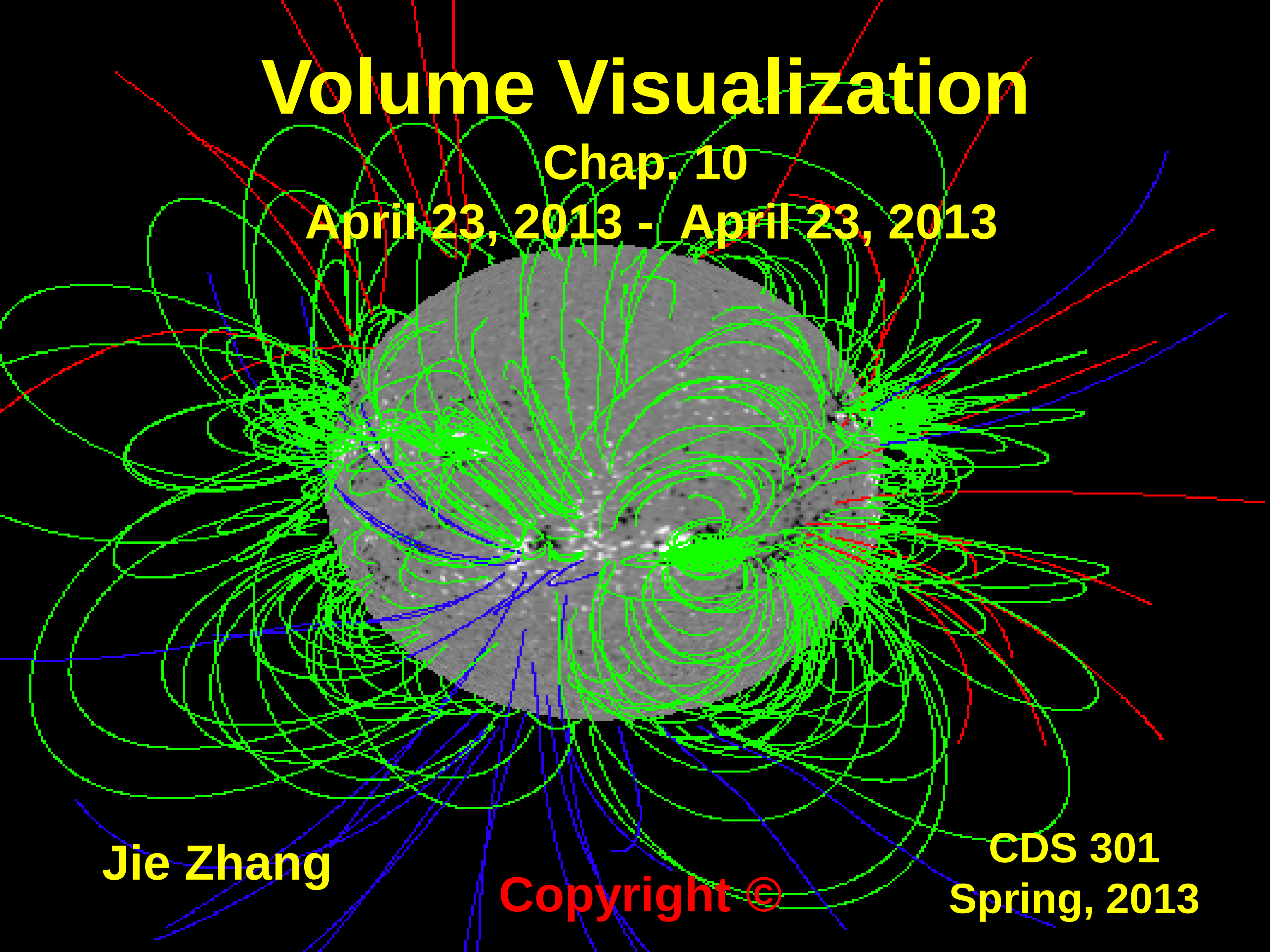


# Volume Visualization

## Chap. 10

