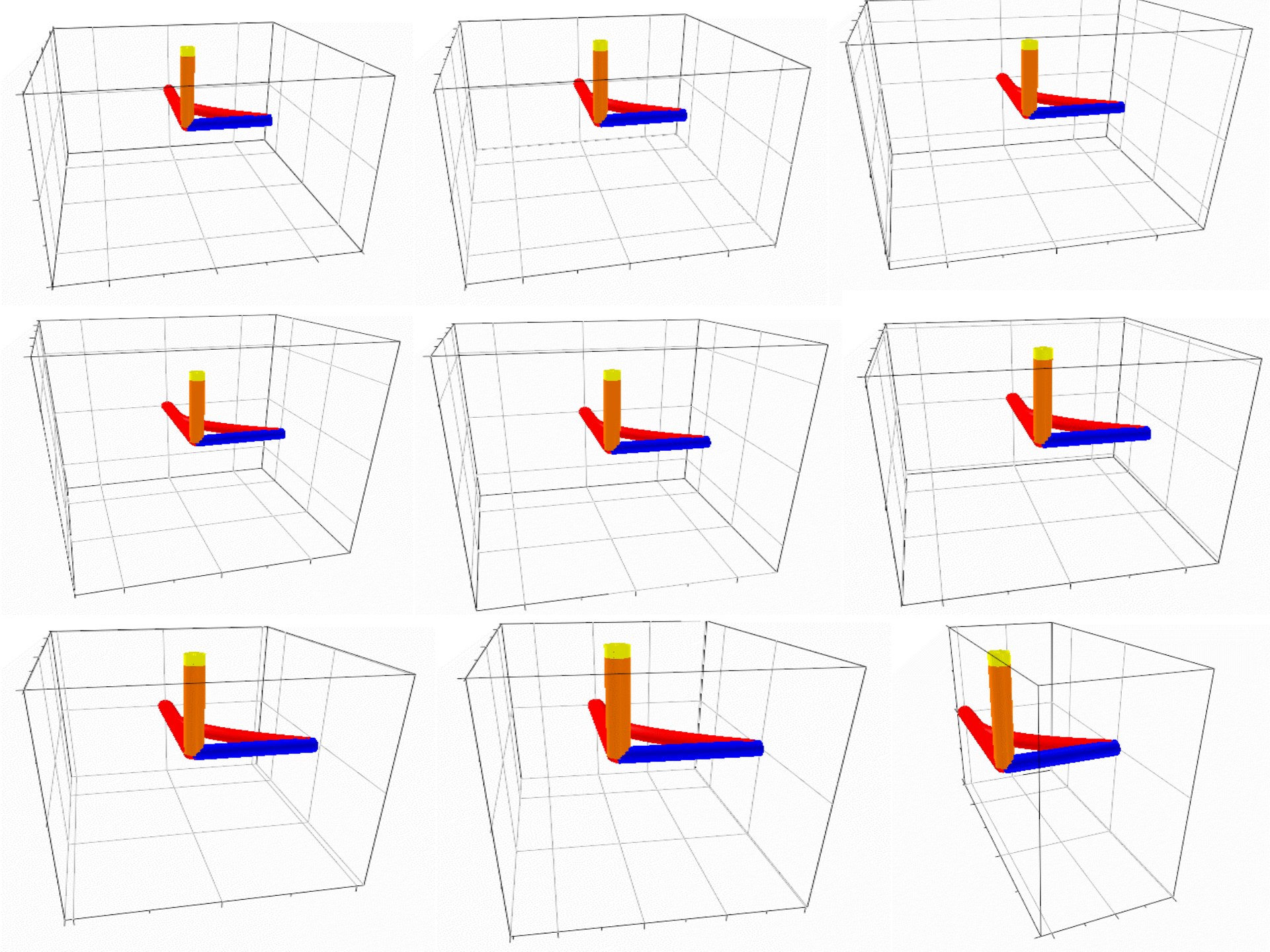
- Double twist can be given by the mapping:

$$\hat{D}(s,t) = (1 - 2\cos^2 s \sin^2(t/2)) + I(\sin(2s)\sin^2(t/2)) + K(\cos s \sin t)$$

