

CS53000 - Spring 2023

Introduction to Scientific Visualization

# Introduction

Jan 9, 2023

# Instructor

Xavier Tricoche [xmt@purdue.edu](mailto:xmt@purdue.edu)

- Associate Prof of Computer Science
- Visualization, Graphics, Data Analysis, Machine Learning, Scientific Computing, Applications
- LWSN 3154P

# Teaching Assistant

- Chris May [may5@purdue.edu](mailto:may5@purdue.edu)
- Office hours and meetings TBD



# Today

- Introduction
- Syllabus
- Class overview
- Graphics Intro
- Homework





**Arauna**  
realtime ray tracing





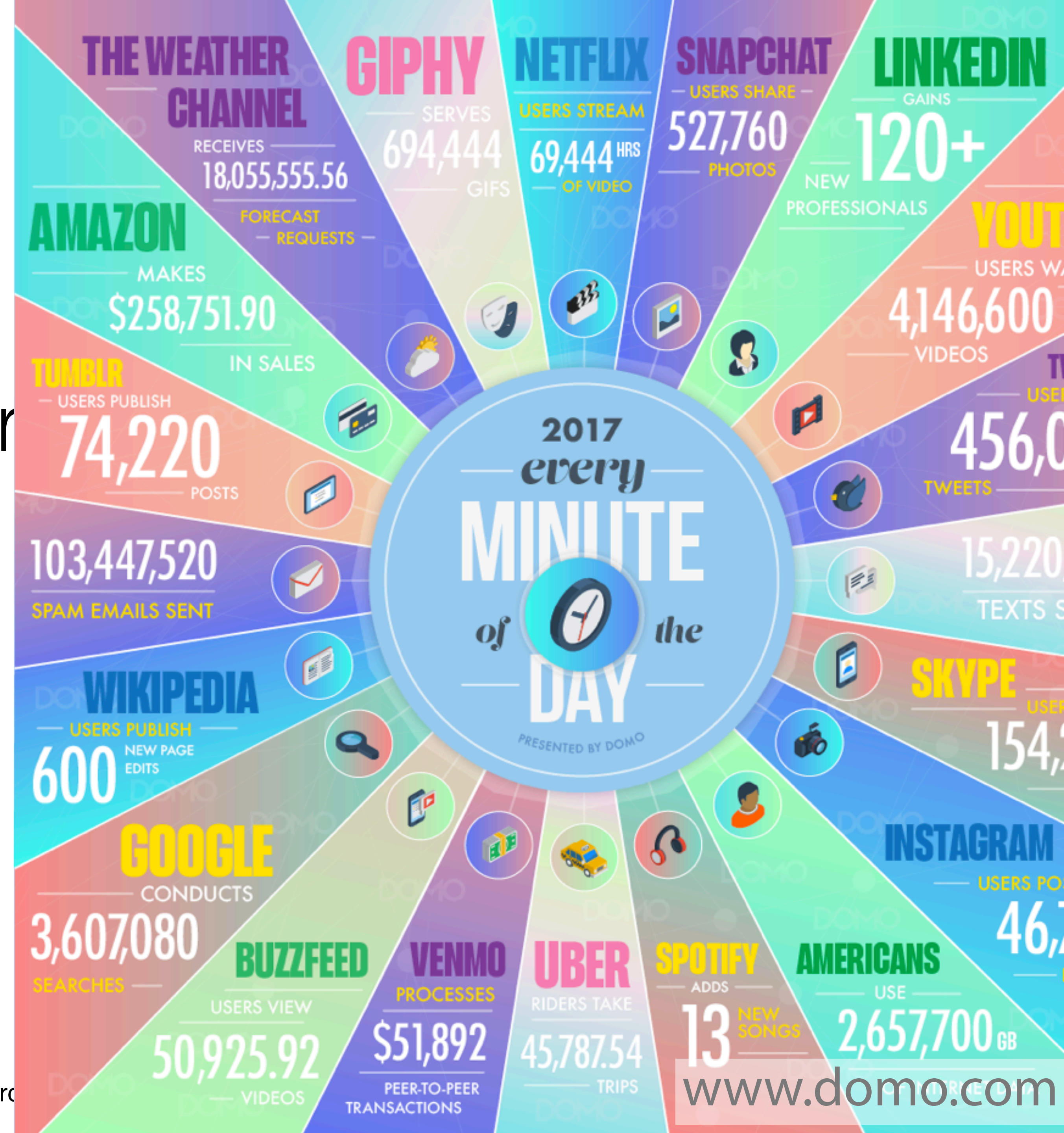
CS53000 is NOT a Computer Graphics class

Arauna  
realtime ray tracing



# Big

- $2.5 \times 10^{18}$  bytes/min
- 90% of world data cr



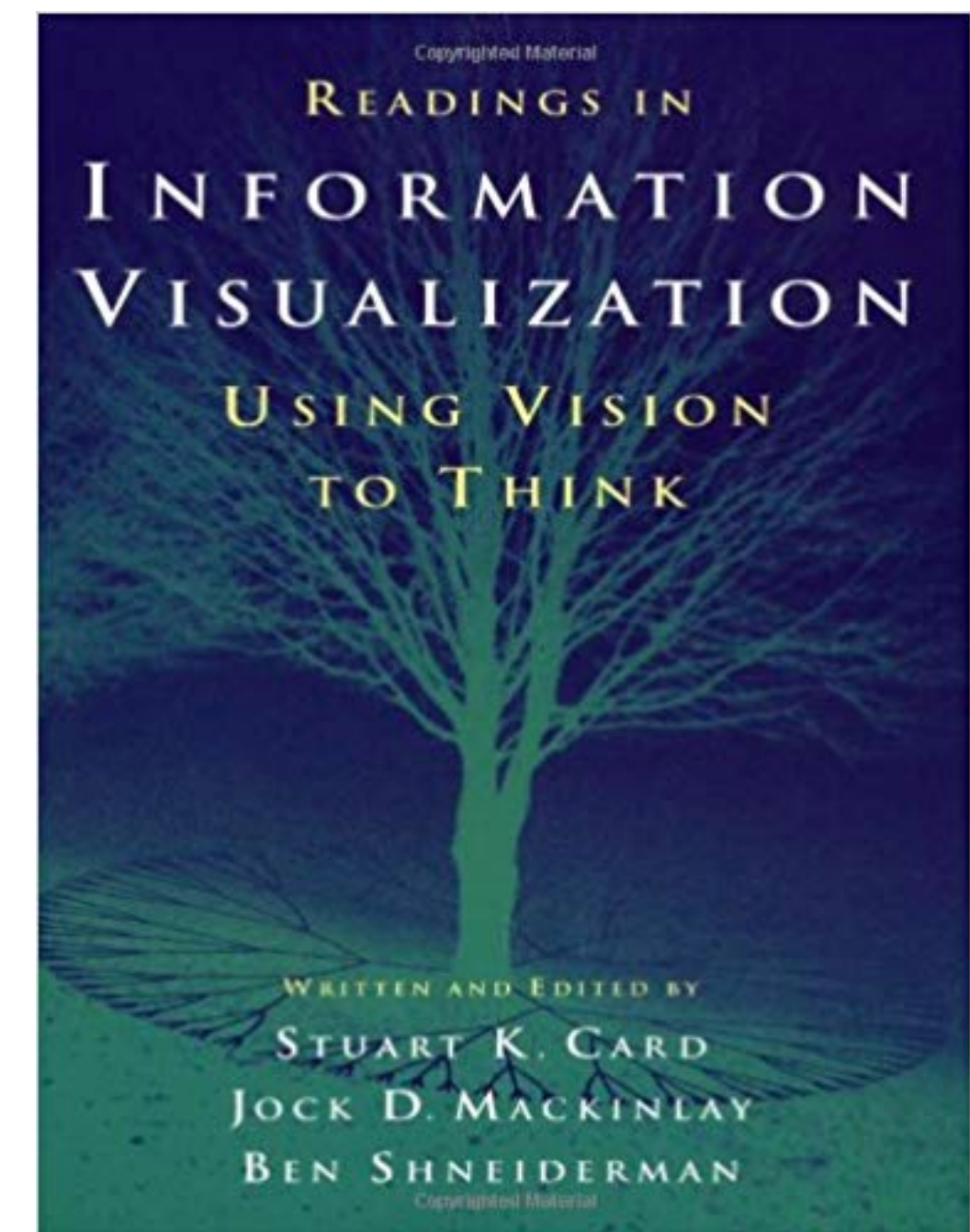
www.domo.com



# Classical Definitions

“The use of computer-generated, interactive, visual representations of data to amplify cognition.”

**[Card, Mackinlay, & Shneiderman 1999]**



# More Definitions

“Creation of images that convey salient information about underlying data and processes”

**[Hansen & Johnson, 2005]**

“Communication of information using graphical representations”

**[Ward et al., 2010]**

# More Definitions

"Computer-based visualization systems provide visual representations of datasets designed to help people carry out tasks more effectively."

**[Munzner, 2014]**





# Why Visualize?

To point out interesting things

MTHIVLWYADCEQGHKILKMTWYN  
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SGHLMFHKMVPSTWYACEQTWRN

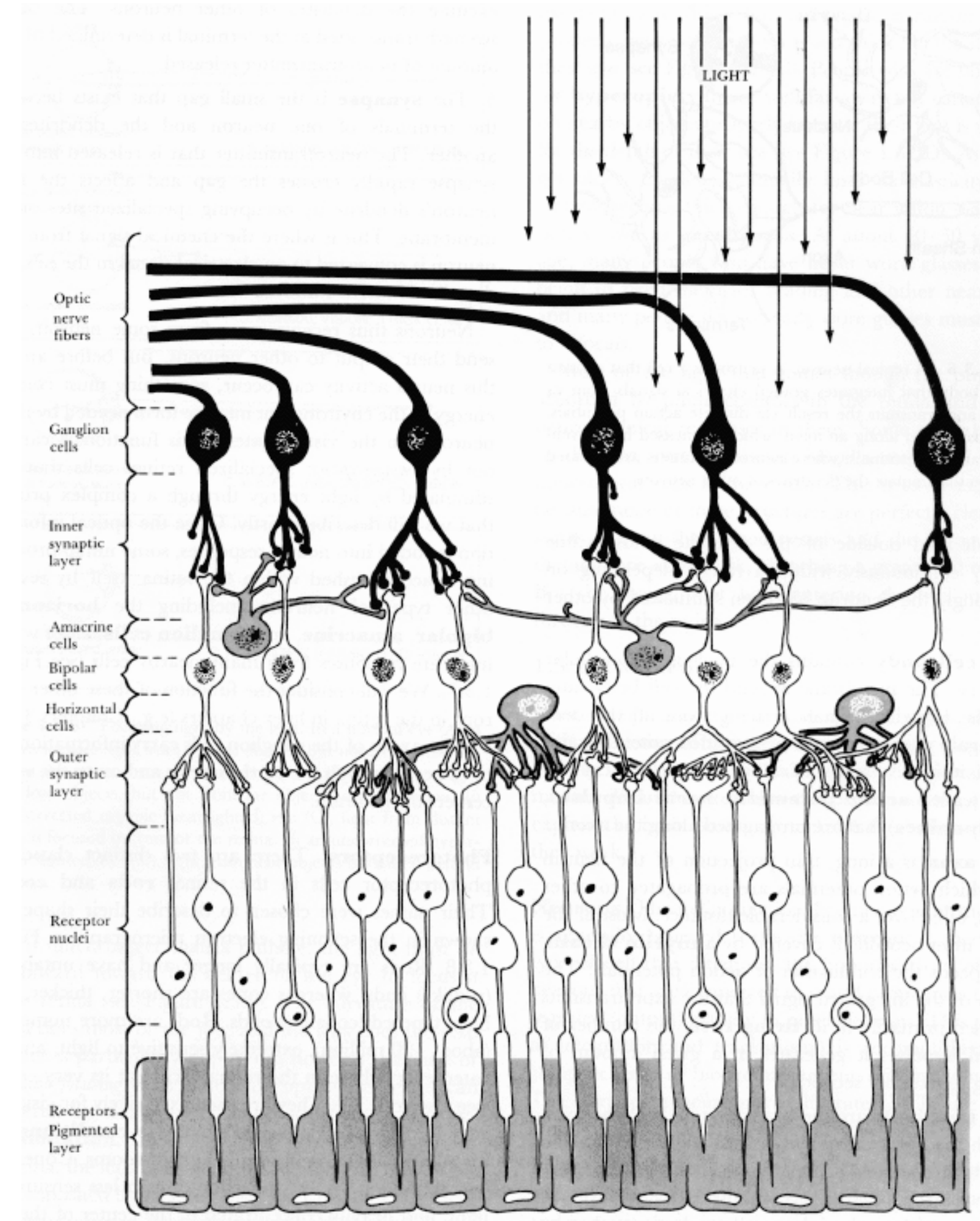
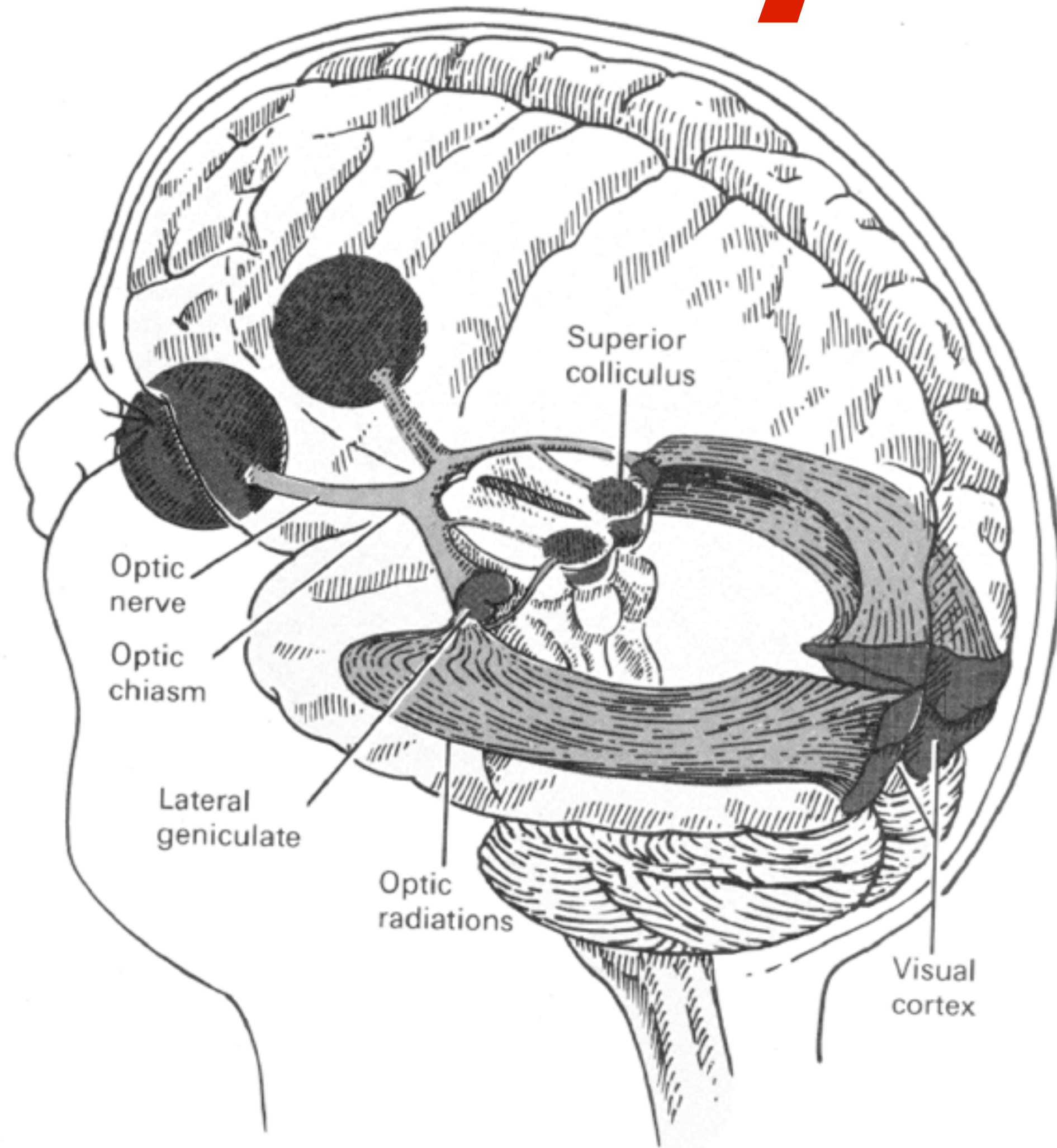
# Why Visualize?

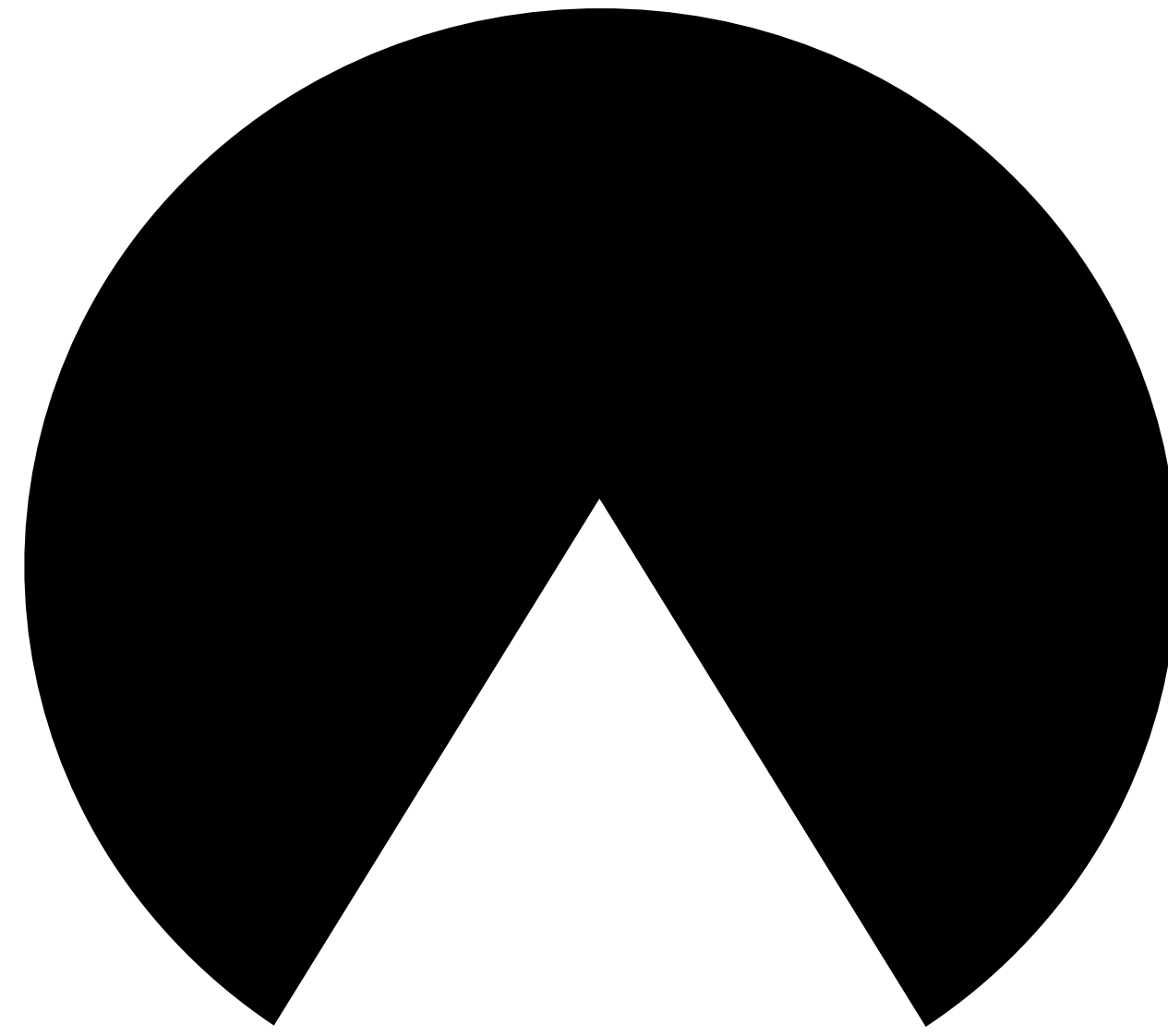
To point out interesting things

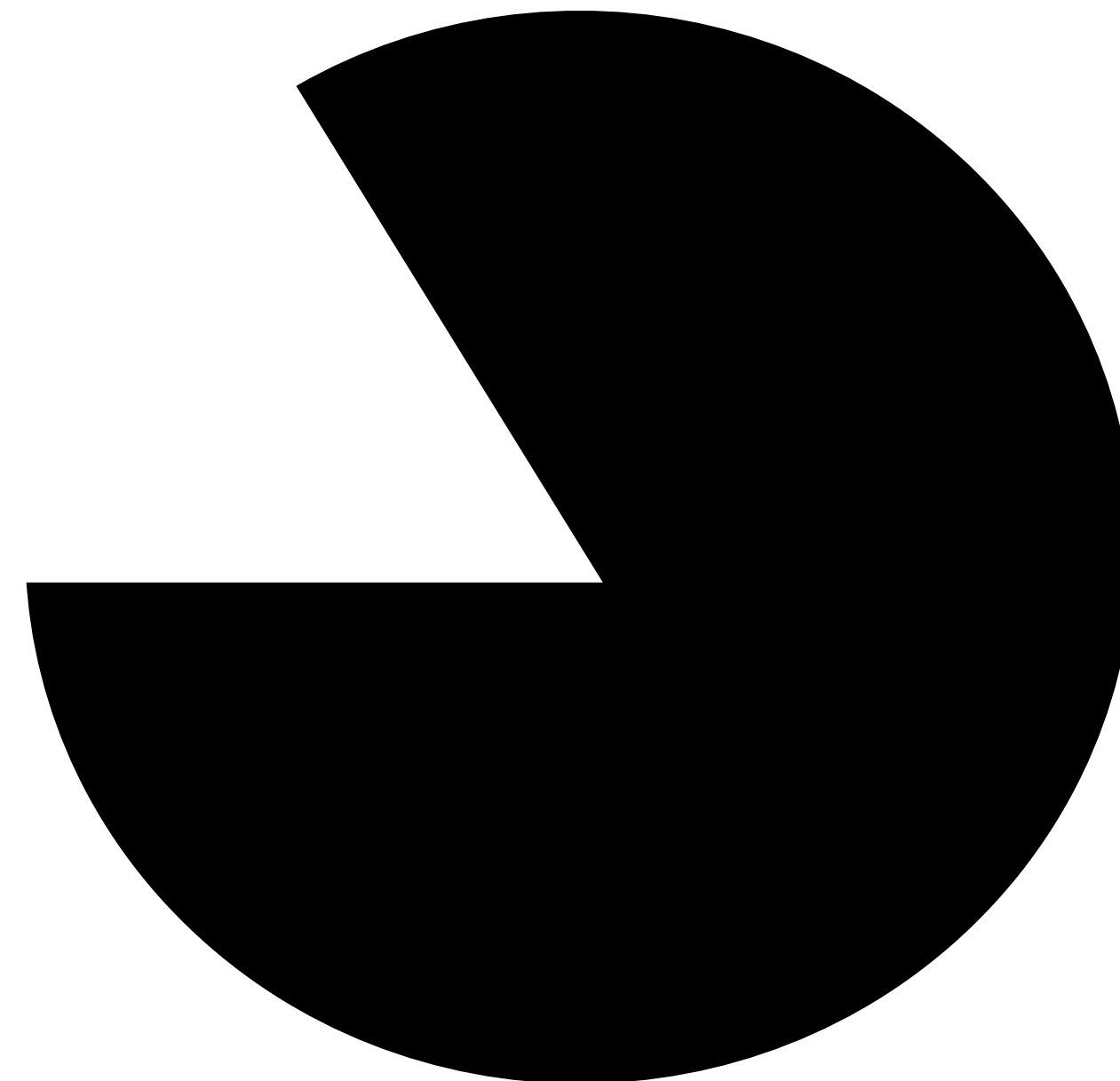
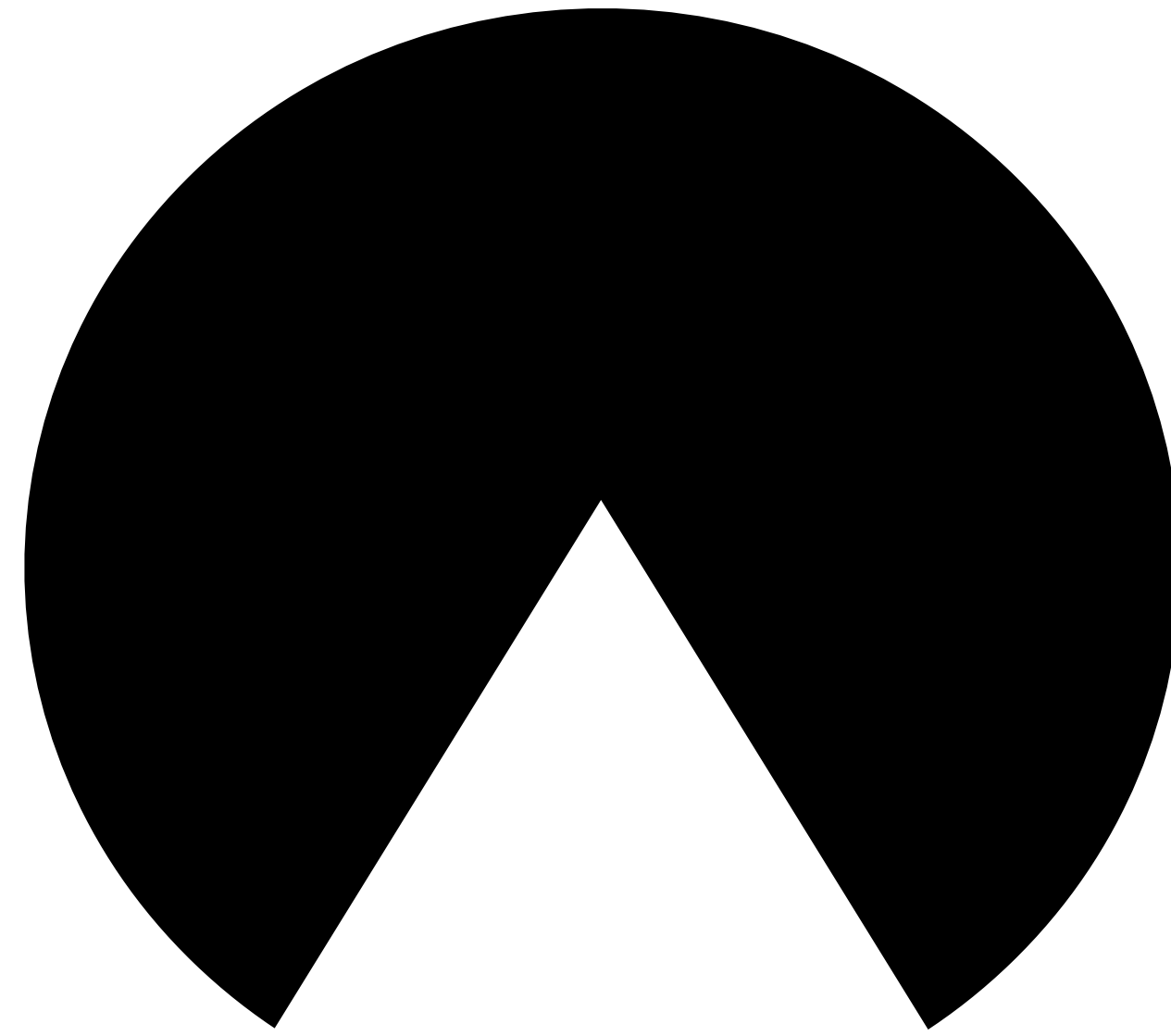
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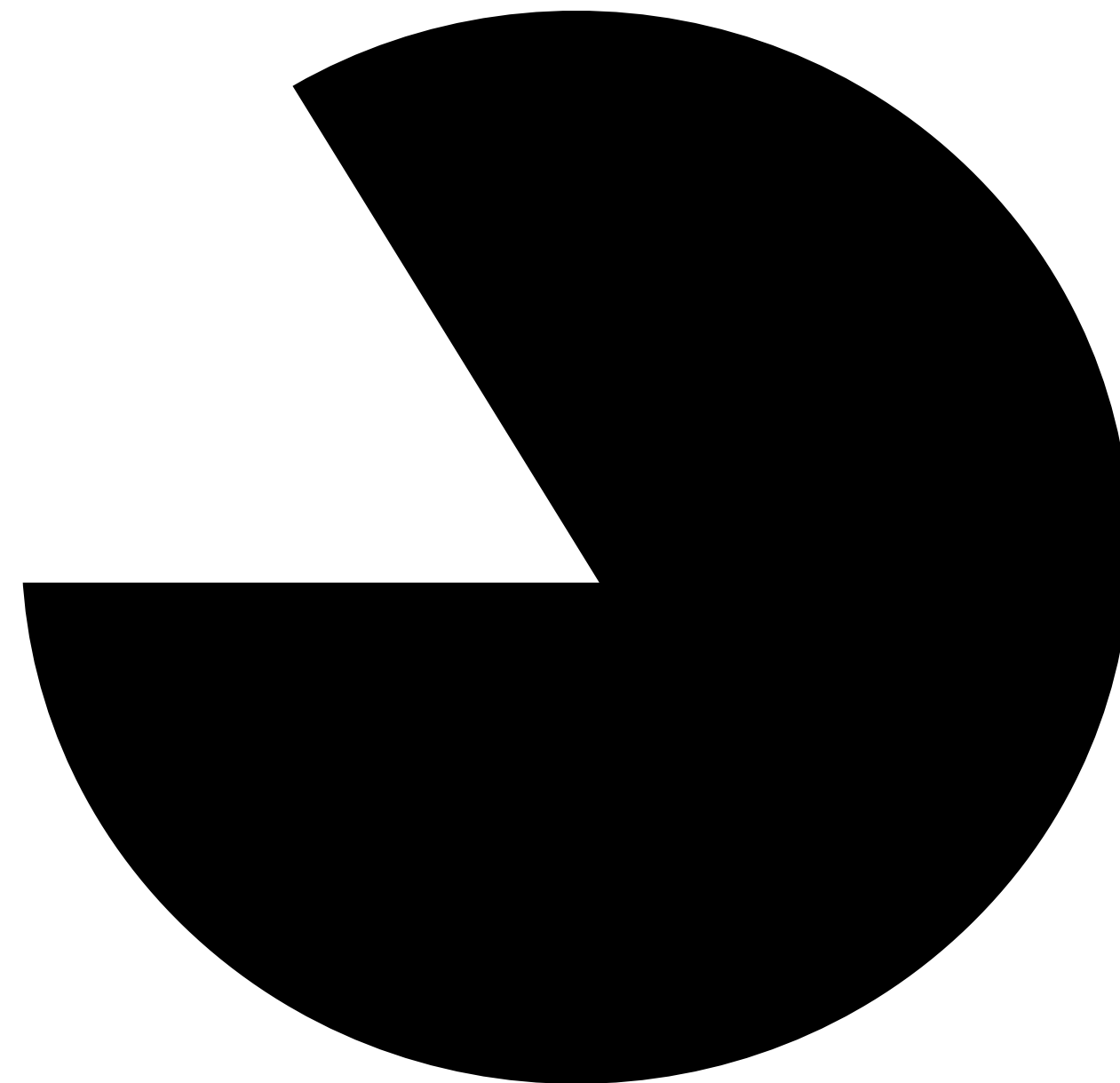
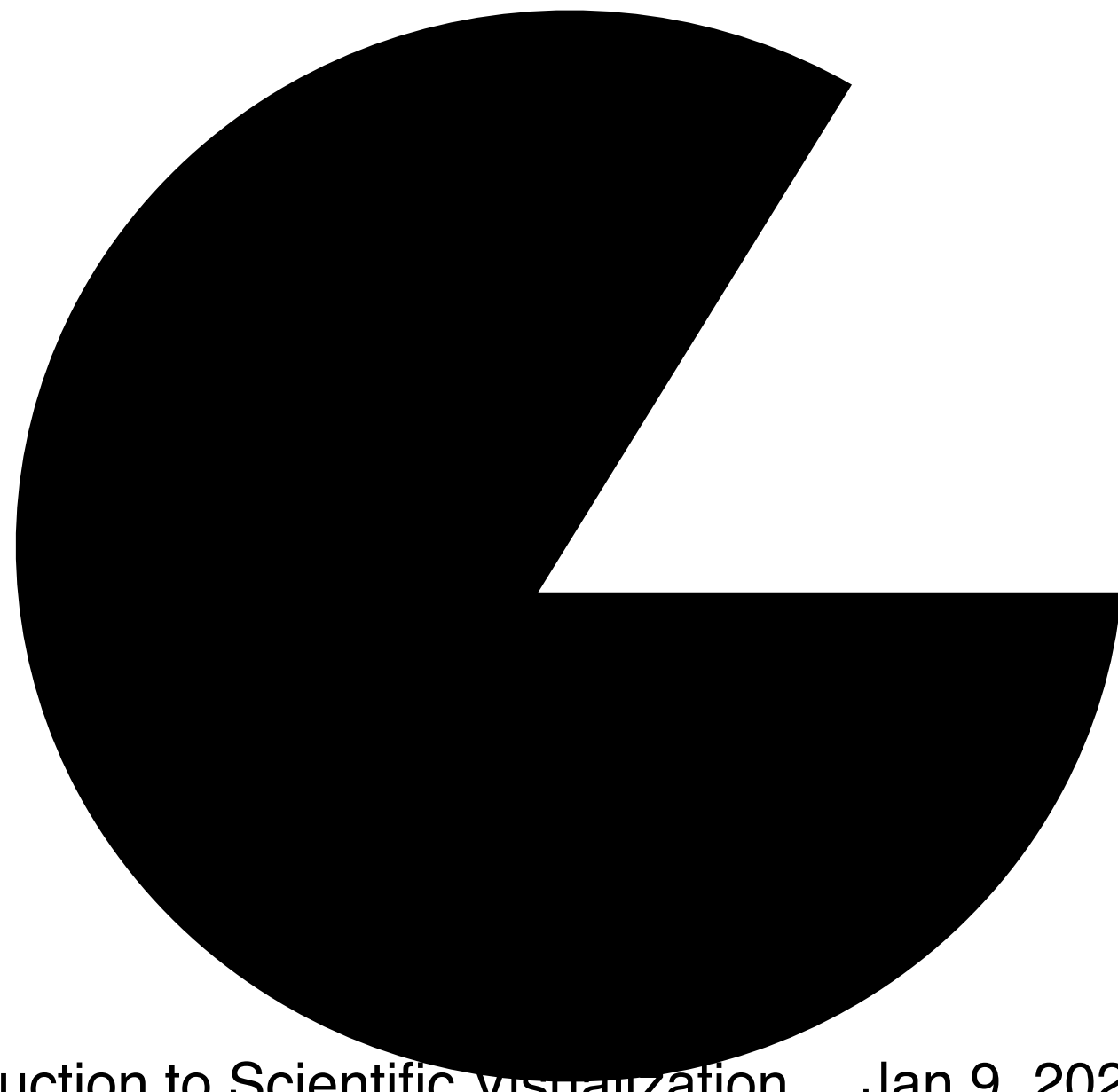
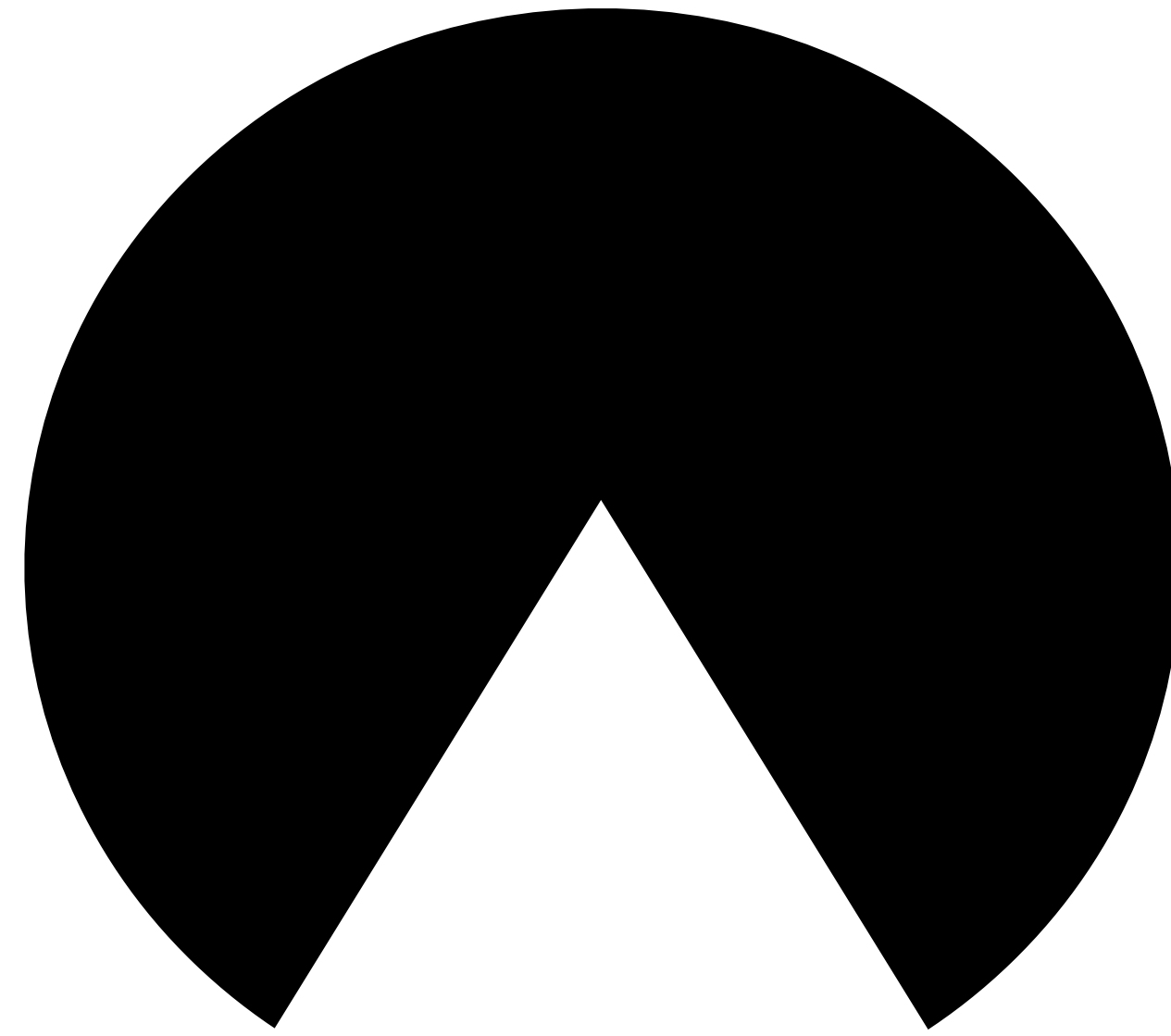