where $0 \le s \le \pi/2$ and $0 \le t \le 2\pi$

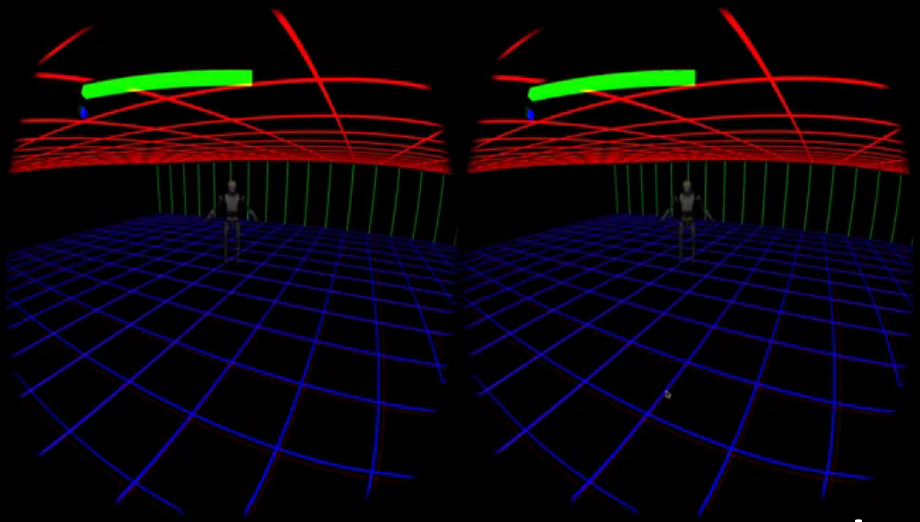
- I??? K???
  - Rotations can be conveniently described by *quaternions*
  - 4D complex numbers r + x I + y J + z K where

$$I^2 = J^2 = K^2 = IJK = -1$$



Throw Up Simulator (TUS)

- Implemented these rotations in Unity and Oculus Rift



- Feel free to test out your stomachs after the presentation

ODE Solver

- Solves ODEs in real time with user-selected initial conditions
  - LEAP motion
- Approximates solutions using a fourth-order Runge-Kutta method
- 15 chaotic attractors
  - Lorenz, Rossler, to name a few

“Strange” Attractors

$$\dot{x} = (z - \beta)x - dy$$

$$\dot{y} = \delta x + (z - \beta)y$$

$$\dot{z} = \gamma + \alpha z - \frac{z^3}{3} - (x^2 + y^2)(1 + \varepsilon z) + \xi z x^3$$

$$\dot{x} = \alpha(y - x) + \delta xz$$

$$\dot{y} = \zeta y - xz$$

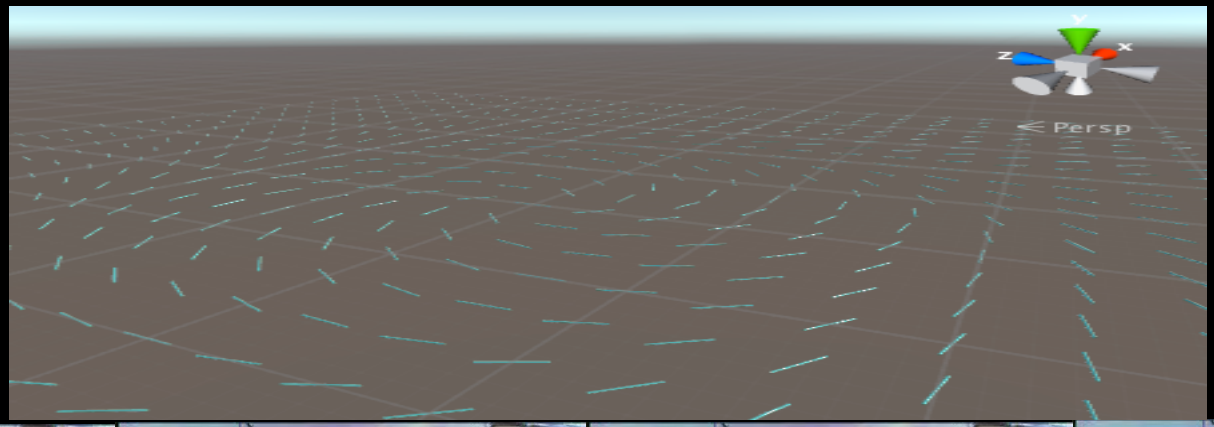
$$\dot{z} = \beta z + xy - \varepsilon x^2$$

Courtesy of ChaoticAtmospheres on DeviantArt

ODE Footage

Future Plans

- Turn ODE solver into outreach carnival game
  - Attractor golf



Future Plans

- Moduli spaces with Jack Love
- Hyperbolic geometry?

Acknowledgments

- Thank you to our advisor, Dr. Sean Lawton
- MEGL
- NSF

Stick around to experience the Rift