# Why Visualize?

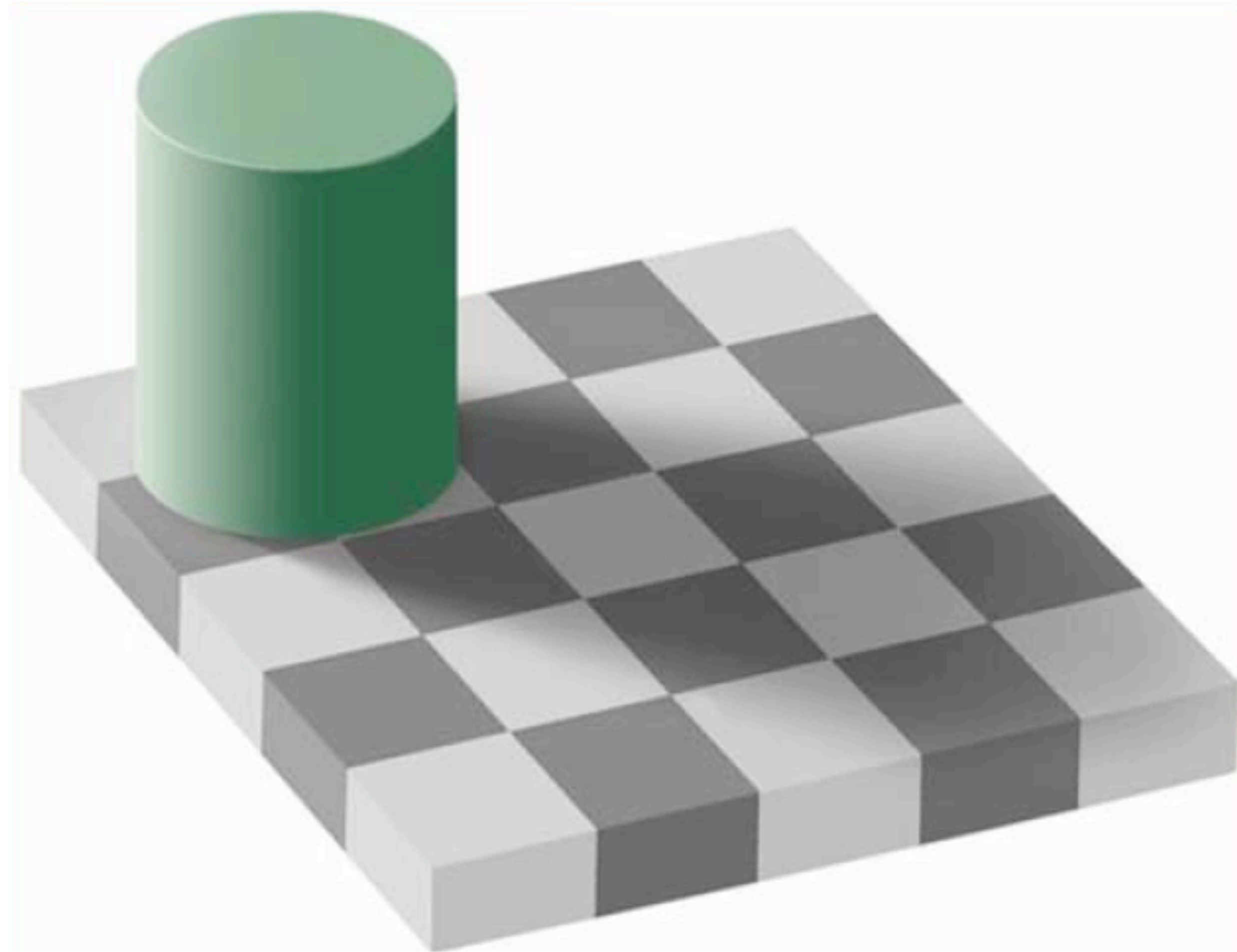


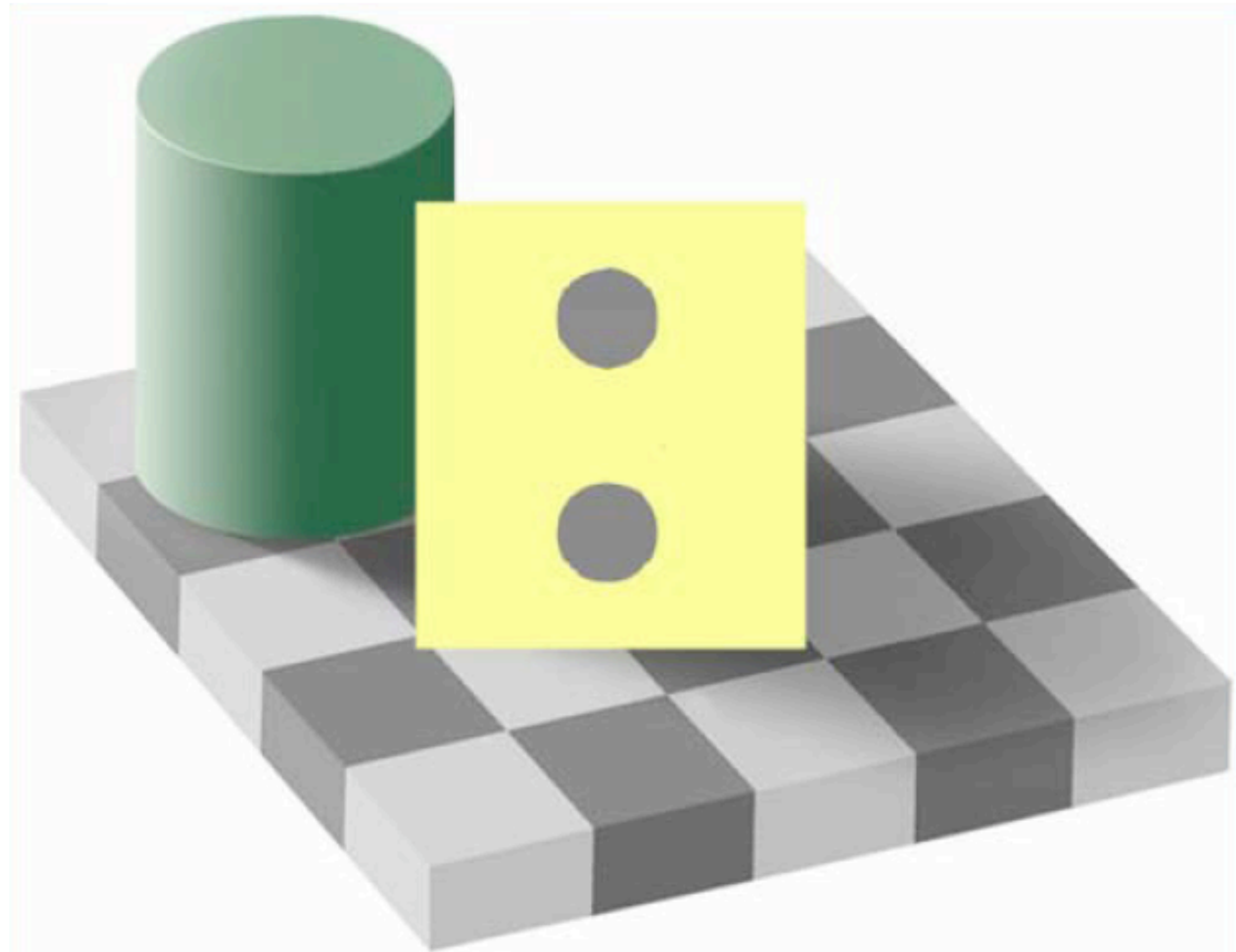


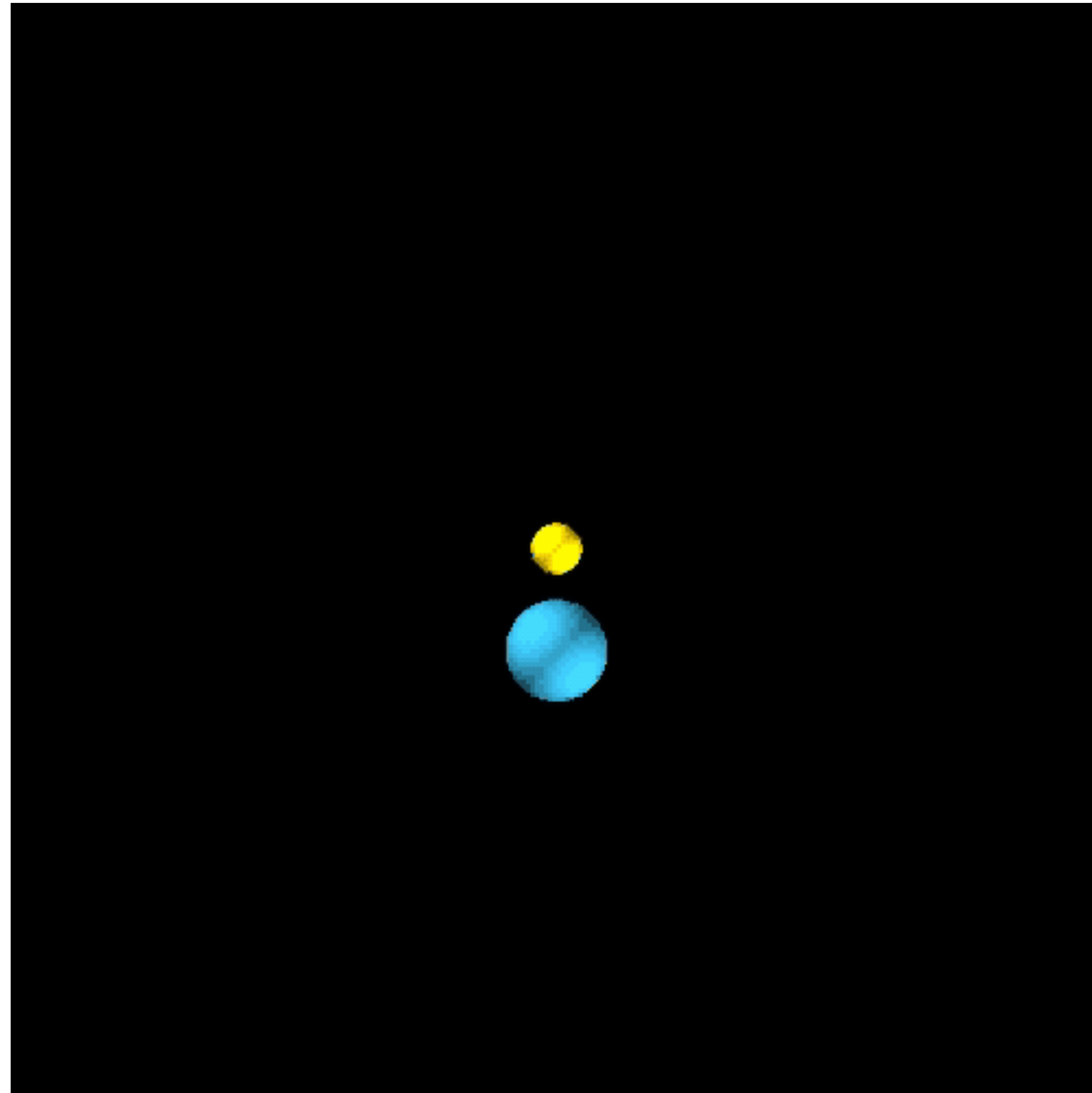


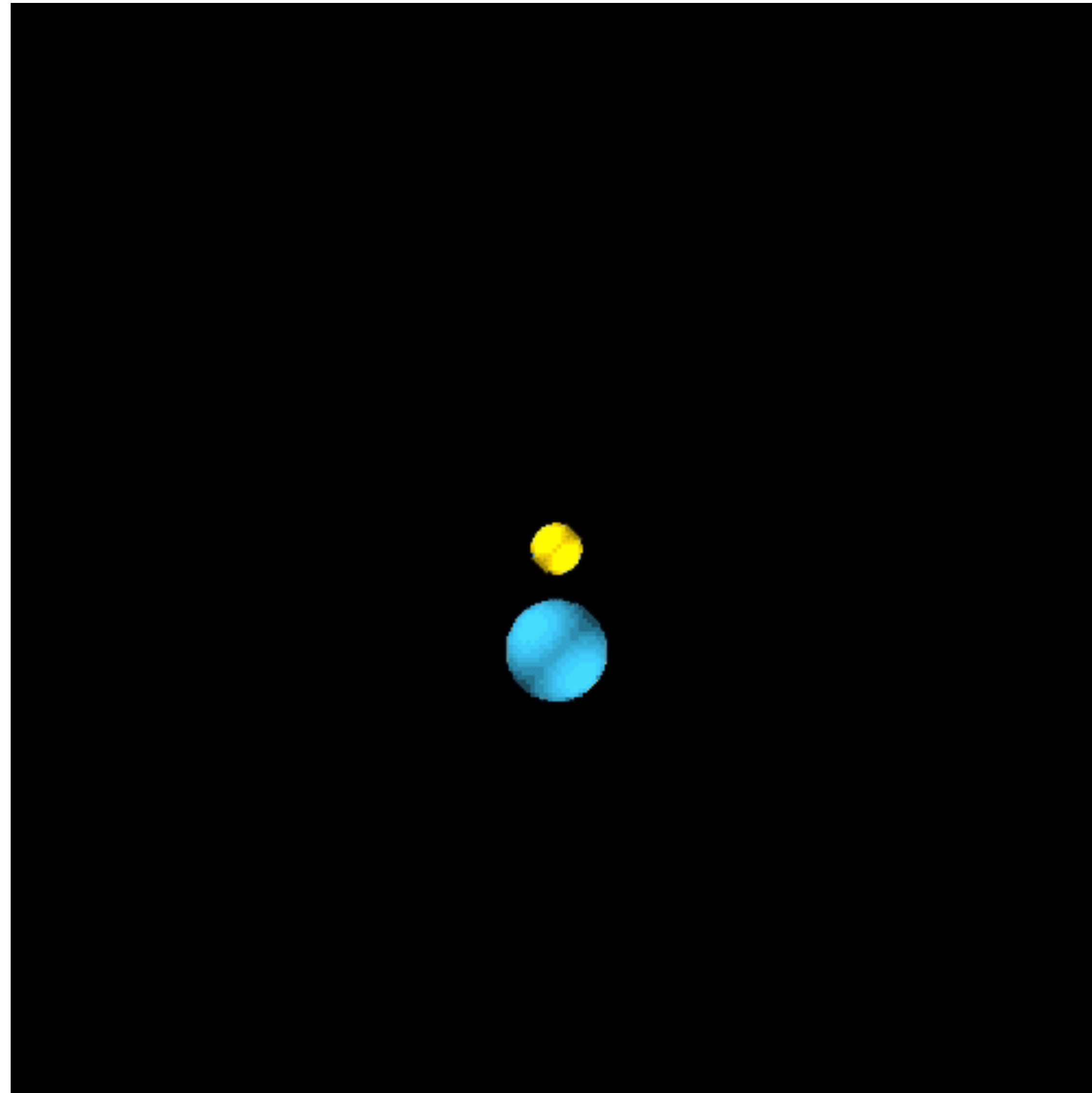




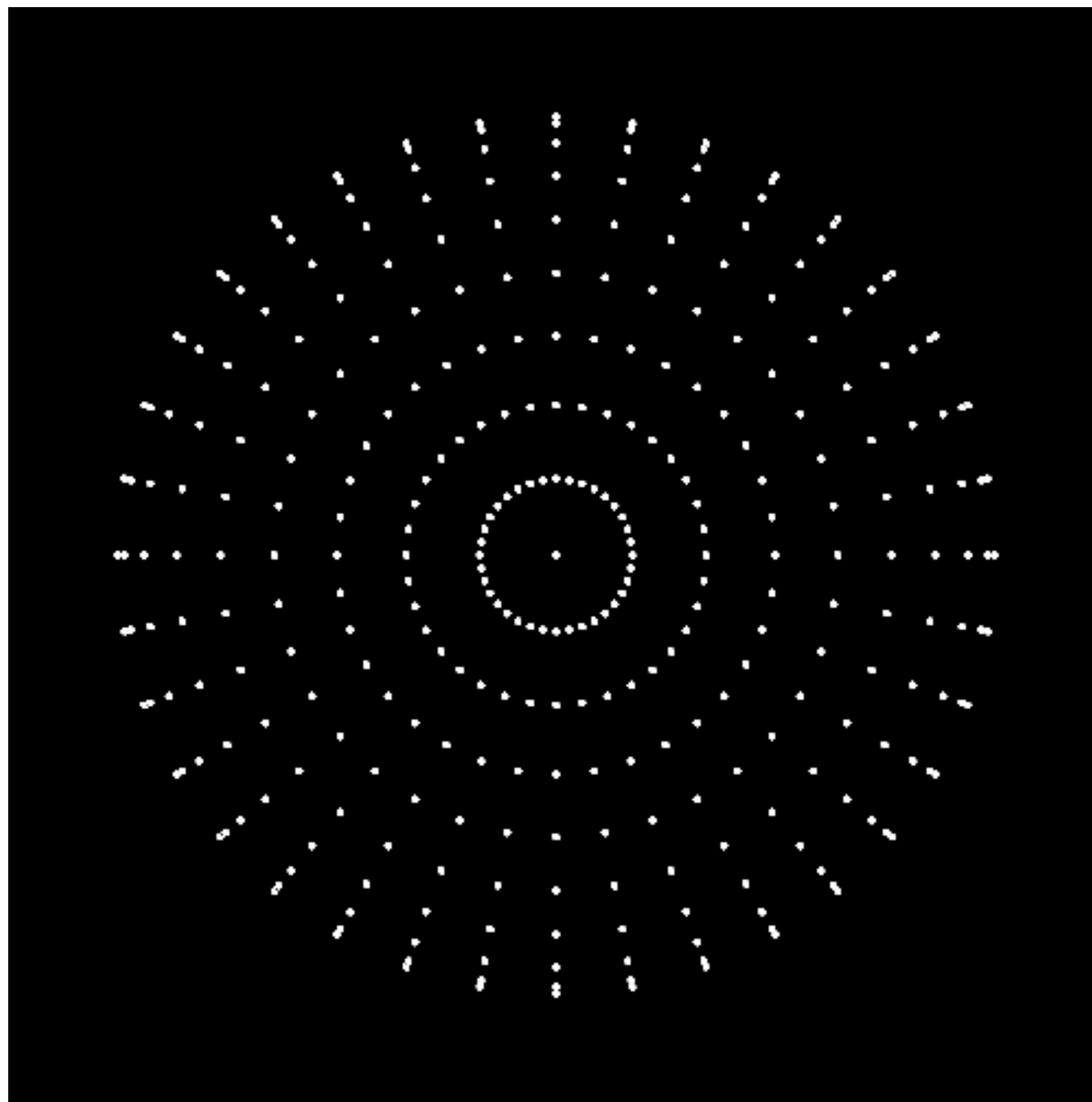


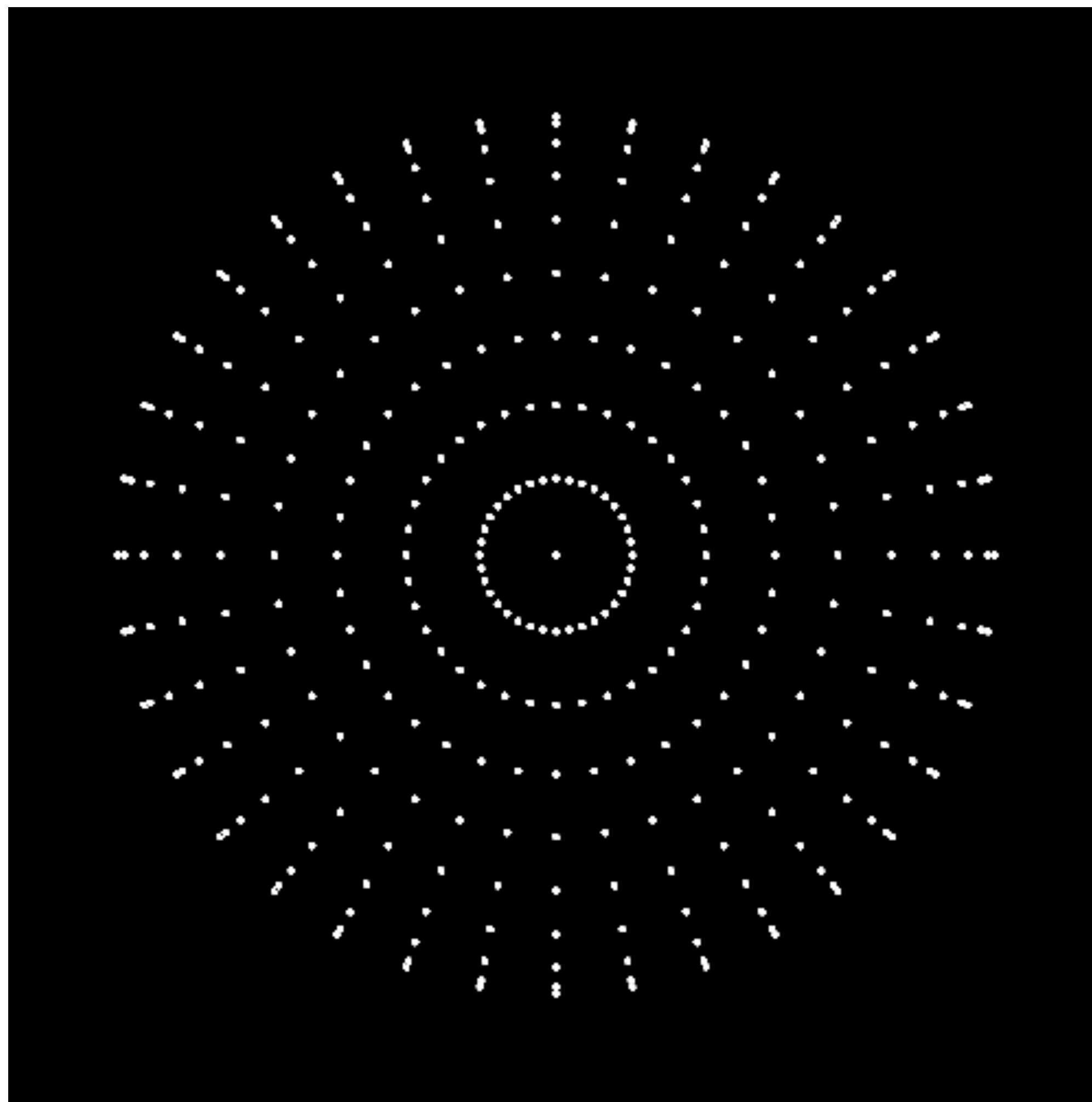












# Visualization Objectives

- Record information
- Analyze data to support reasoning
- Confirm hypotheses
- Communicate ideas to others

# Syllabus

# On Brightspace

The screenshot shows a web browser window displaying a Brightspace course page. The browser's address bar shows the URL `purdue.brightspace.com/d2l/home/703134`. The page header includes the Purdue University logo, the course title "Spring 2023 CS 53000-LE1...", and the instructor's name "Xavier Tricoche". A navigation menu below the header lists "Course Home", "Content", "Classlist", "Grades", "Class Progress", "Course Tools", and "Help". The main content area features a banner image of the Purdue University archway with the text "Spring 2023 CS 53000-LE1 LEC". Below the banner, there are two side-by-side panels. The left panel, titled "Announcements", contains a notice about "Upcoming Turnitin Downtime" posted on January 5, 2023, at 9:02 AM, with a "Global" icon. The text of the announcement states that Turnitin will be unavailable on Saturday, January 14th, from 12:00pm to 8:00pm EST / 11:00am to 7:00pm CST for scheduled maintenance. The right panel, titled "Calendar", shows the date "Monday, January 9, 2023" and a section for "Upcoming events" which currently displays "There are no events to display" with a "Create an event" link.



# On Brightspace

Homepage - Spring 2023 CS 53000-LE1...  
purdue.brightspace.com/d2l/home/703134

PURDUE UNIVERSITY Spring 2023 CS 53000-LE1...  
Xavier Tricoche

Course Home **Content** Classlist Grades Class Progress Course Tools Help

Spring 2023 CS 53000-LE1 LEC

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Posted Jan 5, 2023 9:02 AM • Global  
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Calendar  
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Upcoming events  
There are no events to display. [Create an event](#)

Syllabus - Spring 2023 CS 53000-LE1...  
purdue.brightspace.com/d2l/le/content/703134/Home

PURDUE UNIVERSITY Spring 2023 CS 53000-LE1...  
Xavier Tricoche

Course Home Content **Classlist** Grades Class Progress Course Tools Help

Search Topics

Syllabus

Bookmarks

Course Schedule

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- Start Here 2
- Student Support and Resources 4
- University Policies and Statements 9

Syllabus

To navigate through the course:

1. Begin by reading this *Syllabus*.
2. Read through all of the information in the *Start Here* section, before moving through the rest of the Table of Contents.

Drag a file here to update the attachment

1 of 7 Automatic Zoom View as Text Download

PURDUE UNIVERSITY  
**Course Information**  
Course Number: CS53000 LE1  
CRN: 10607



# On Brightspace

Homepage - Spring 2023 CS 53000-LE1...  
purdue.brightspace.com/d2l/home/703134

PURDUE UNIVERSITY Spring 2023 CS 53000-LE1...  
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Course Home Content **Classlist** Grades Class Progress Course Tools Help

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Course Information

PURDUE UNIVERSITY  
Course Number: CS53000 LE1  
CRN: 10607

PURDUE UNIVERSITY

**Course Information**

Course Number: CS53000 LE1  
CRN: 10607  
Credit Hours: 3  
Time: T/H 9:00 am - 10:15 am  
Location: UNIV 103

**Instructor**

Instructor: Prof. Xavier Tricoche  
Office Hours: T/H 10:30 am - 11:30 am  
Email: [xmt@purdue.edu](mailto:xmt@purdue.edu) (preferred)  
Phone: (765) 496-9416

**Teaching Assistant**

Name: Christopher May  
Email: [may5@purdue.edu](mailto:may5@purdue.edu)  
Office Hours: TBA and by appointment

**Course Description**

Scientific visualization creates interactive visual representations of numerical datasets obtained through simulation or measure to support their analysis. The course introduces the basic principles of this discipline and presents the main techniques used in practice. The lectures cover the visualization of 2D, 3D, and time-dependent datasets corresponding to scalar, vector, and tensor attributes, as well as the depiction of non-spatial or high-dimensional data. The presentation emphasizes the practical role of visualization in science and engineering and is mostly self-contained. The evaluation is based on 5 programming assignments, a midterm exam, and a final project.

**Learning Outcomes**

After completion of the course, you will...

# Basic Facts

- Lectures: T/TH 9:00 am-10:15 pm, UNIV 103
- Office hours: T/TH 10:30 am - 11:30 am
- Performance evaluation:
  - 5 (programming) assignments (total: **60%**)
  - Midterm exam: **20%**
  - Final project: **20%**



# Communication

- Discussions, Q&A's, and announcements will be on **Piazza**



- Click to sign up!

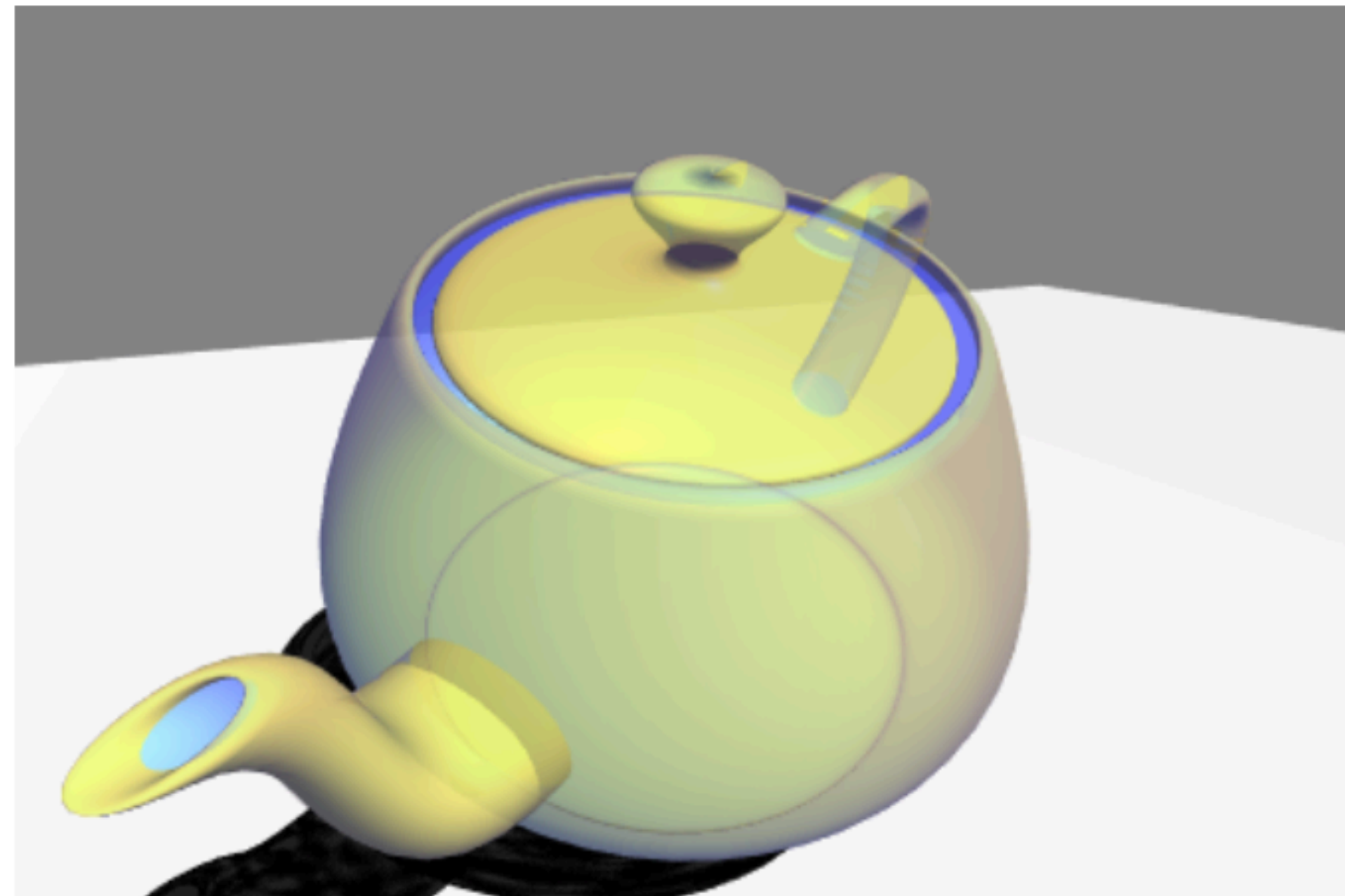
# Lateness Policy

- Assignments due by given deadline
- 5 extension days granted to each student
- 20% penalty for each late day
- No submission accepted past 5th late day

# Class Overview

# Computer Graphics Primer

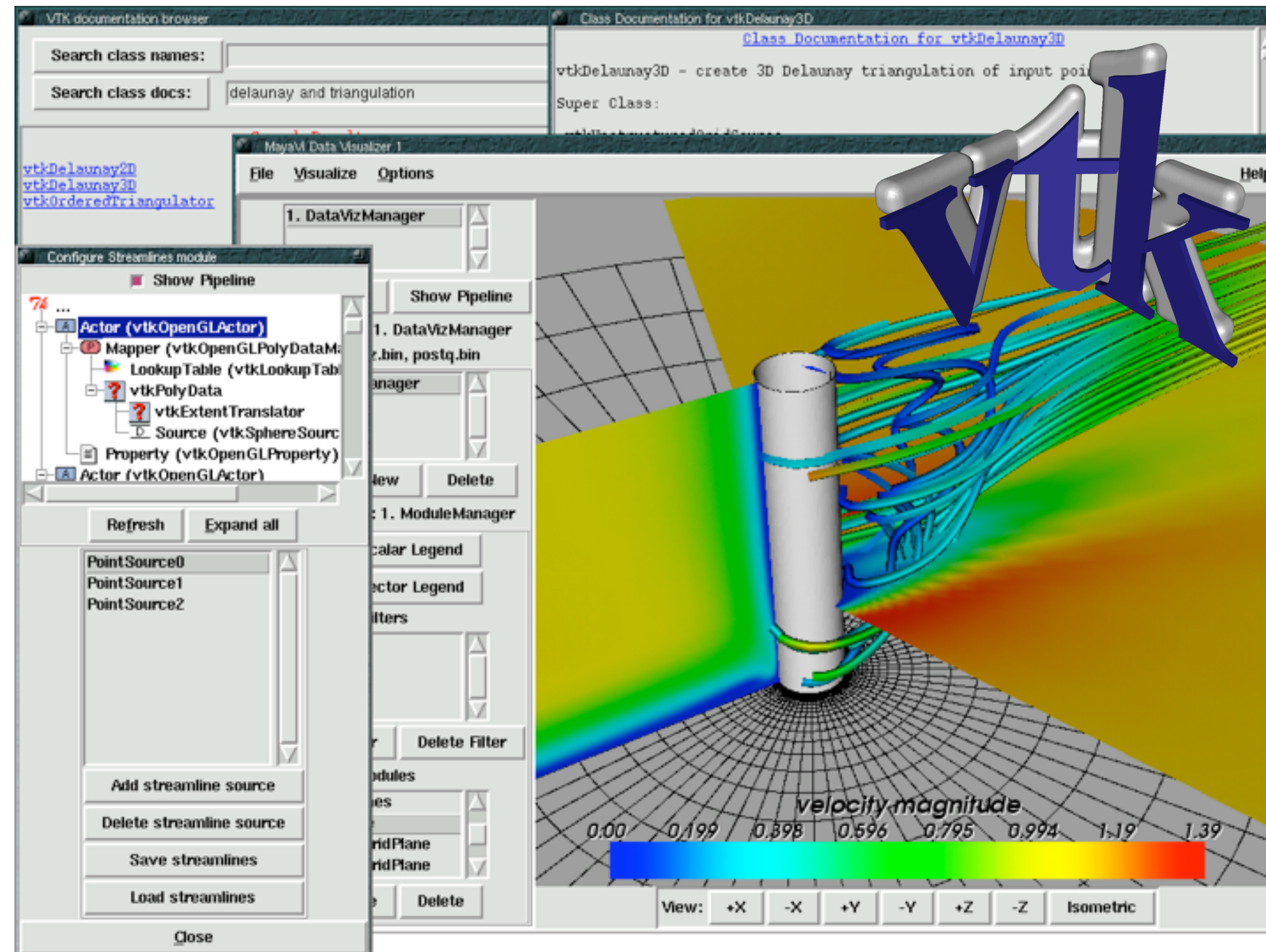
Bare minimum





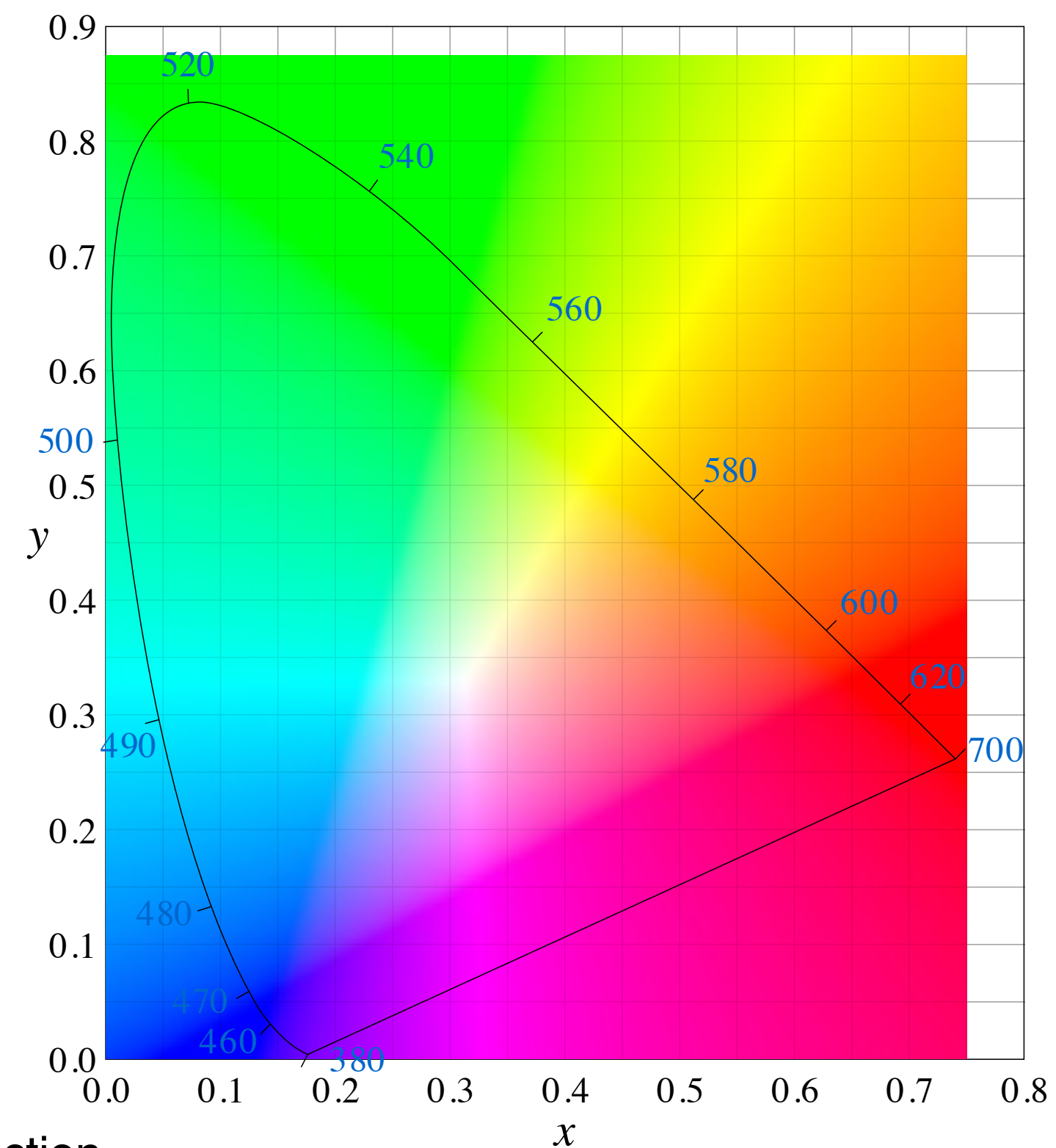
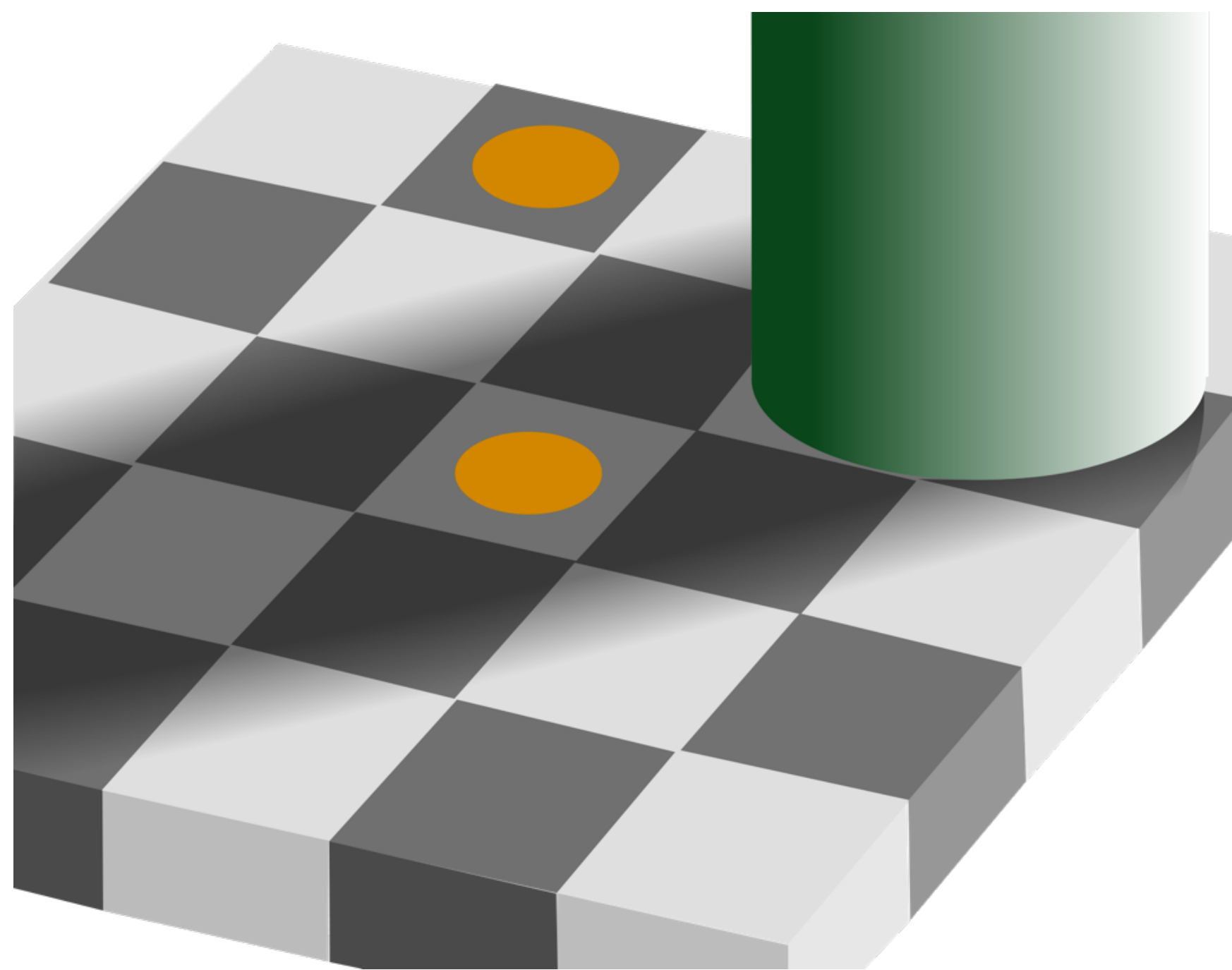
# VTK

## The Visualization Toolkit



# Foundations

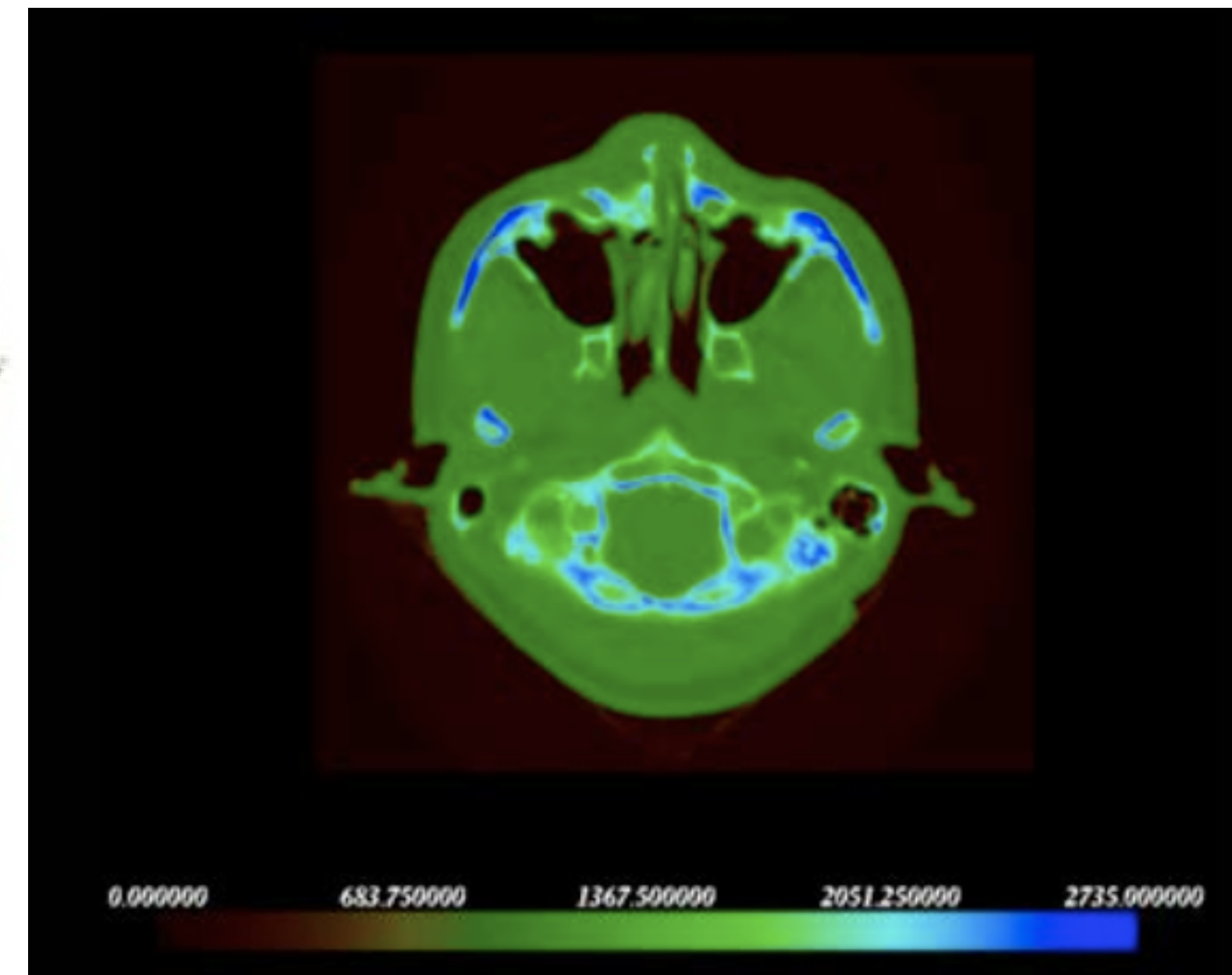
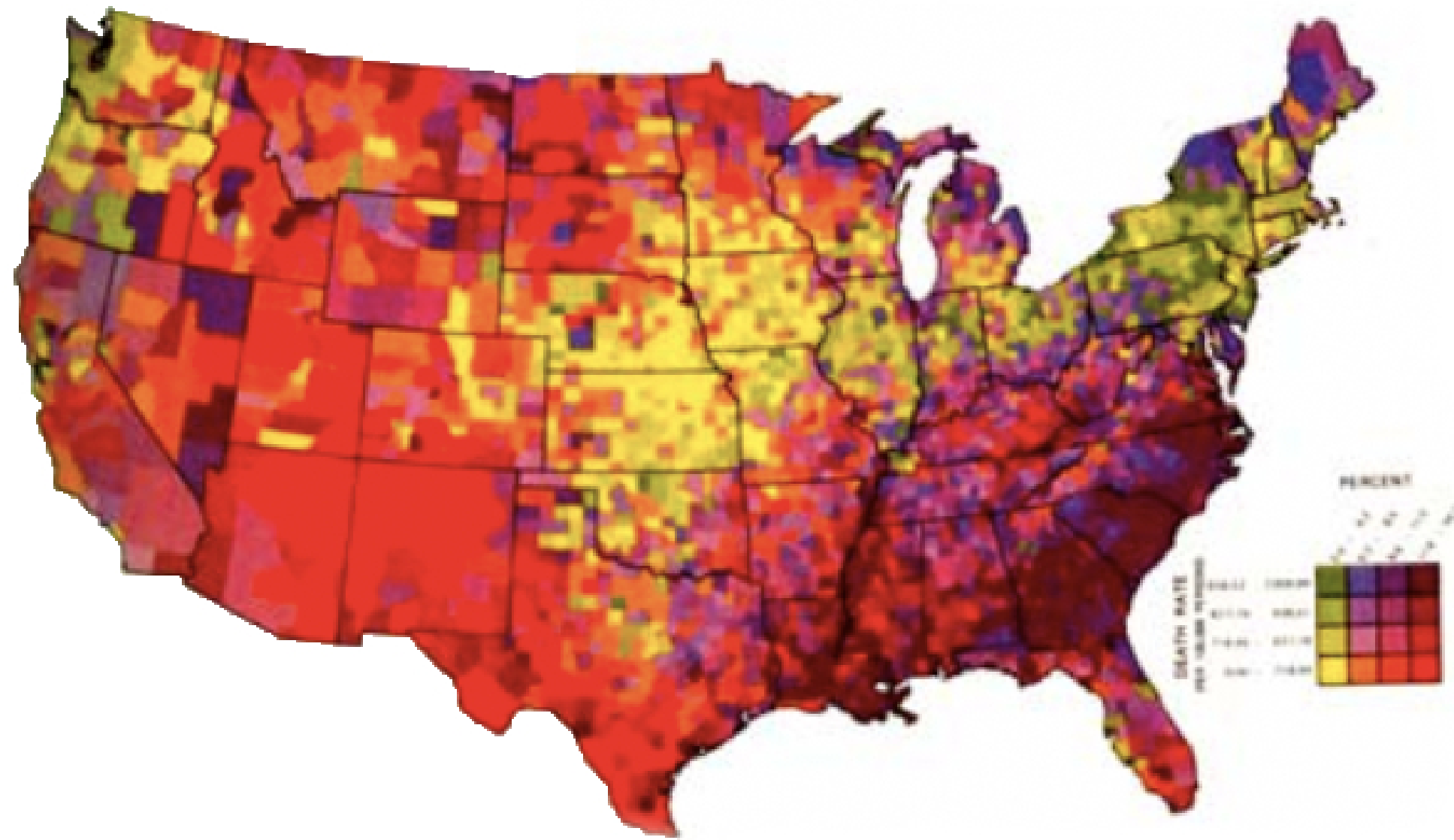
## Visual System and Color Perception





# Foundations

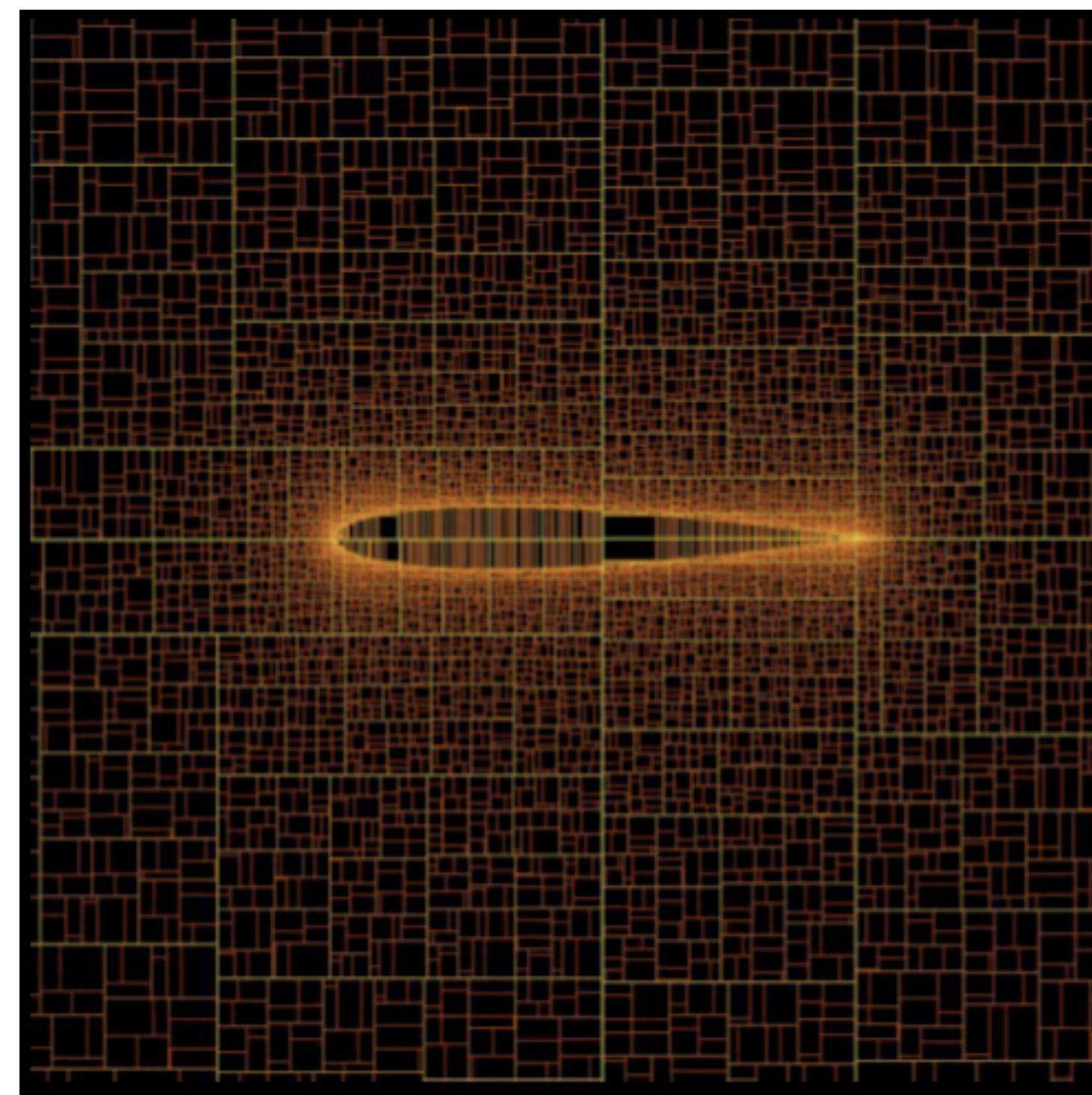
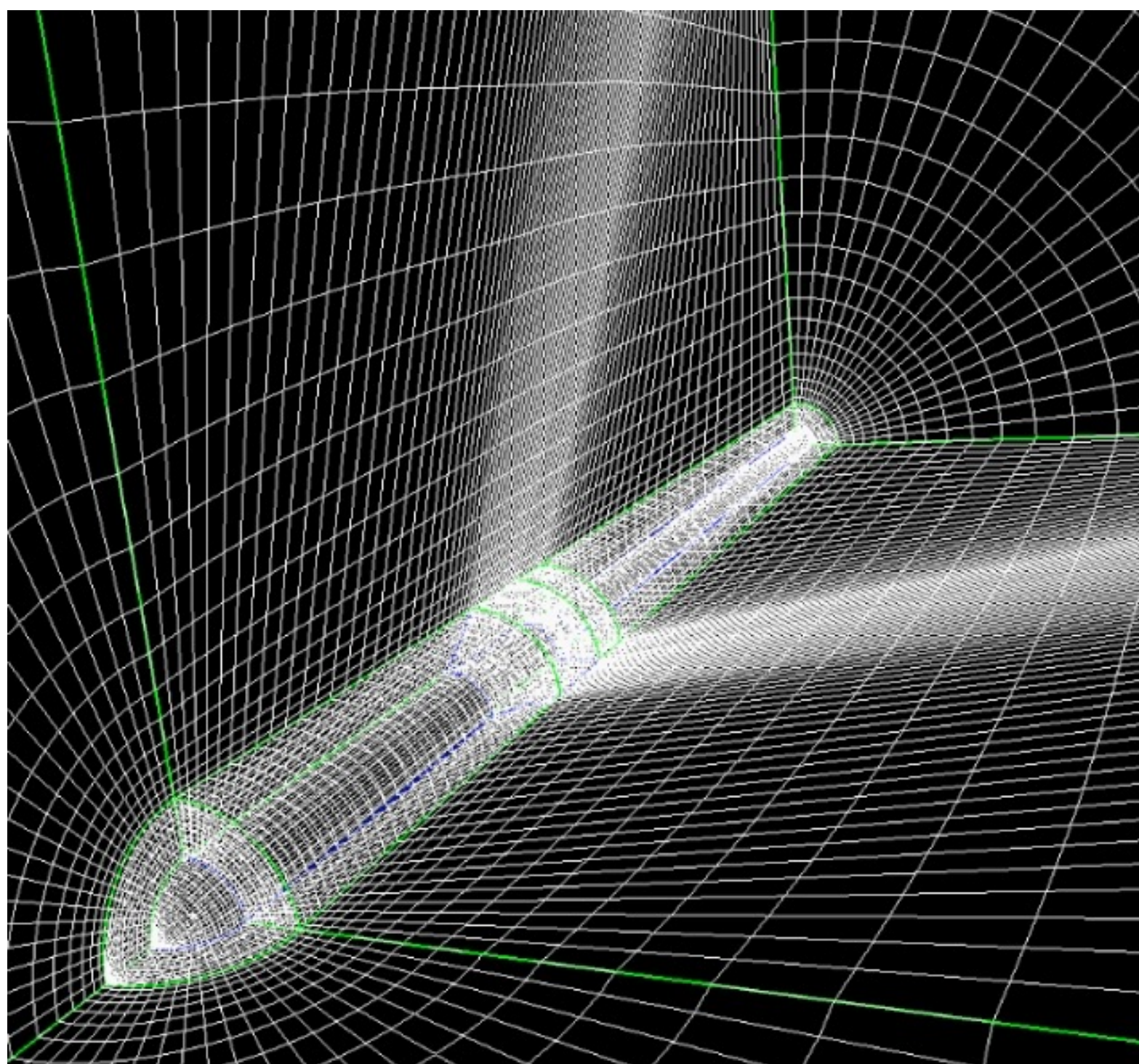
## Color Mapping





# Foundations

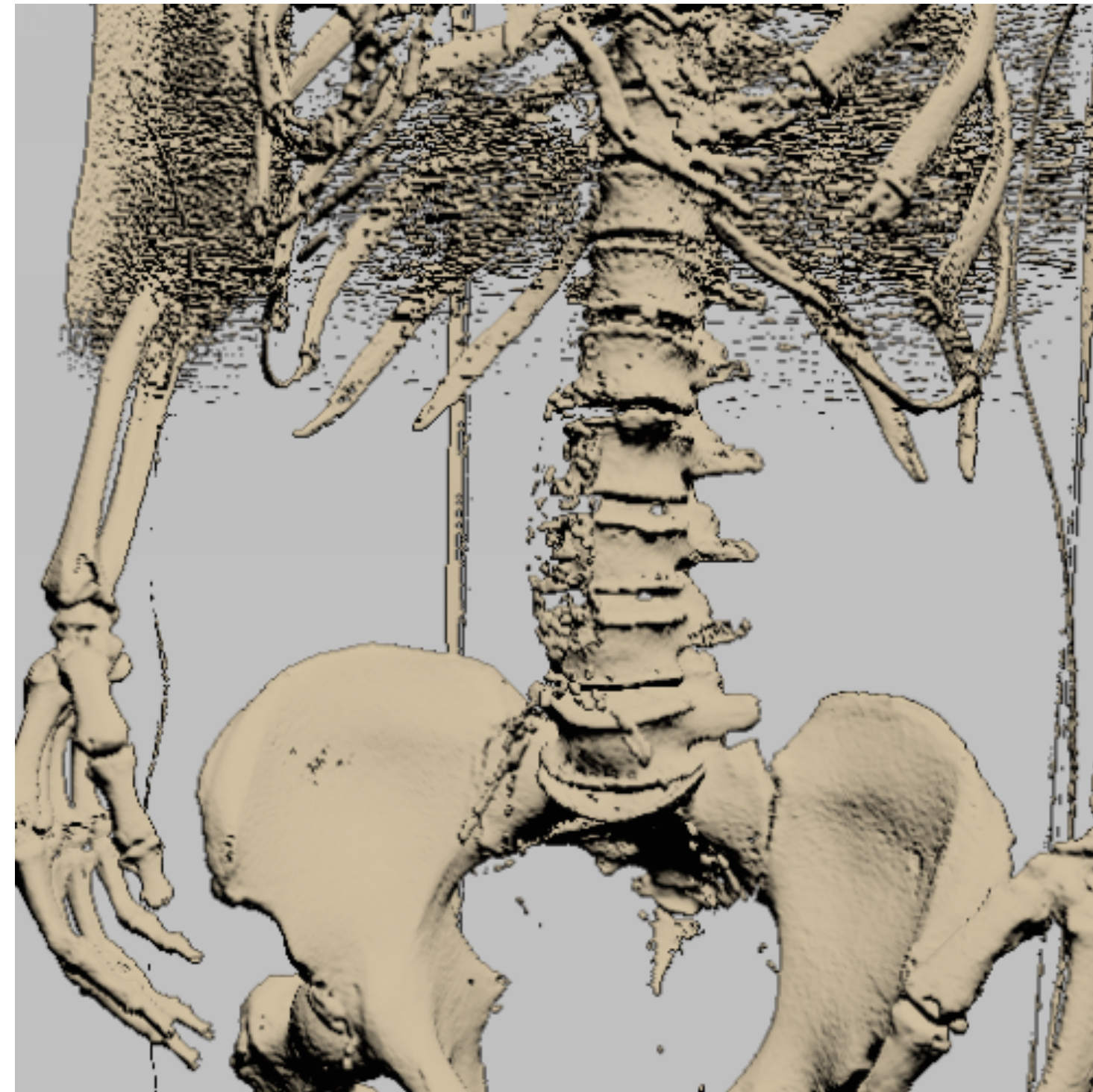
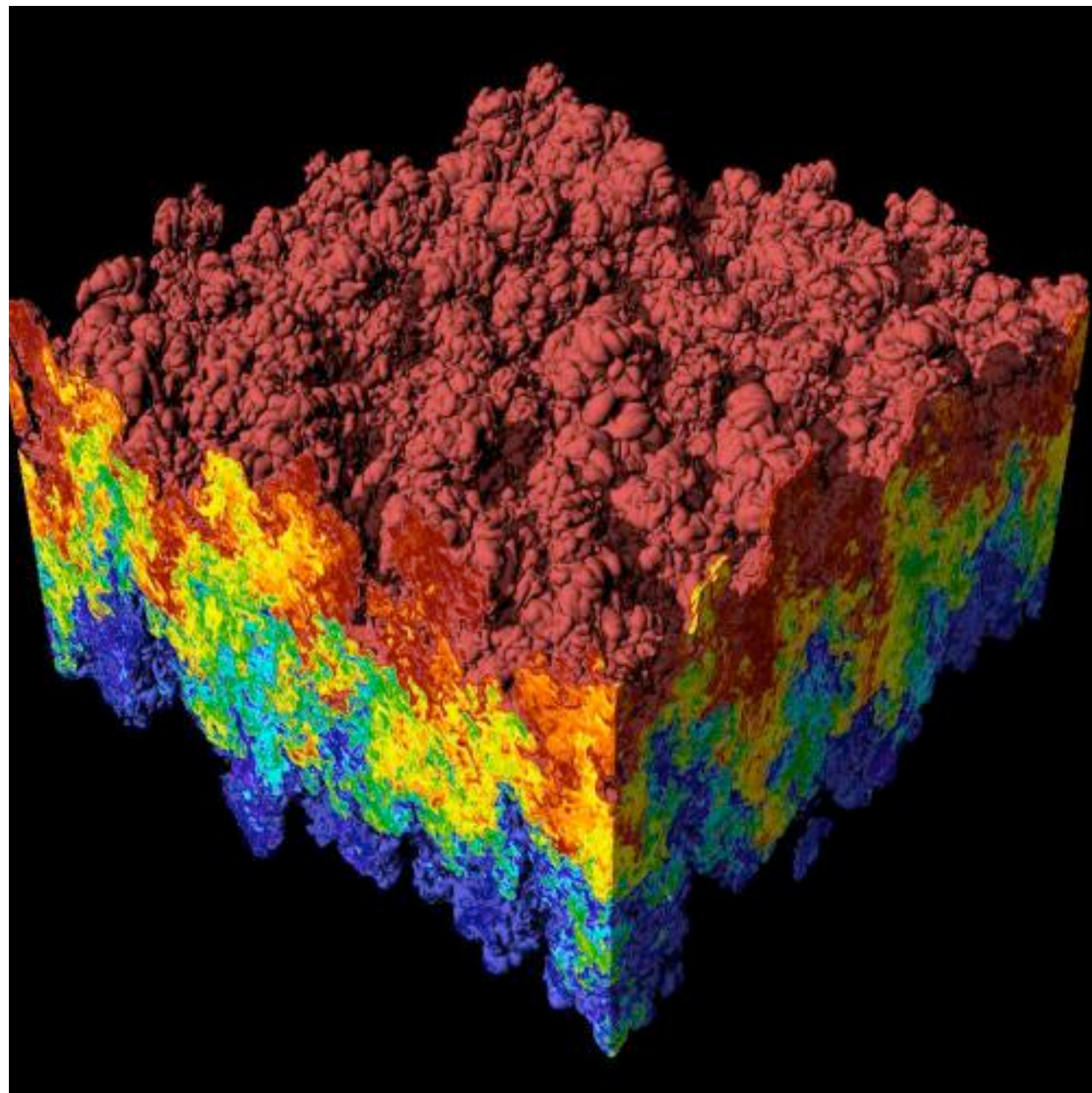
## Data structures and data processing





# Fundamental Techniques

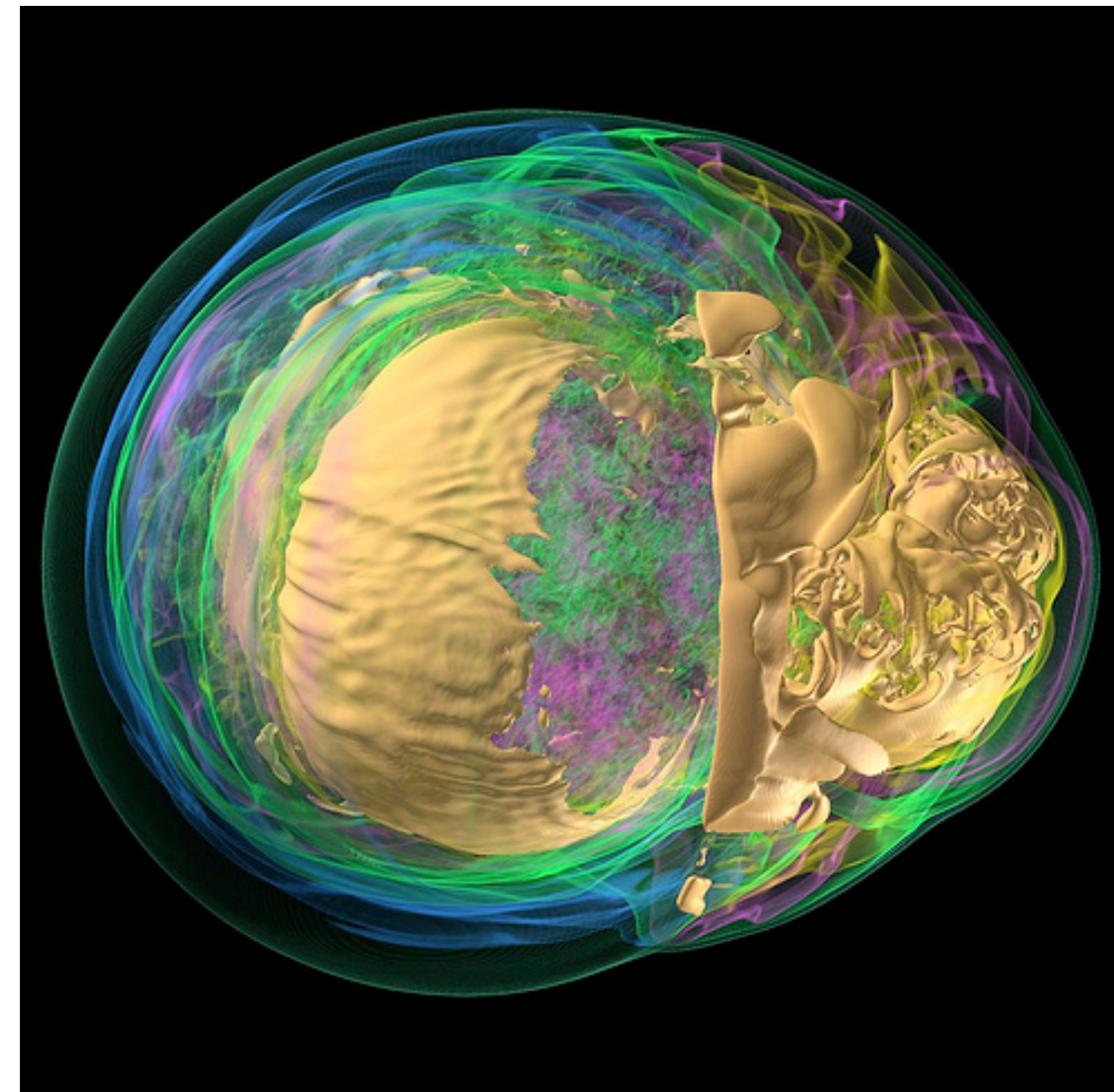
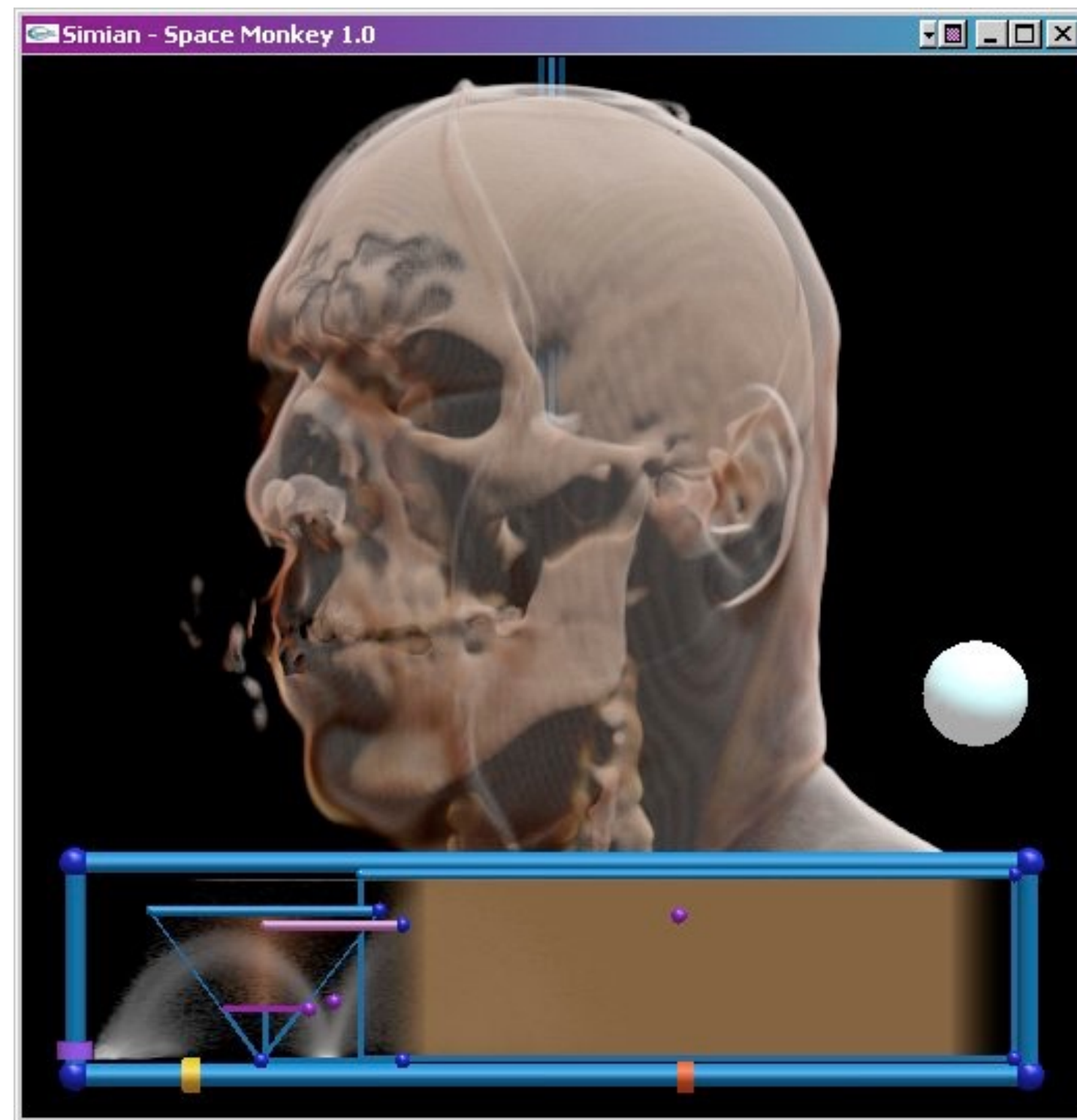
## Level Sets / Isosurfaces





# Fundamental Techniques

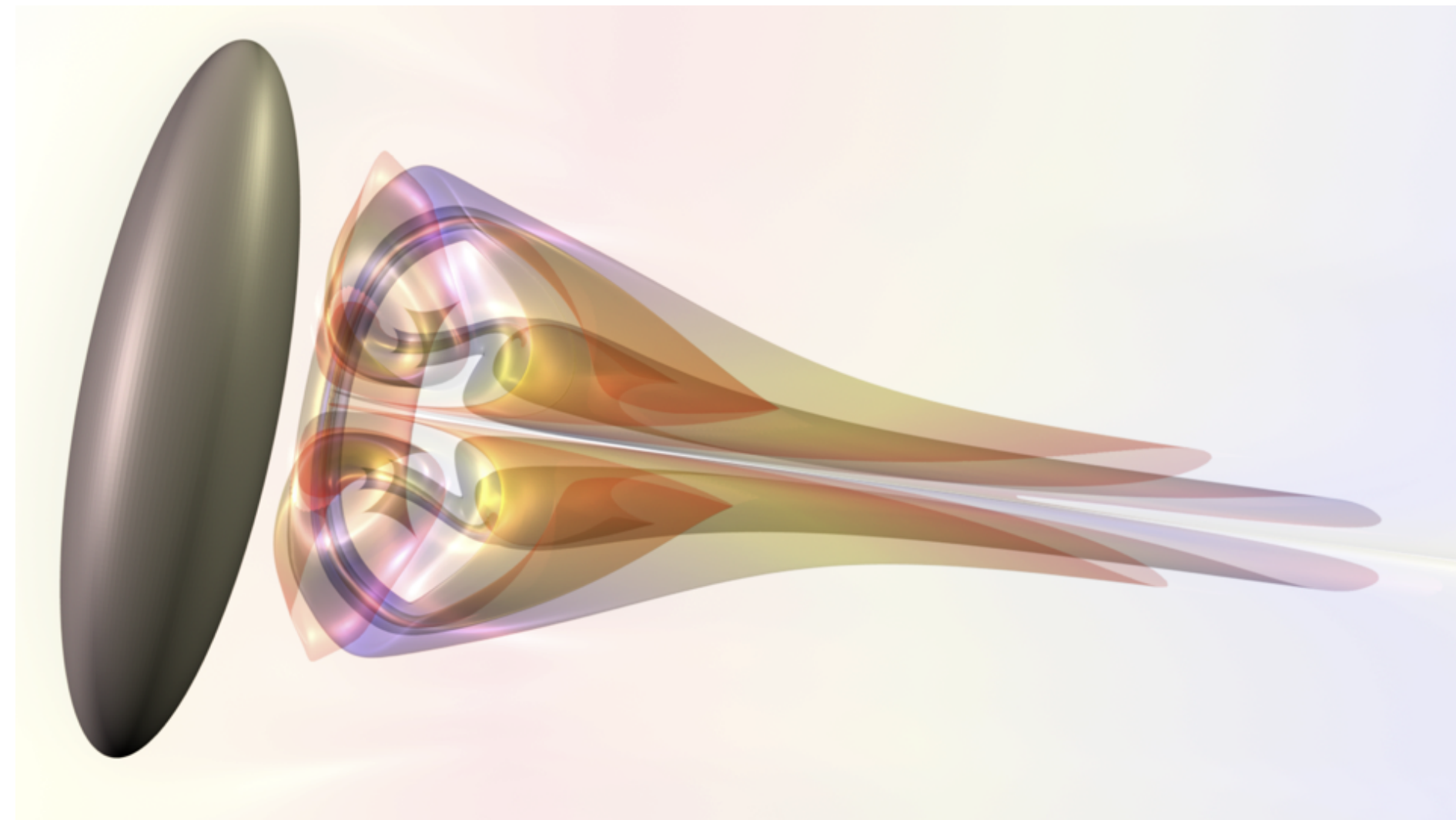
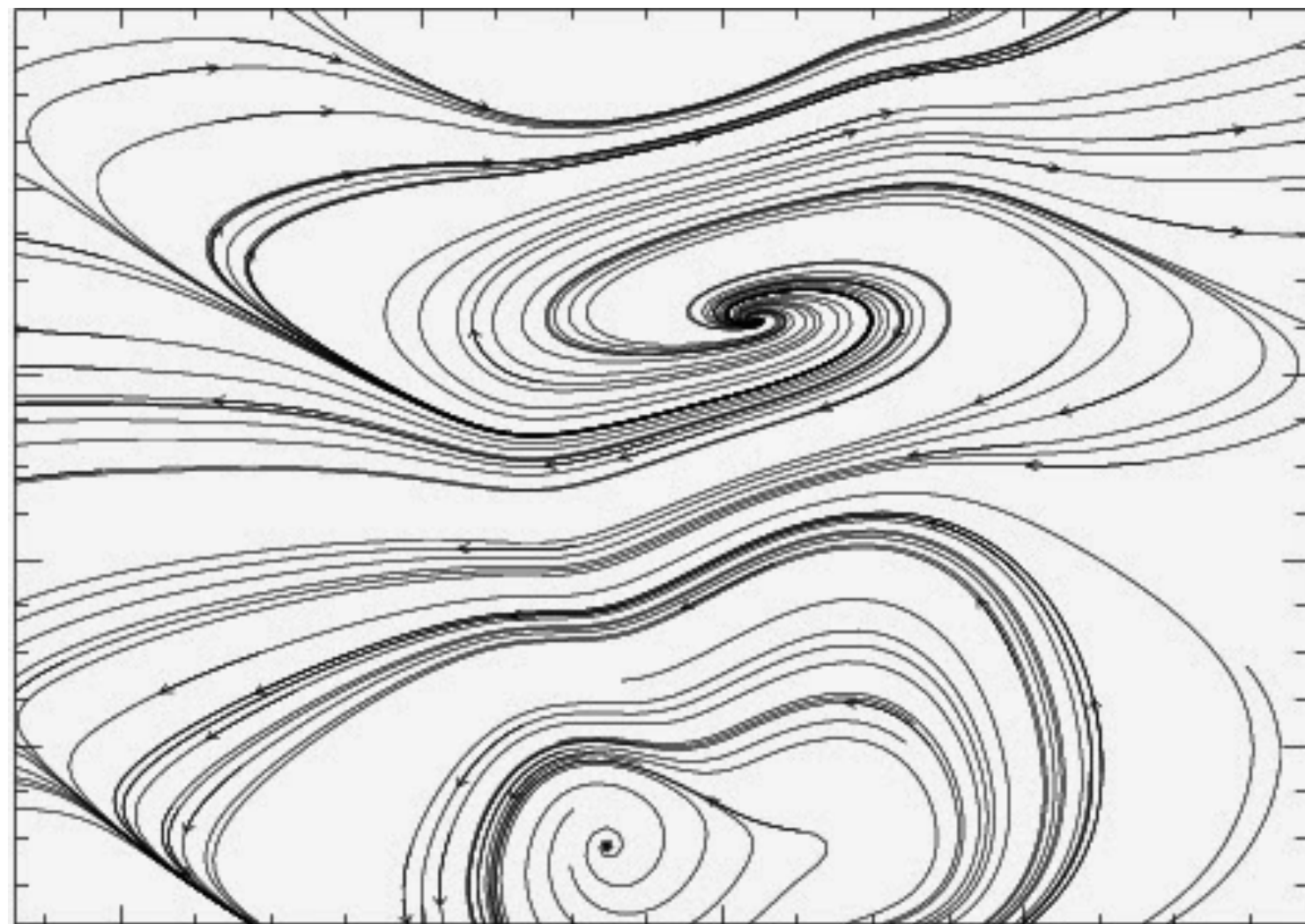
## Volume rendering





# Fundamental Techniques

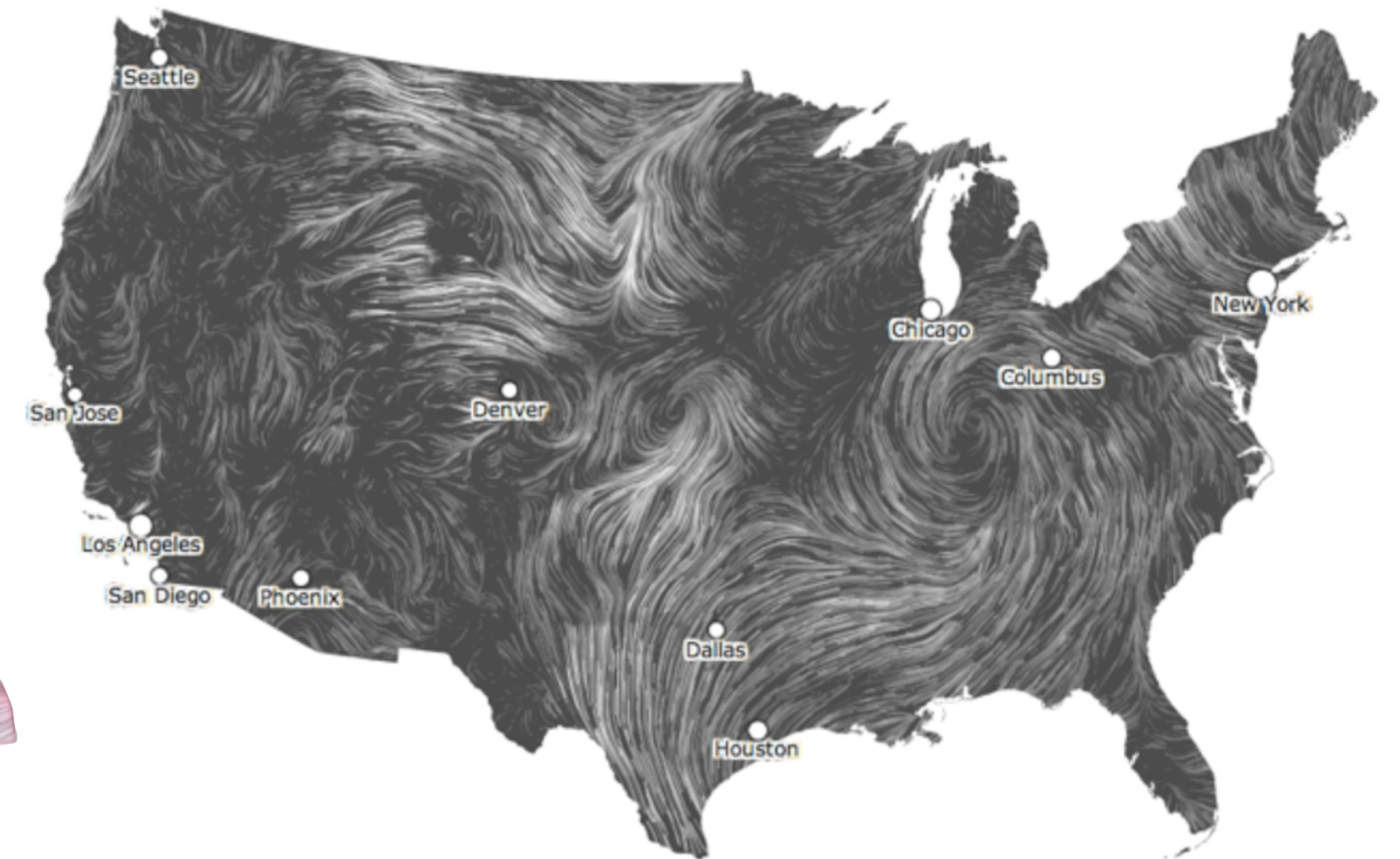
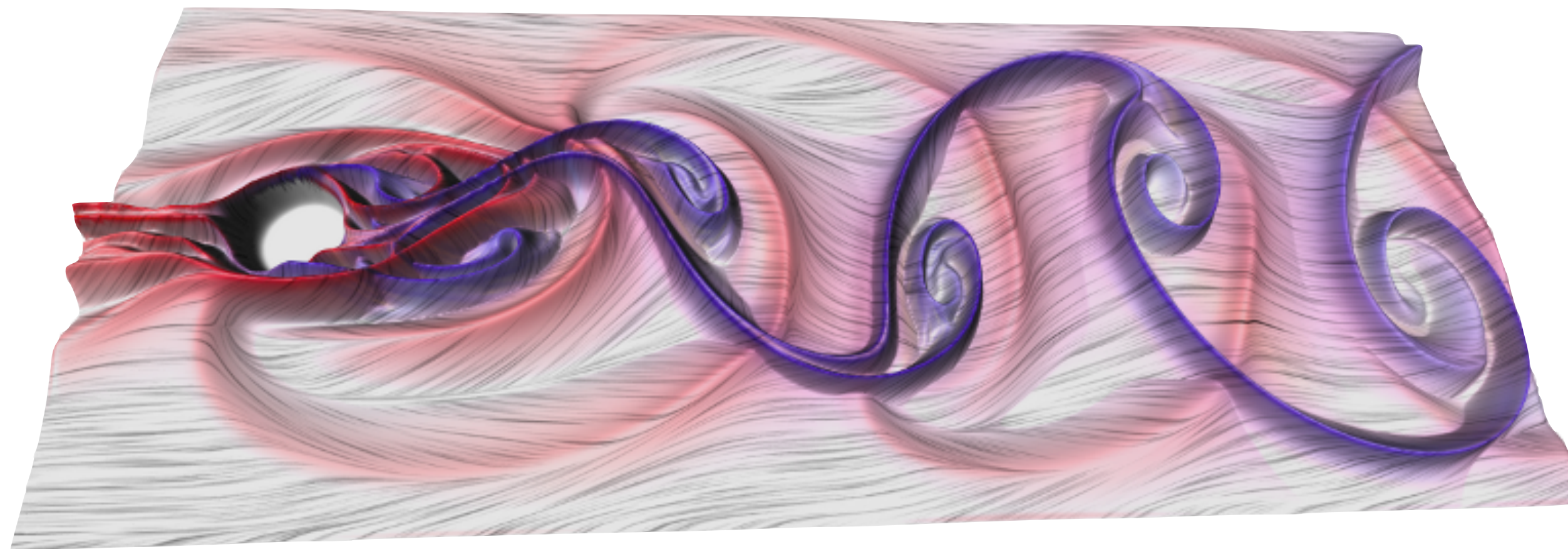
## Vector fields and flows





# Fundamental Techniques

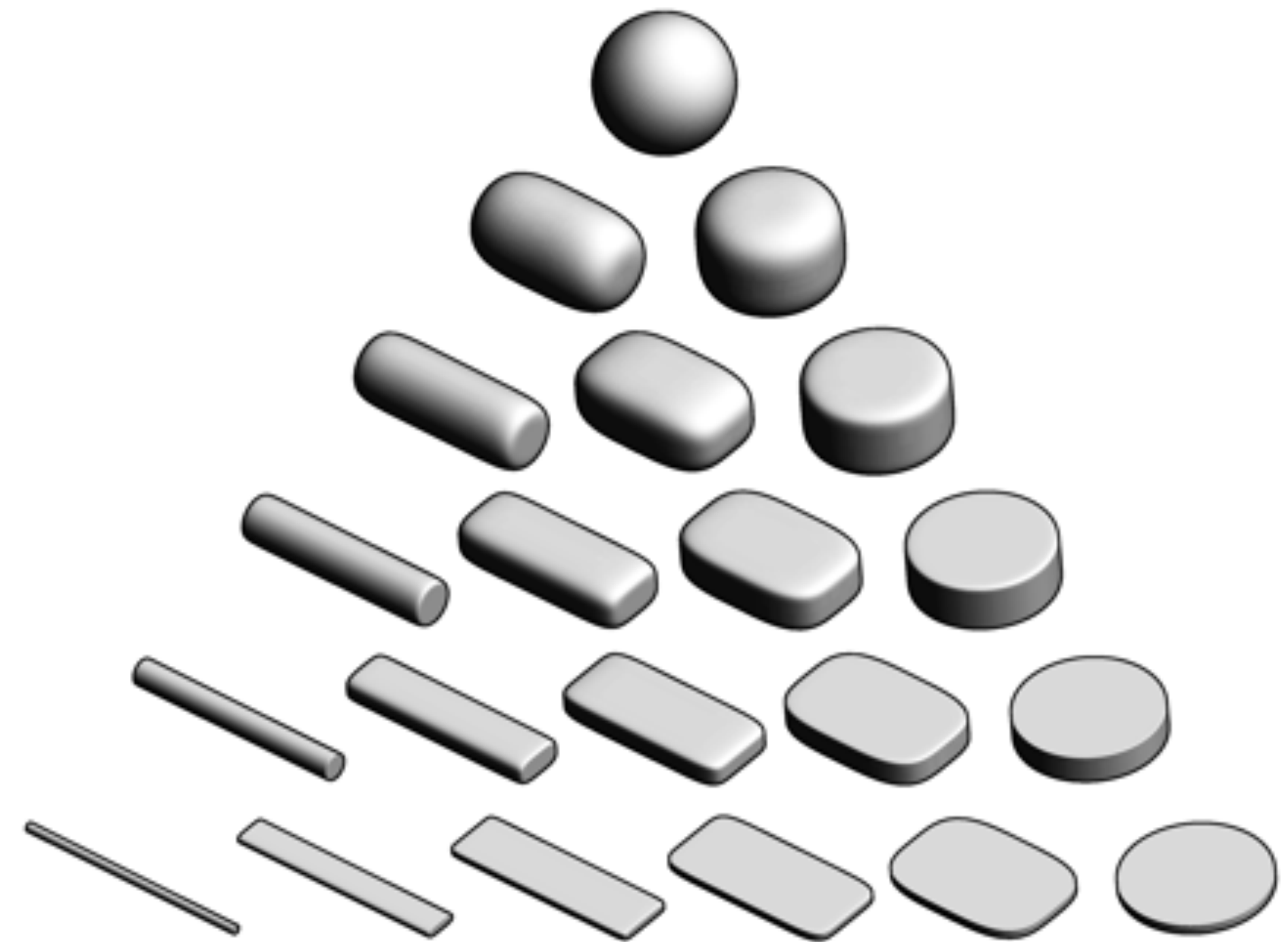
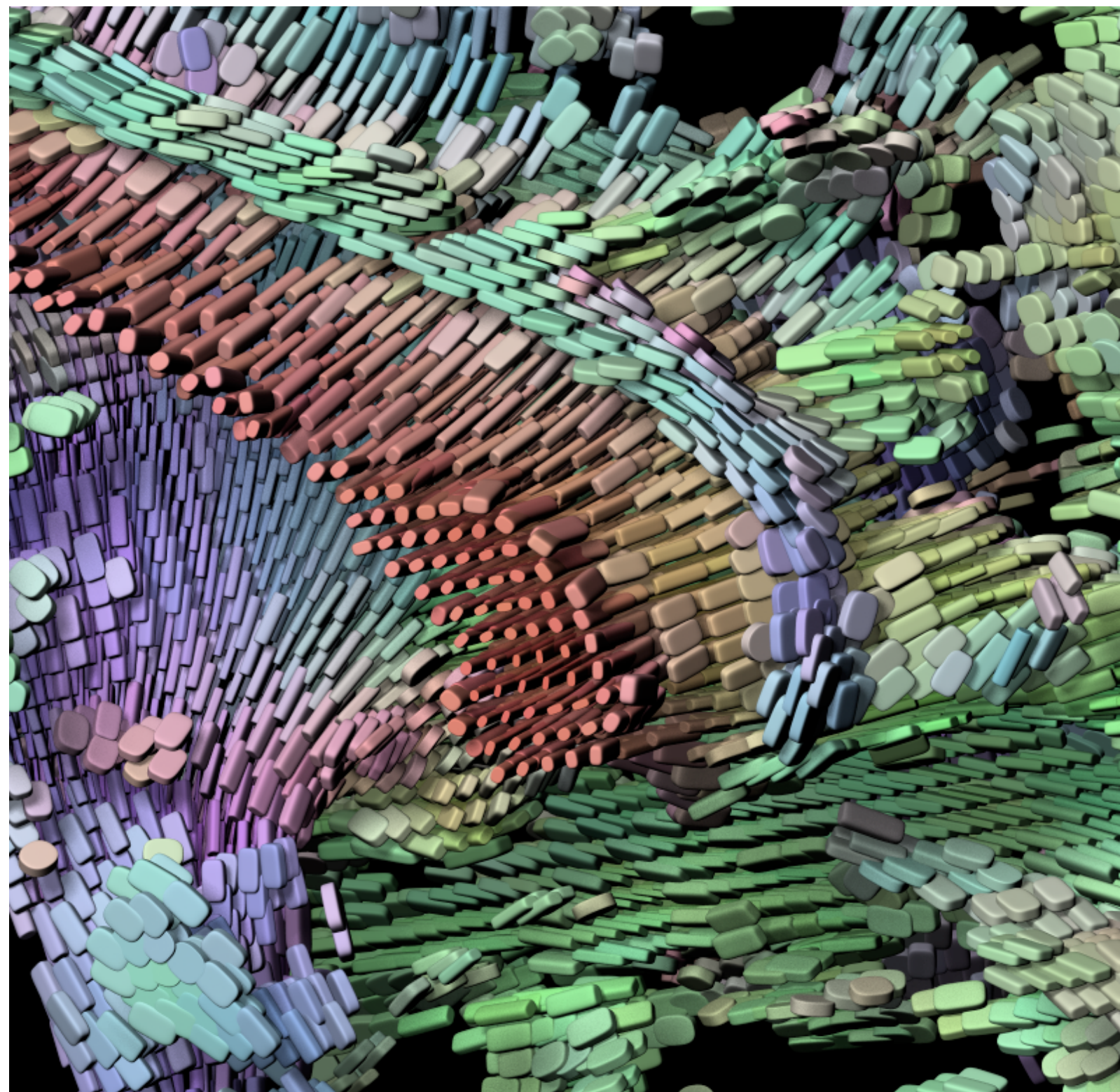
## Flow Visualization





# Fundamental Techniques

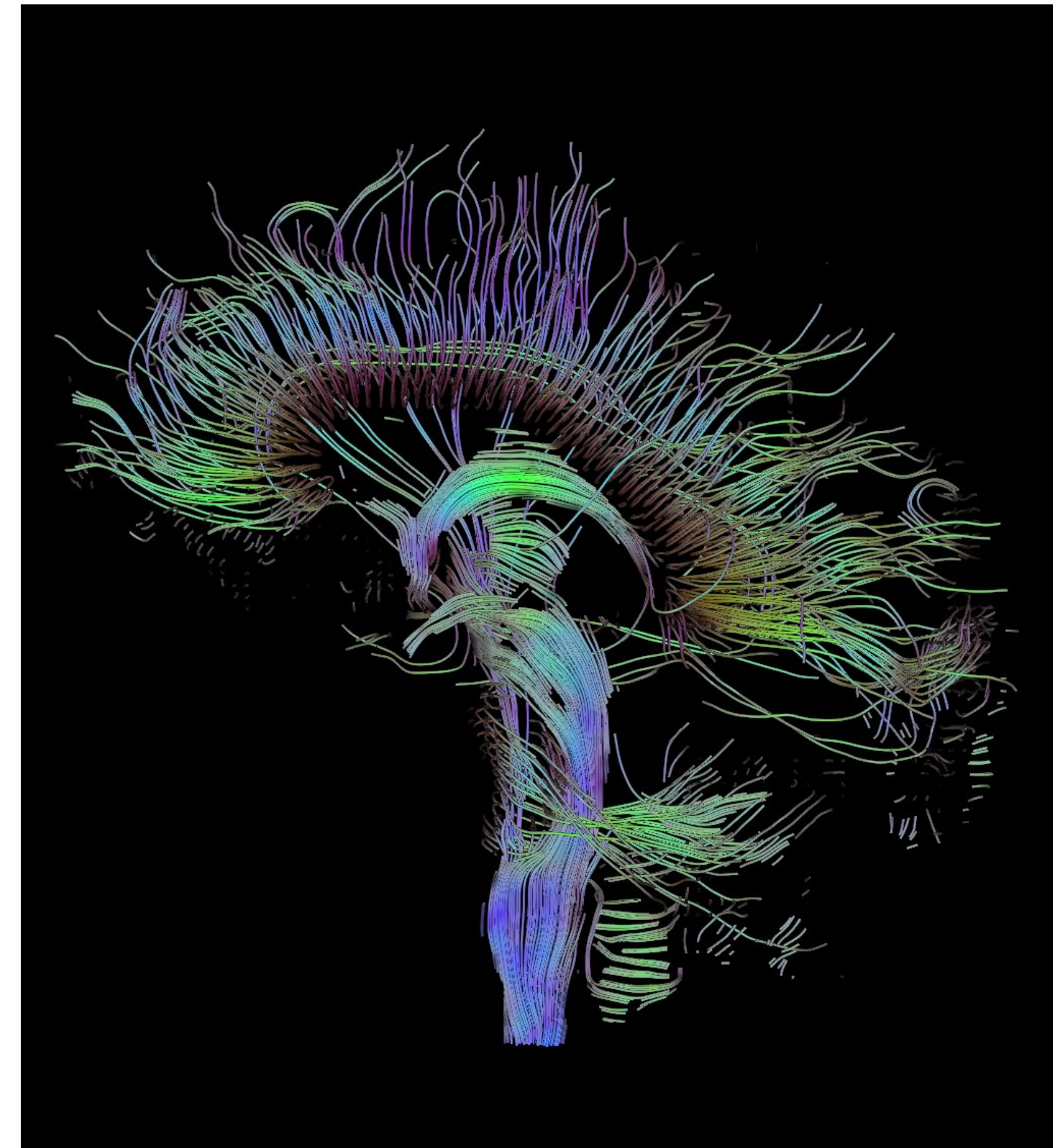
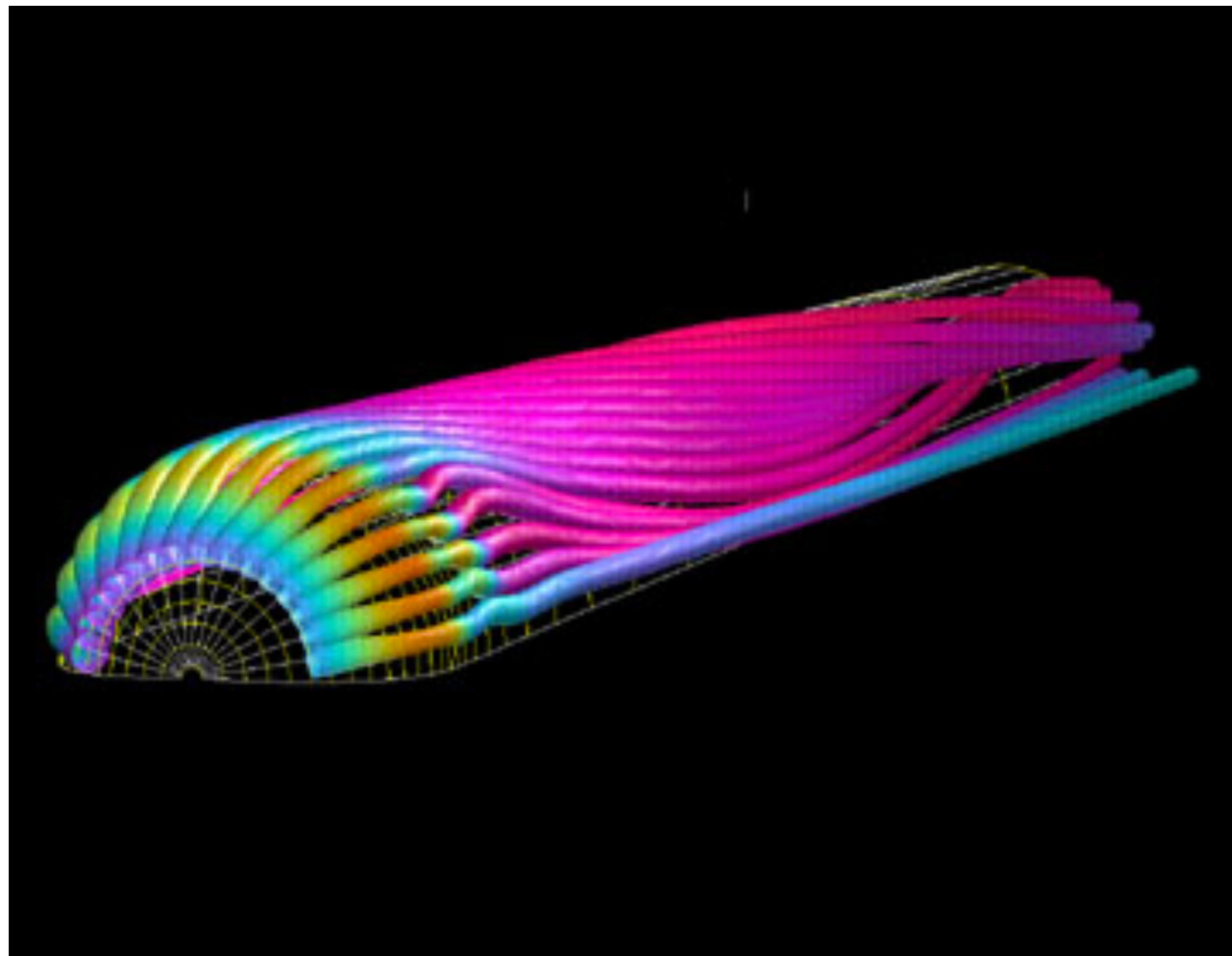
## Tensors and Glyphs





# Fundamental Techniques

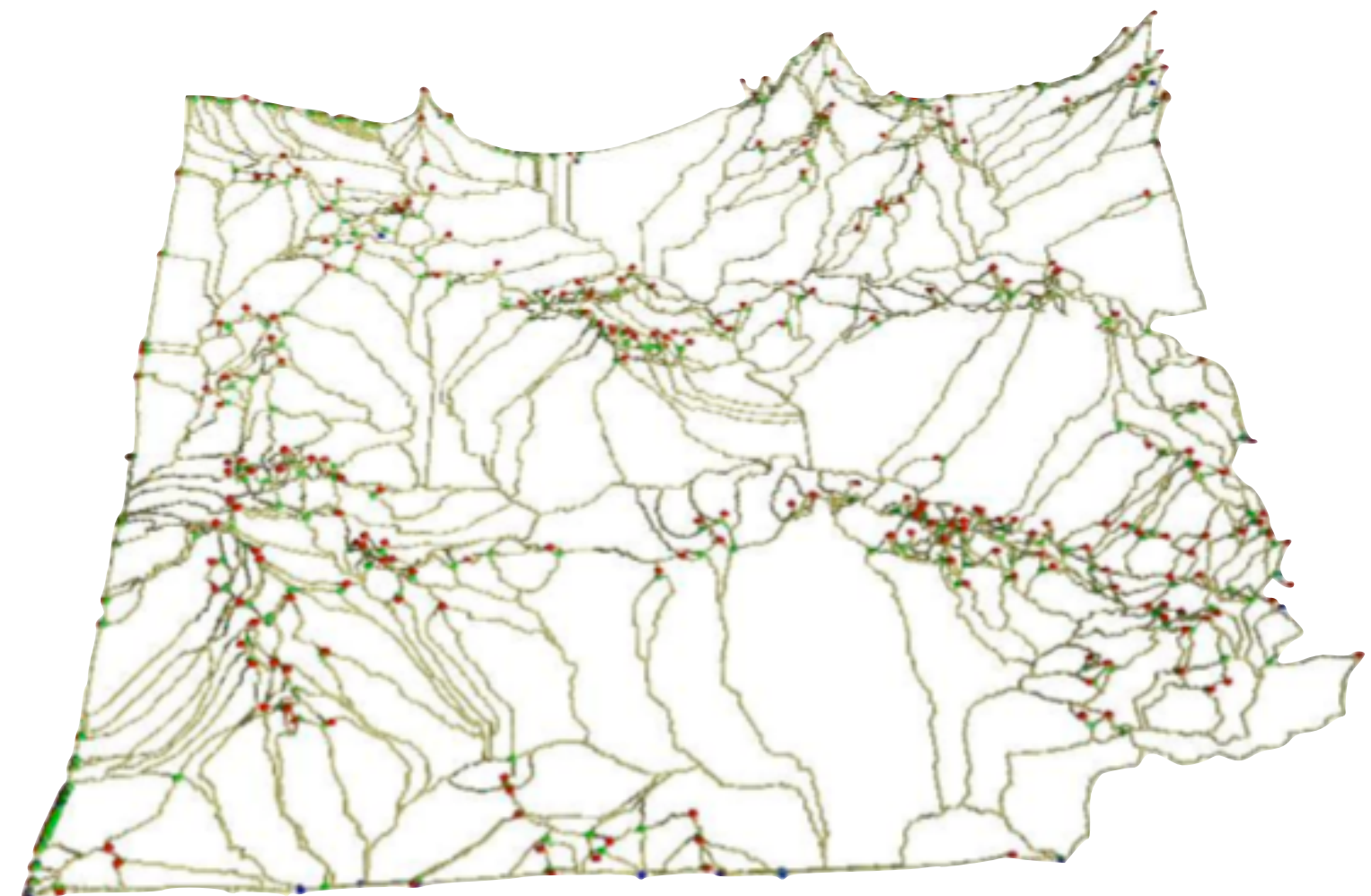
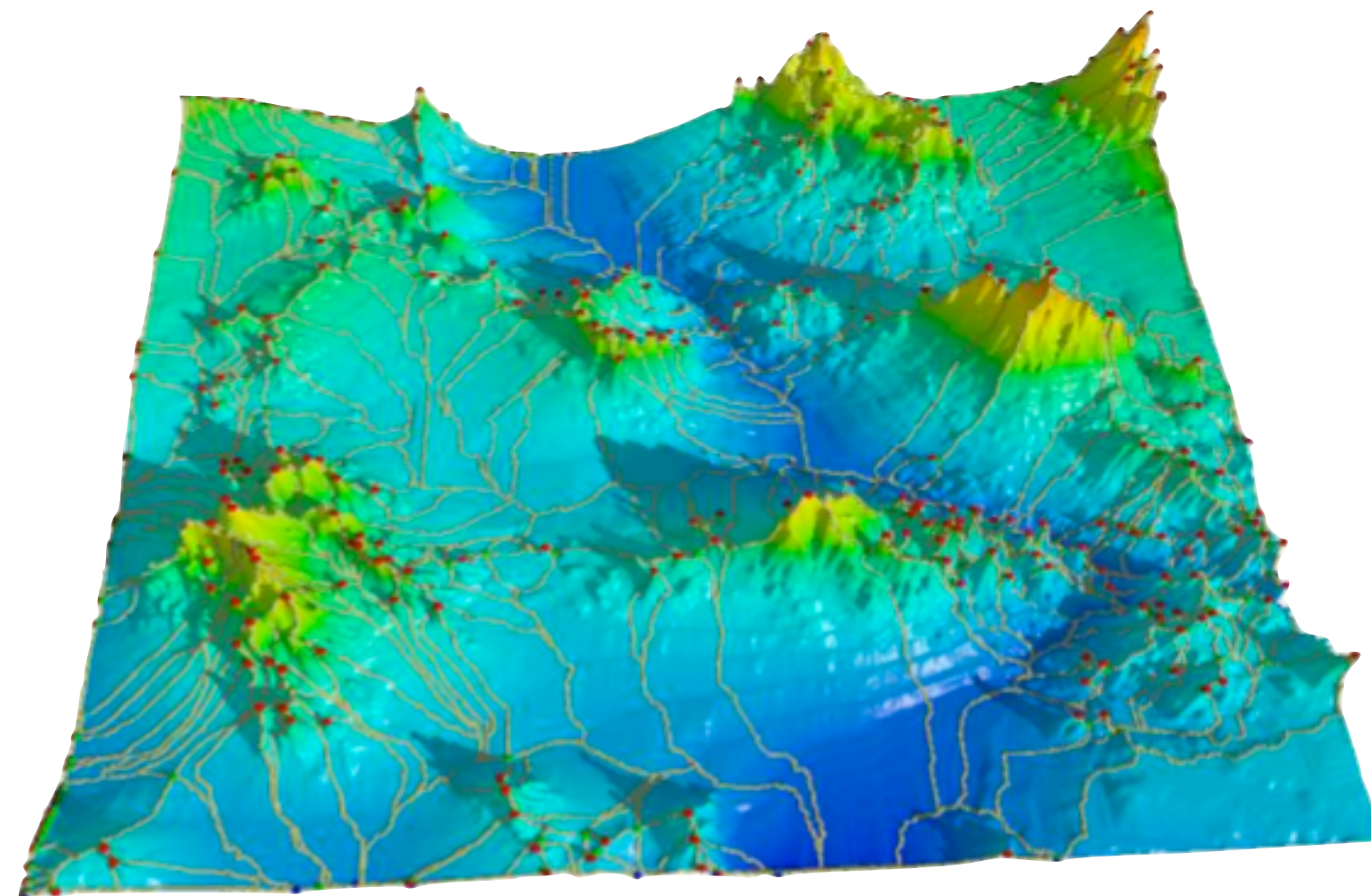
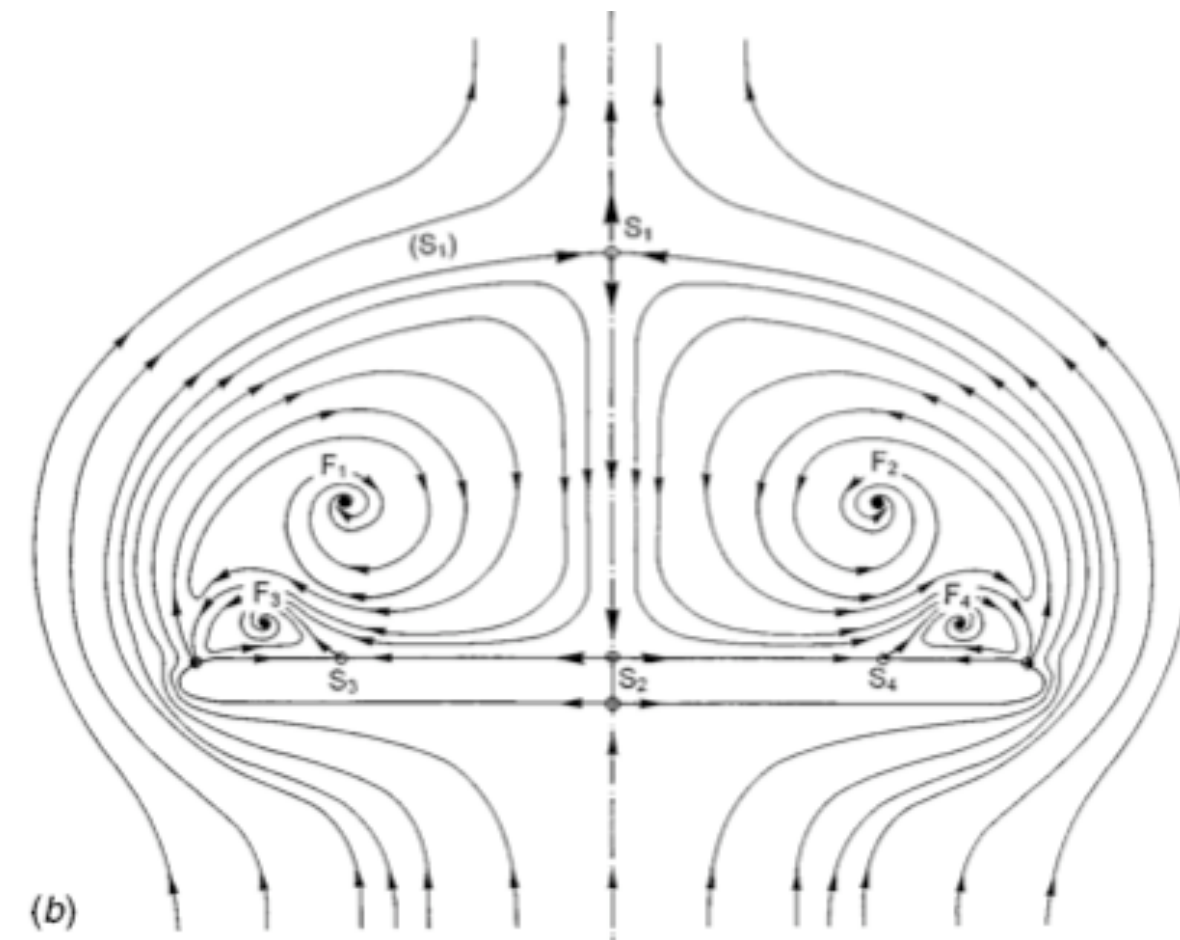
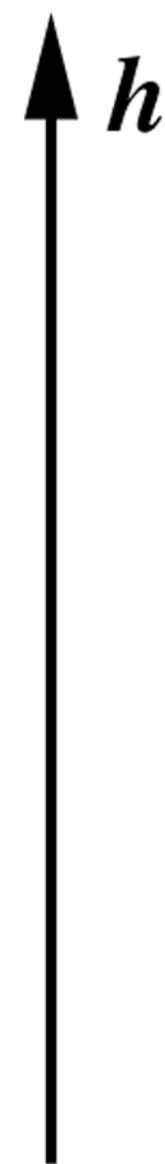
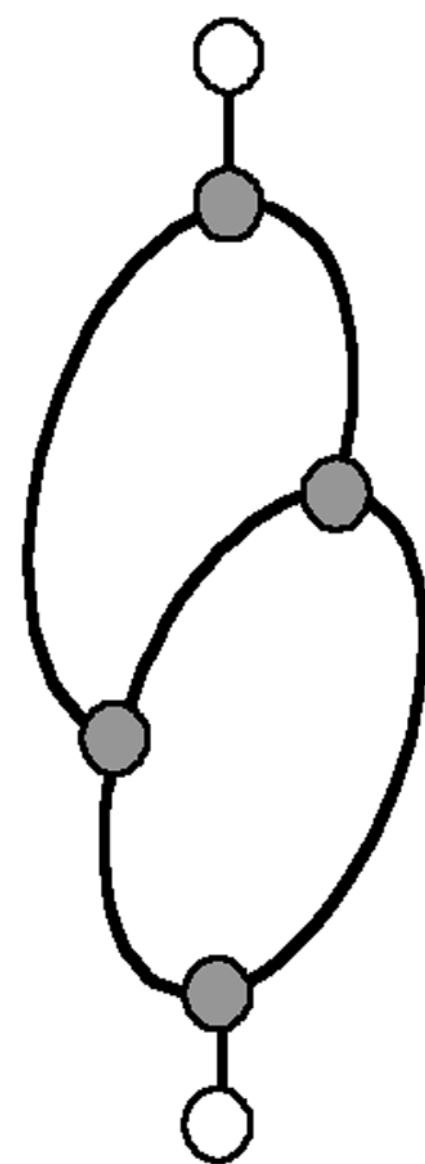
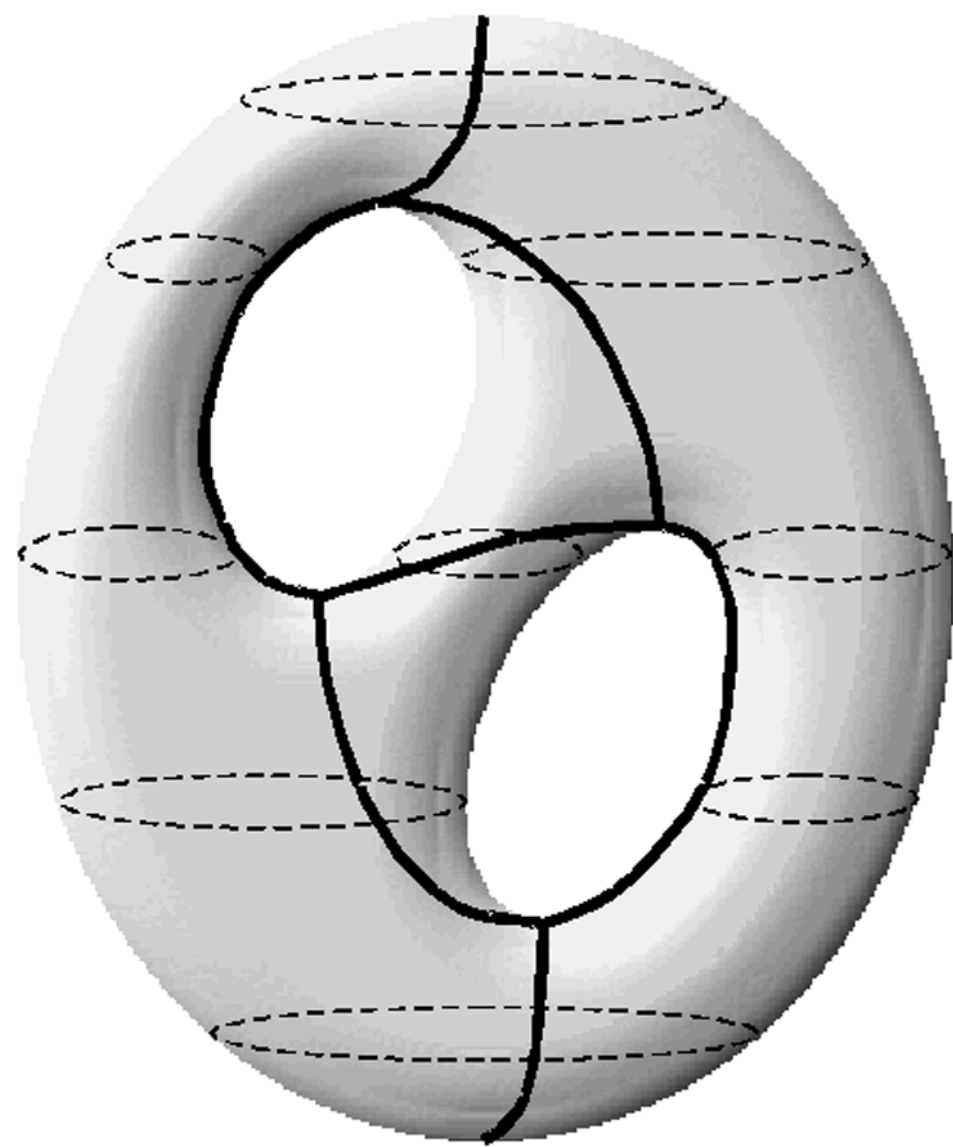
## Tensor lines





# Advanced Techniques

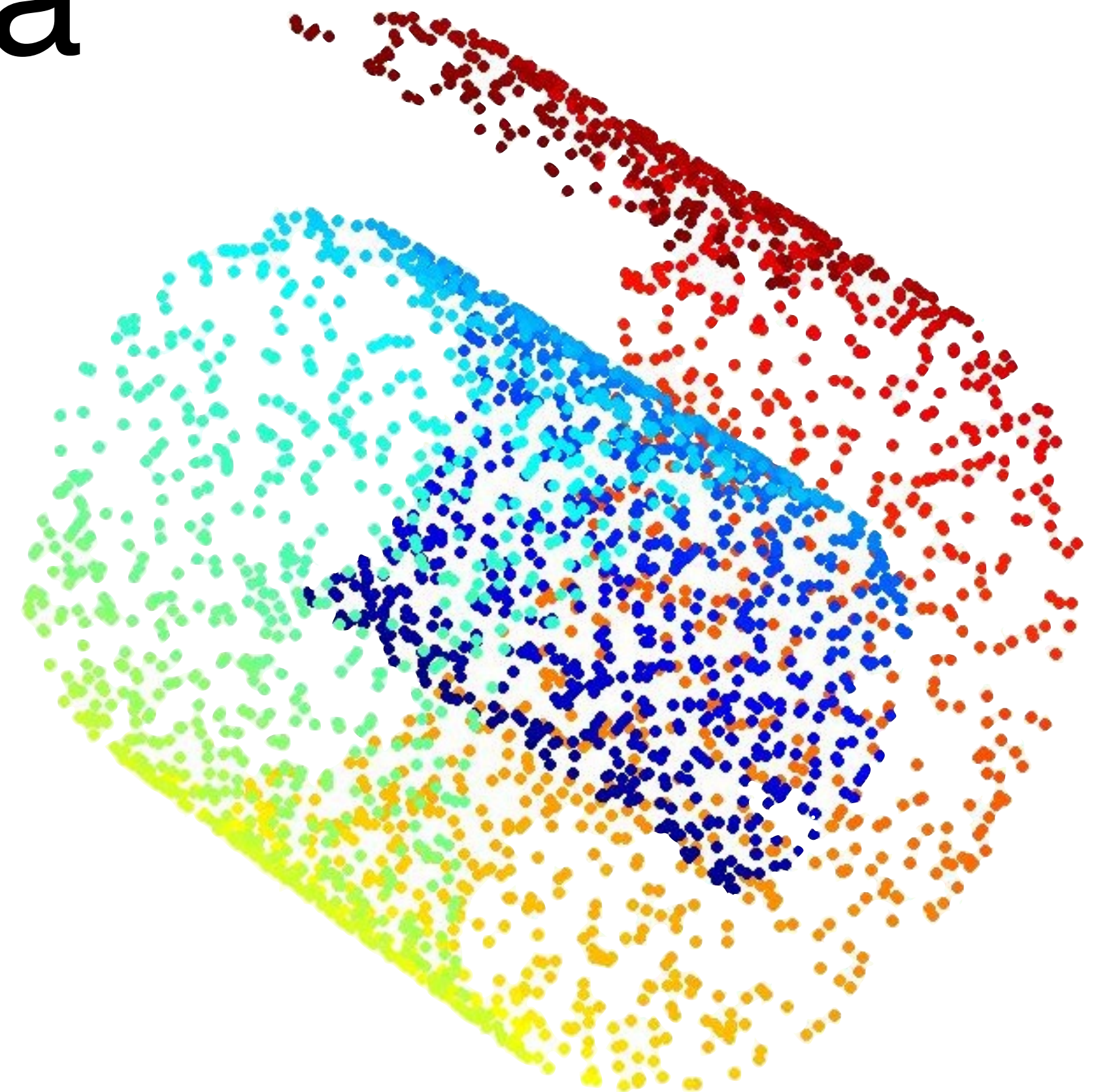
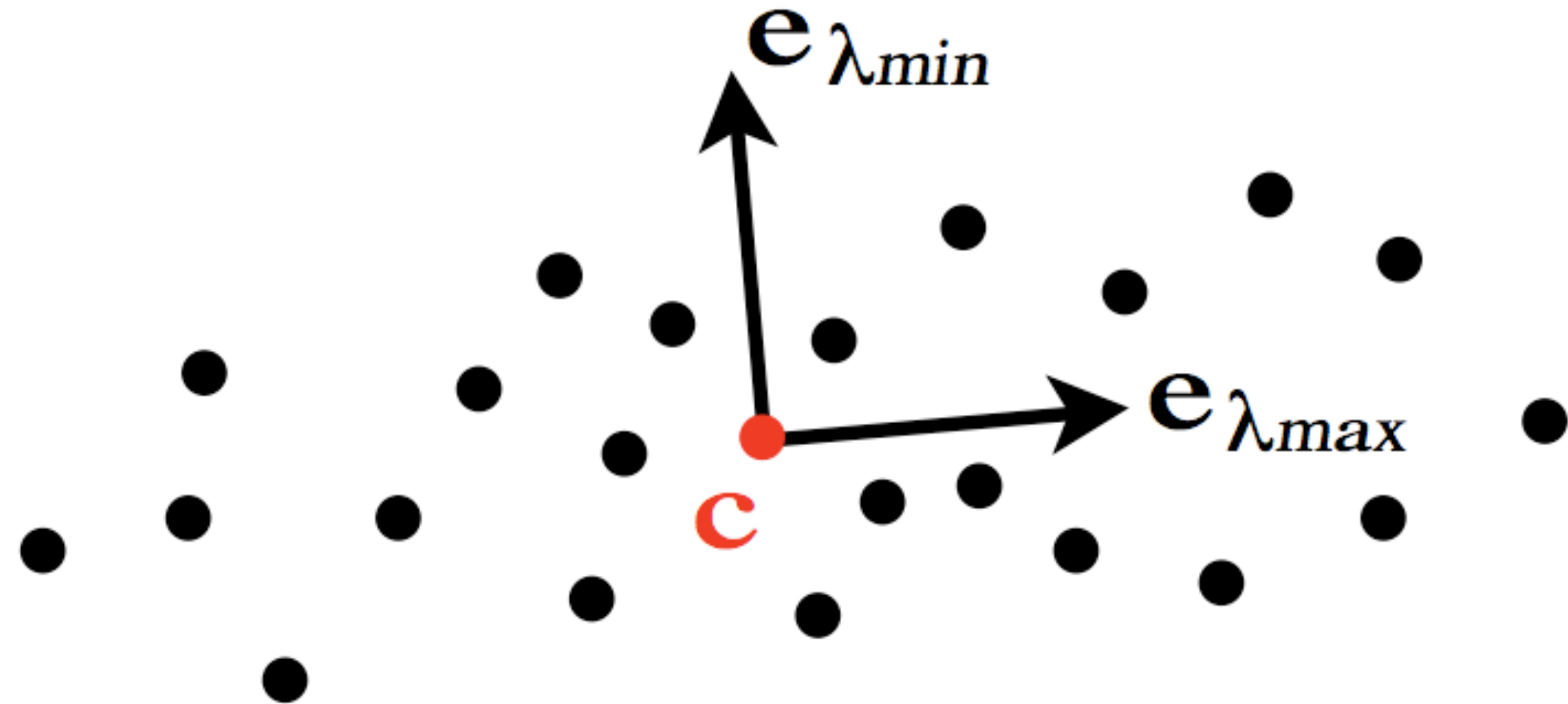
## Topology





# Advanced Techniques

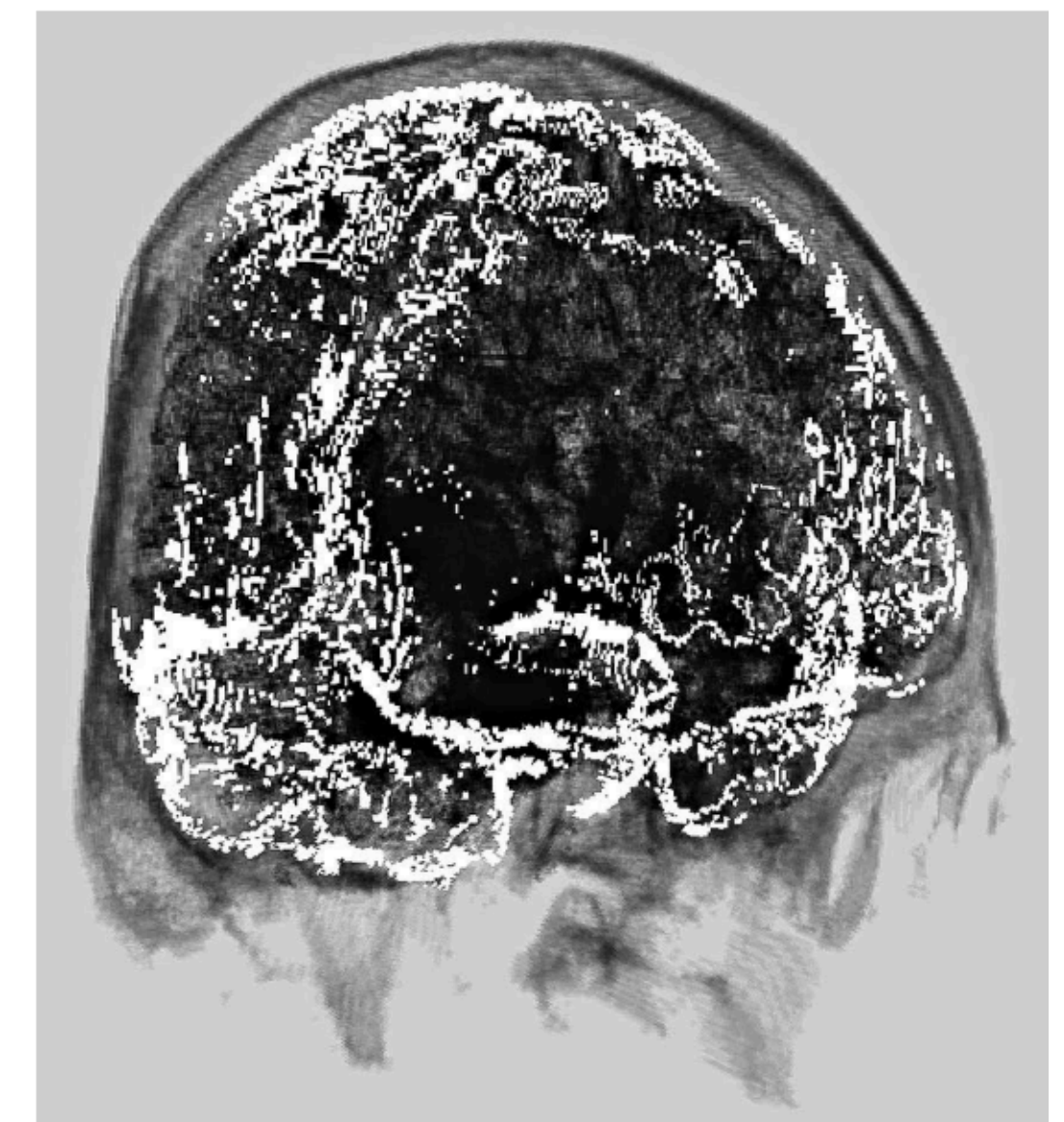
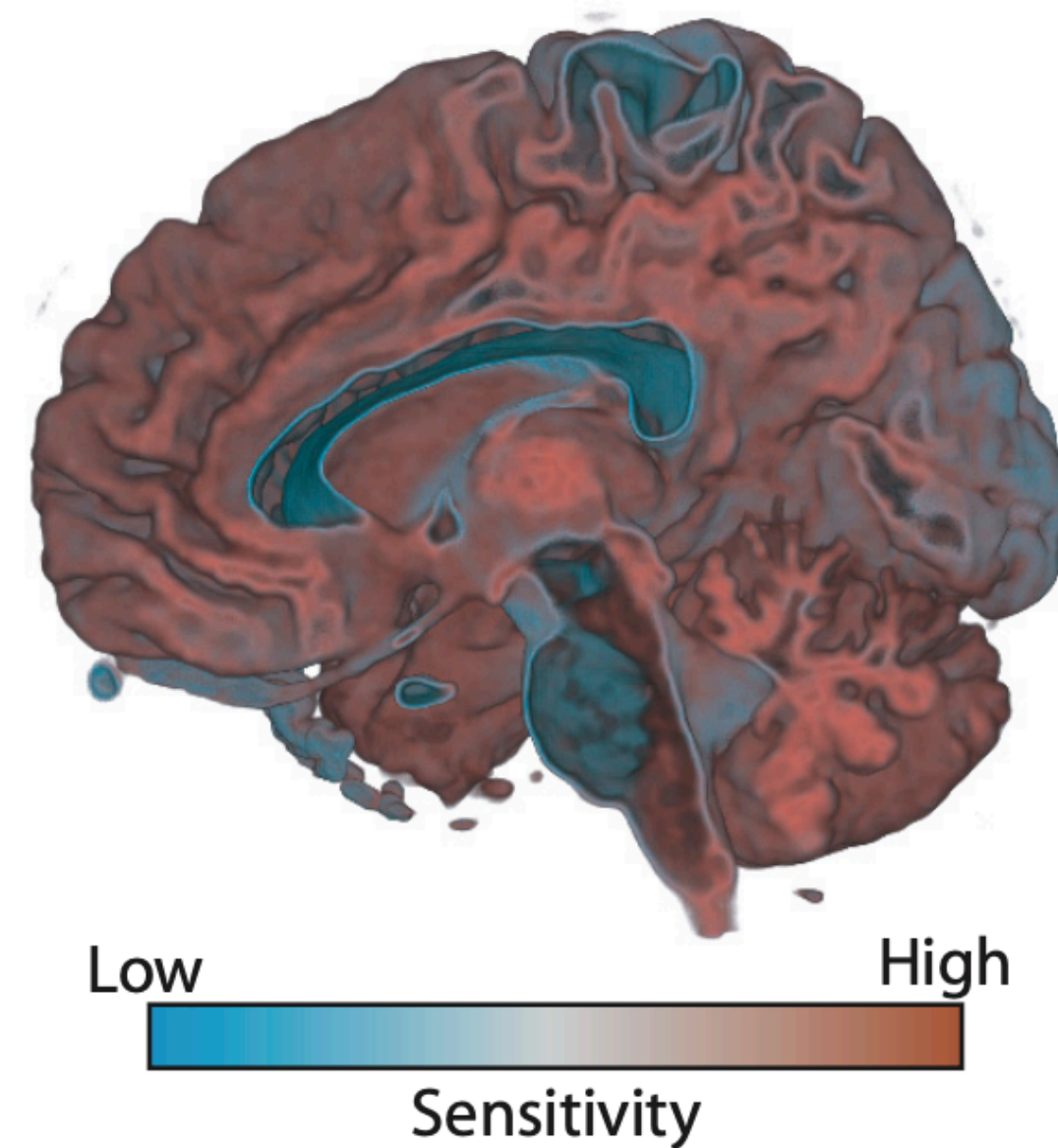
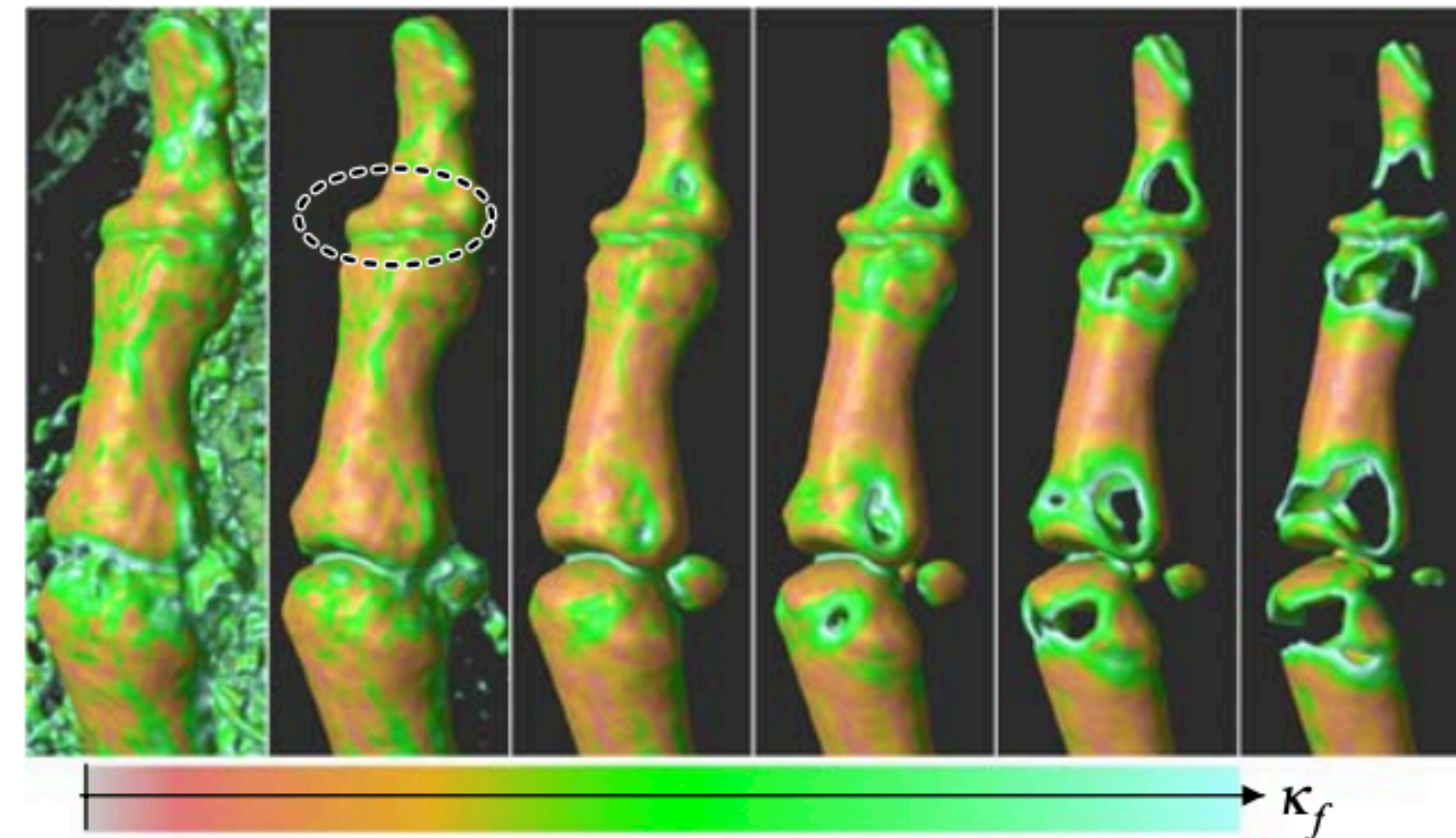
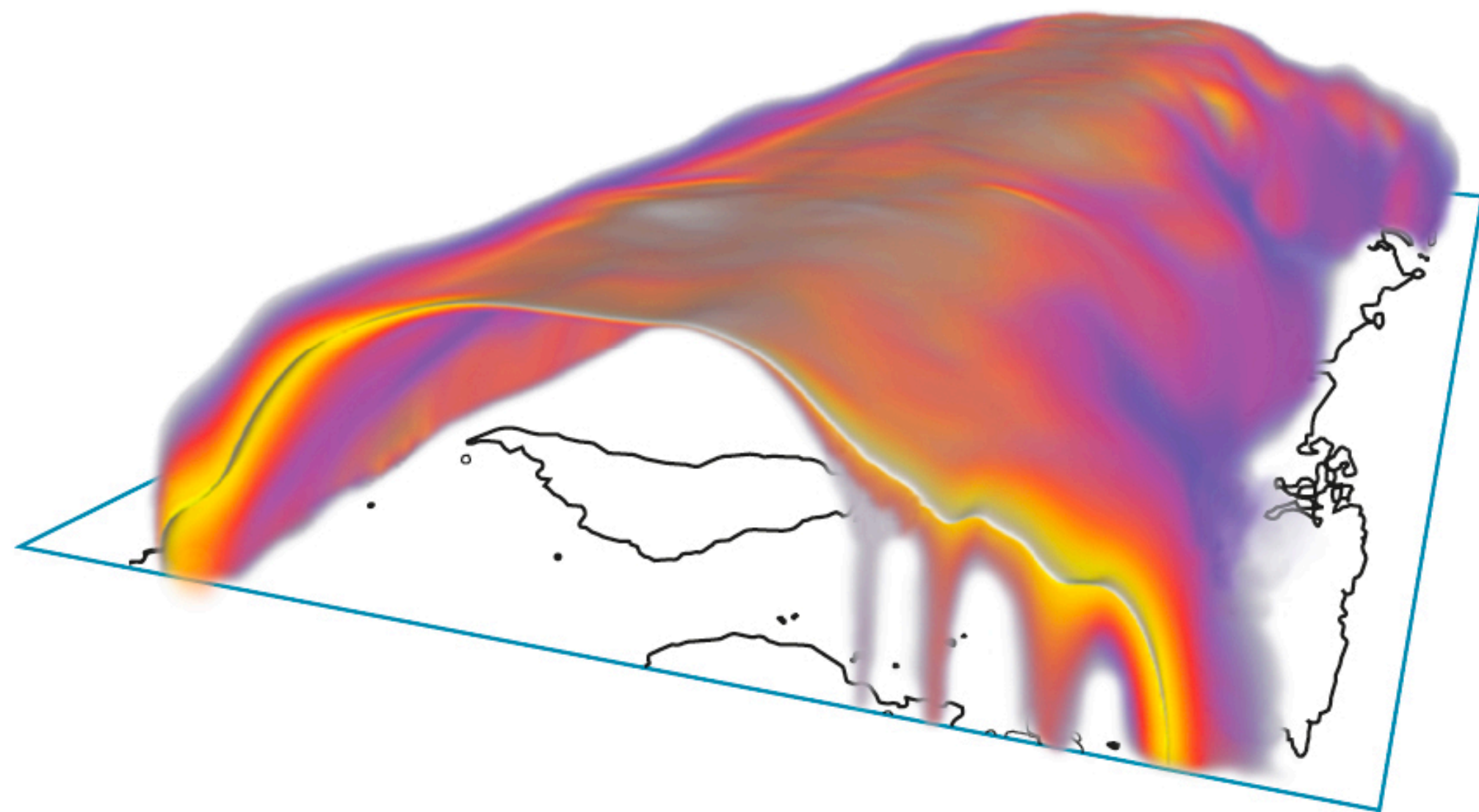
## High-dimensional data





# Advanced Techniques

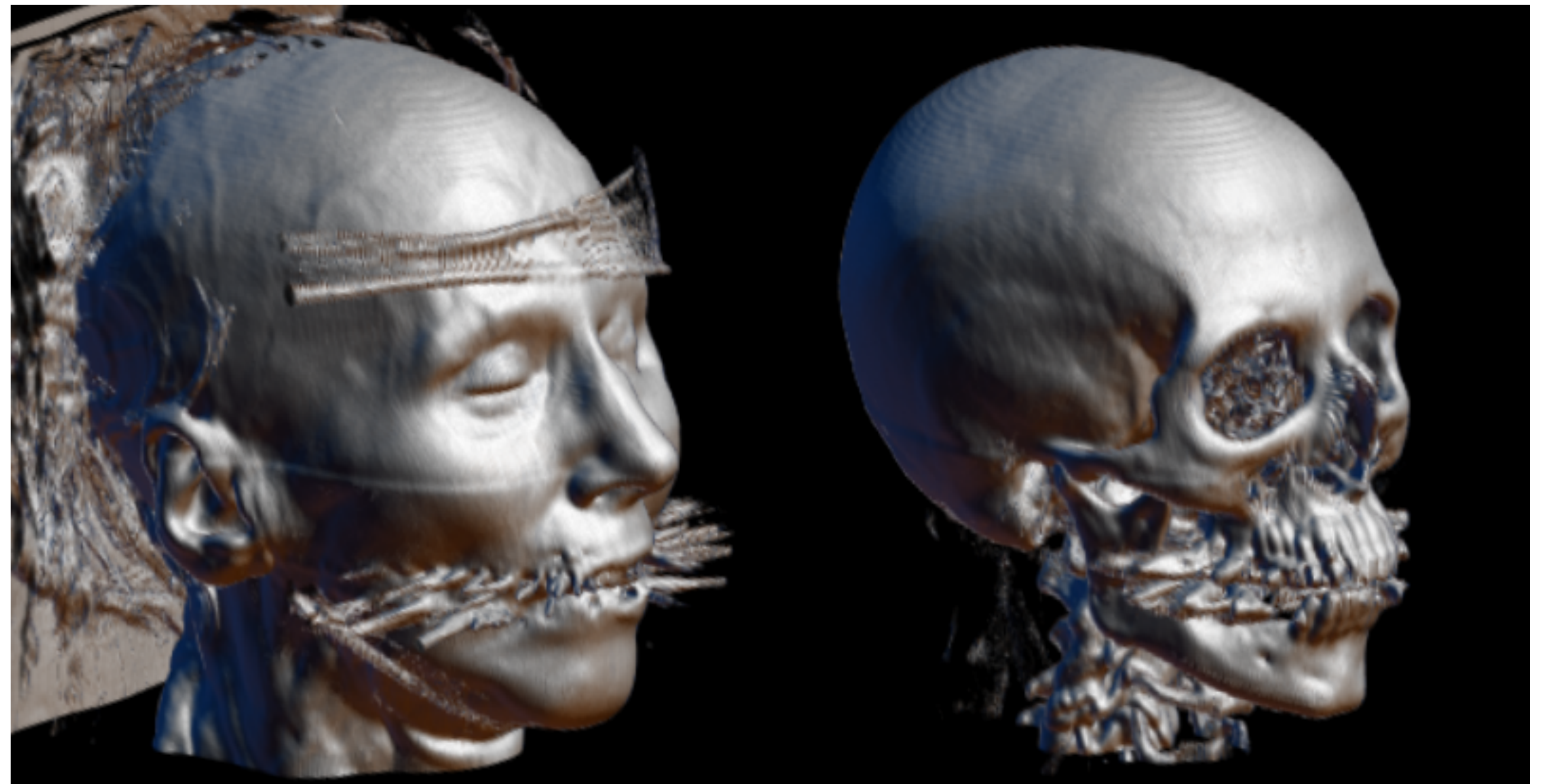
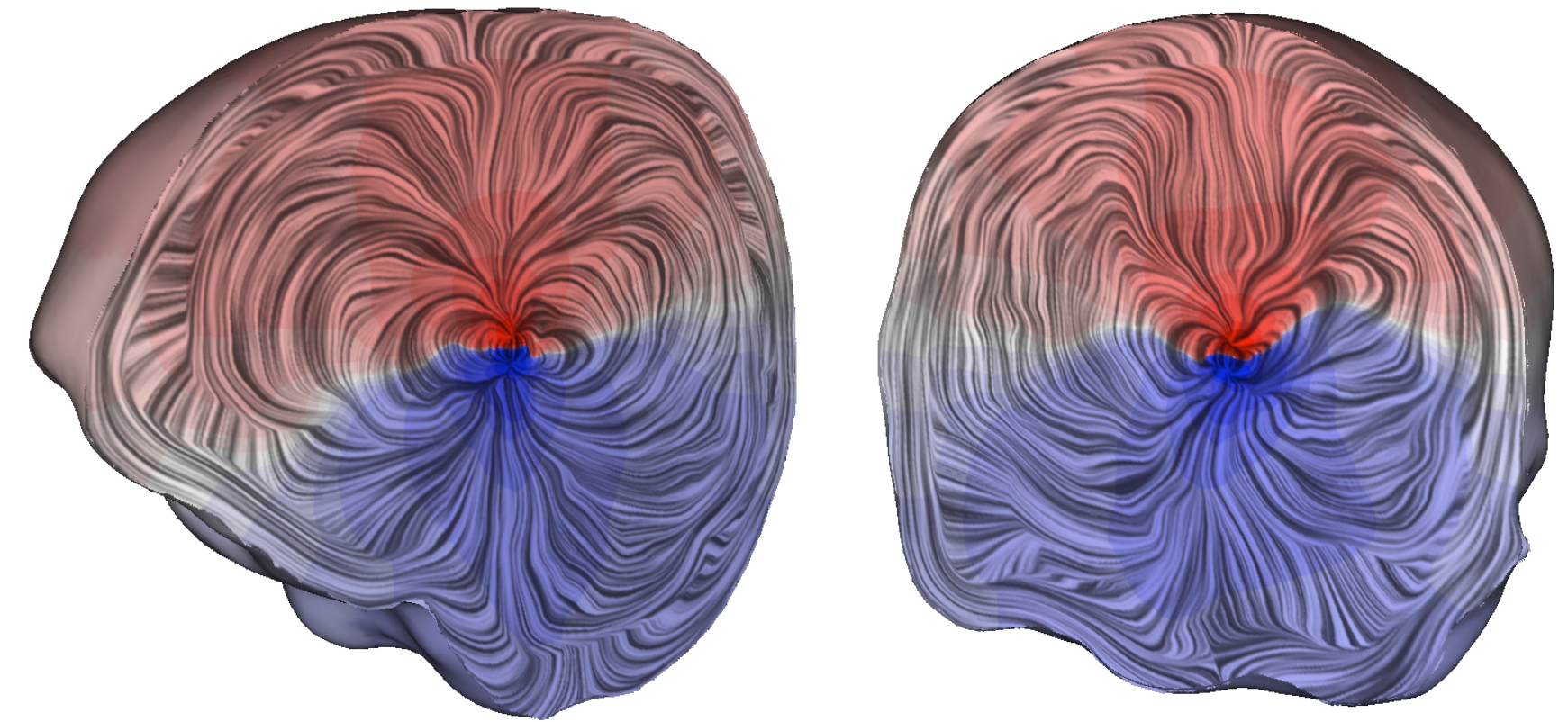
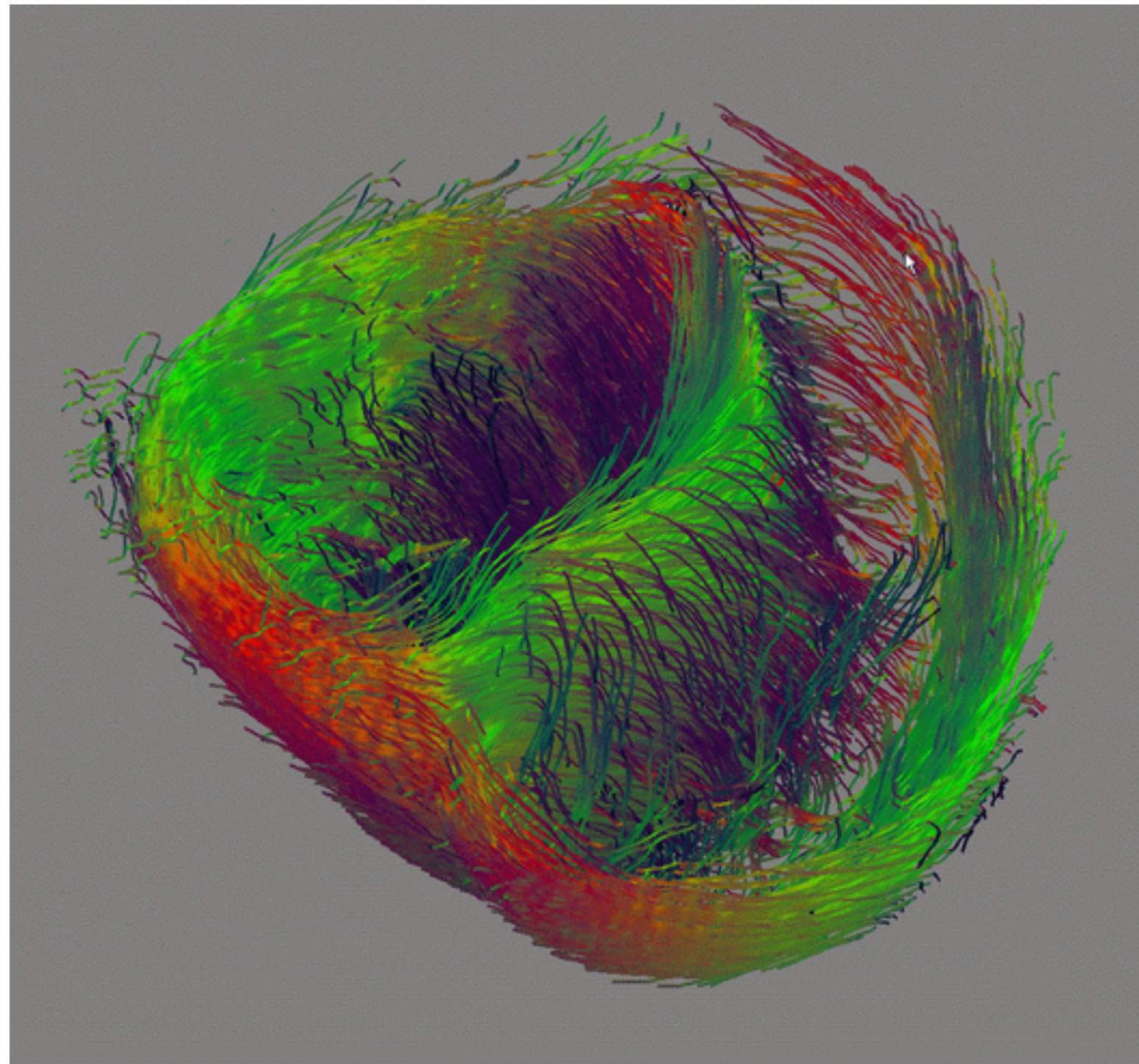
## Uncertainty





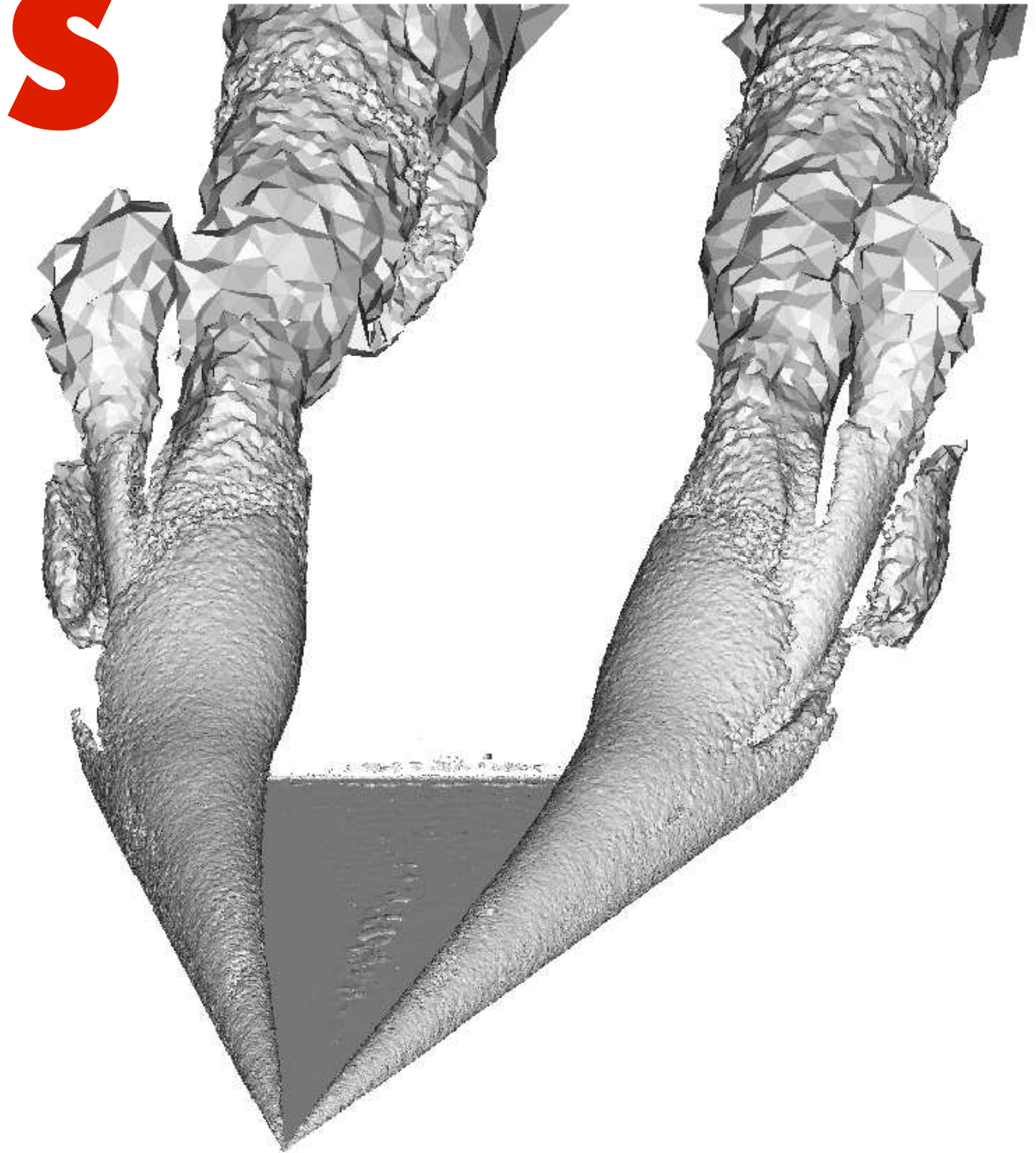
# Applications

## Biomedicine

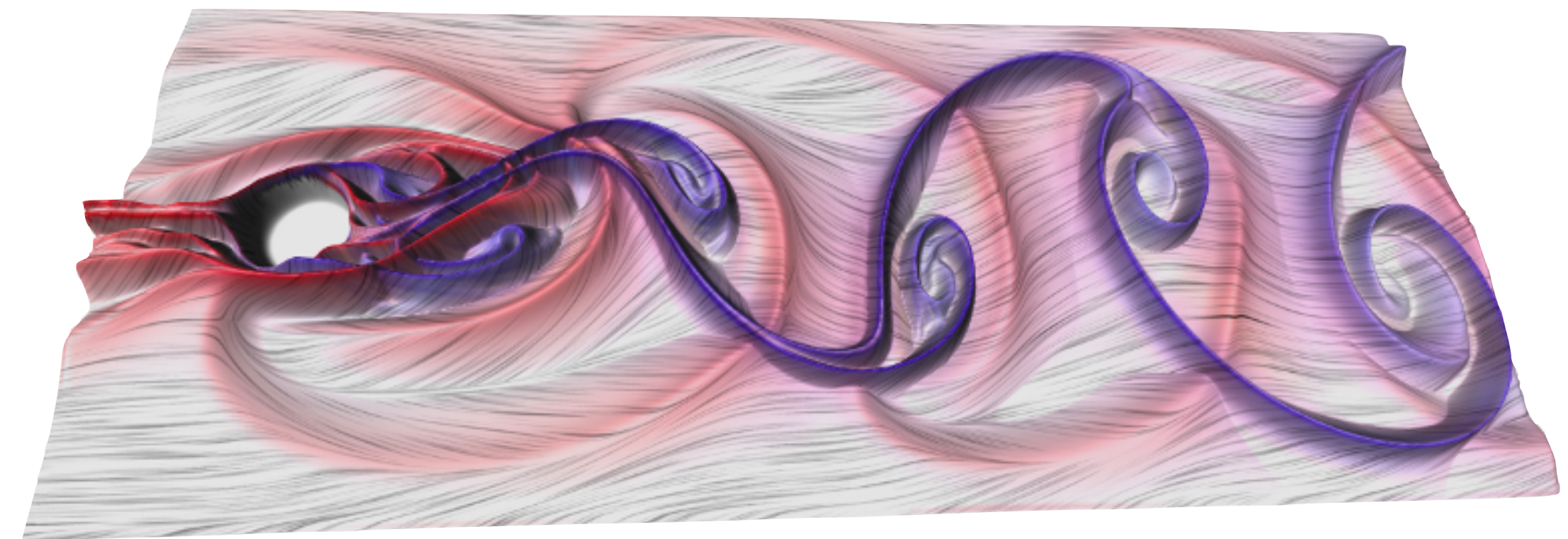




# Applications

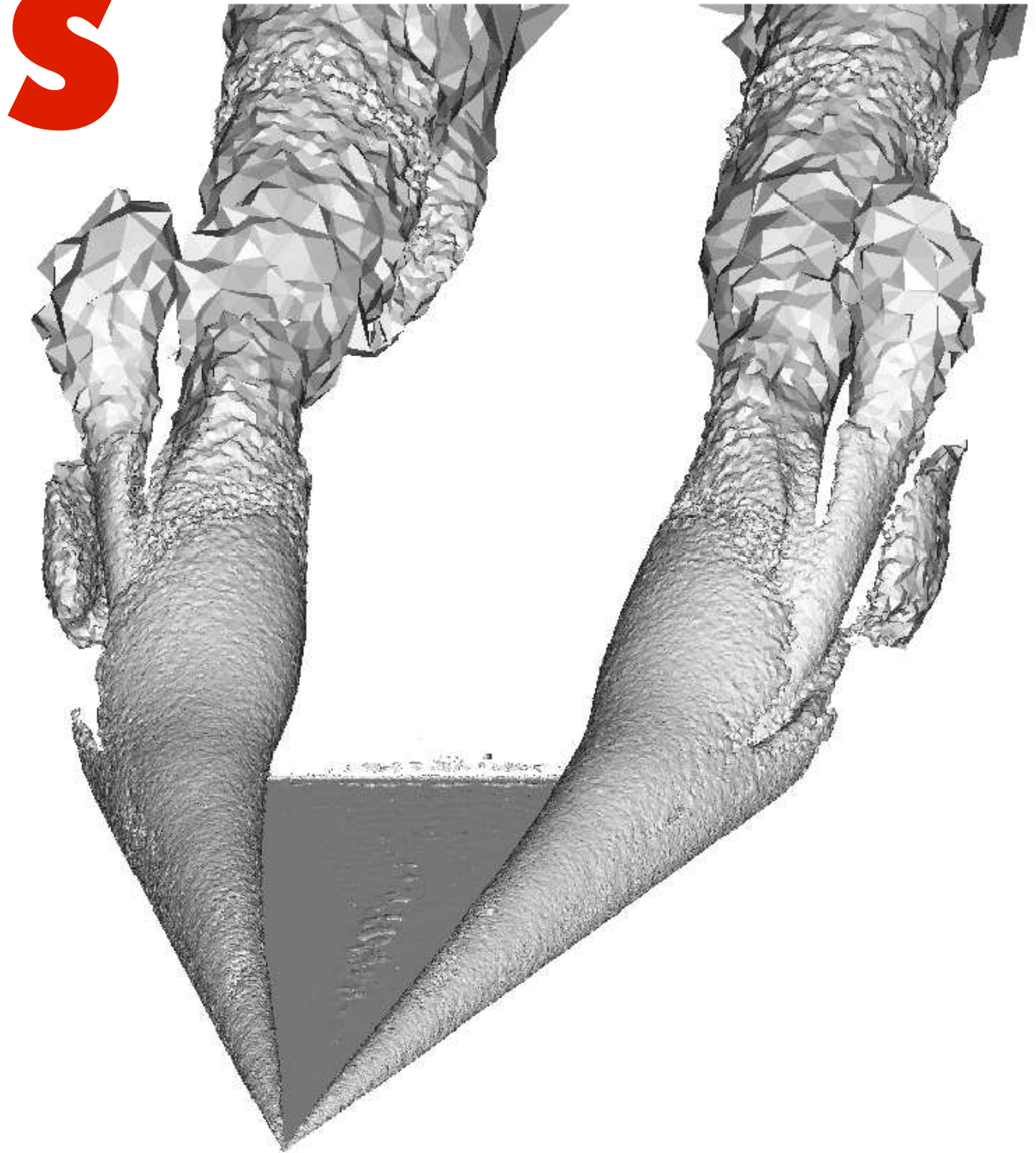


## Computational Fluid Dynamics





# Applications



## Computational Fluid Dynamics