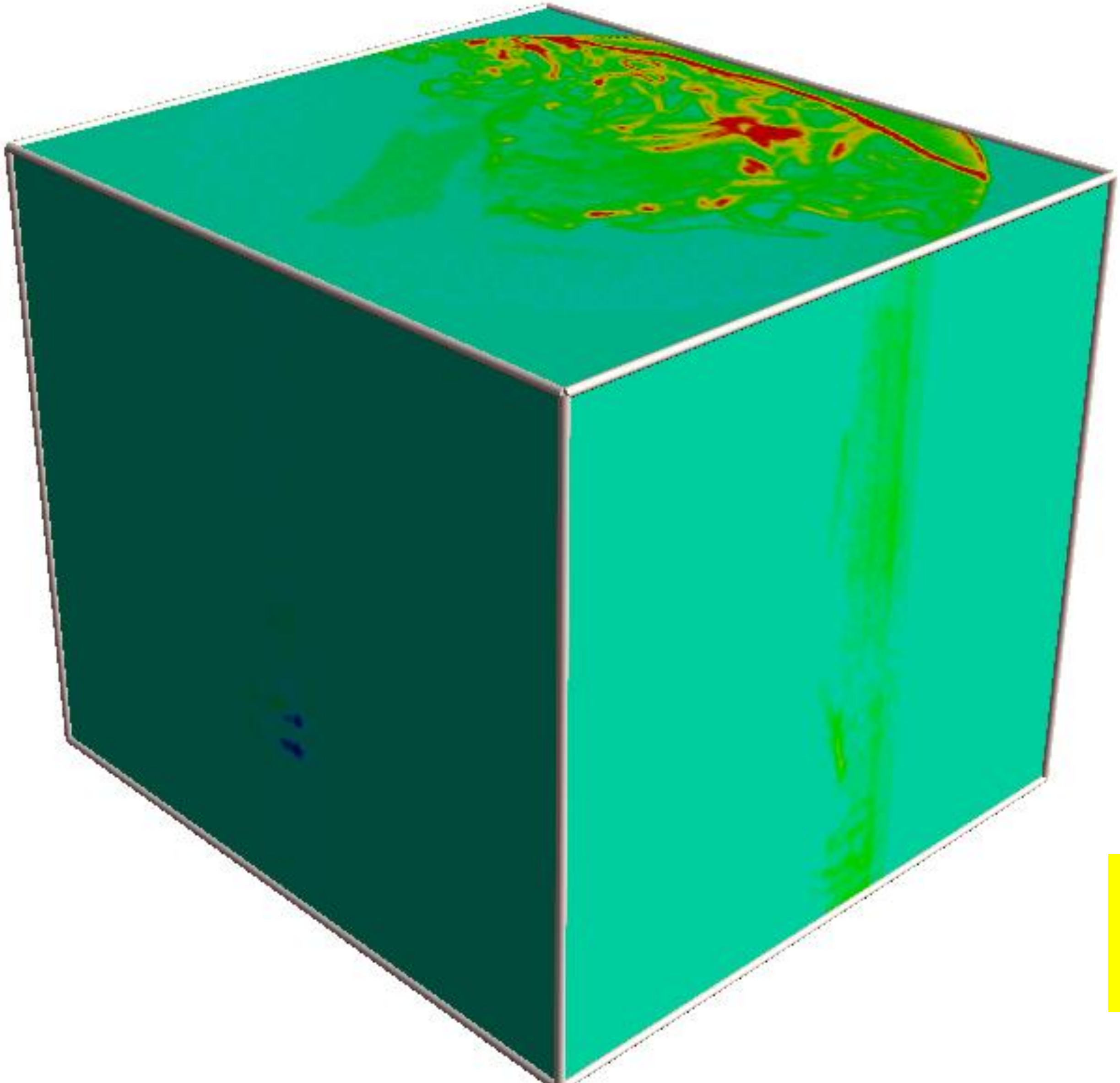
## April 23, 2013 - April 23, 2013

Jie Zhang



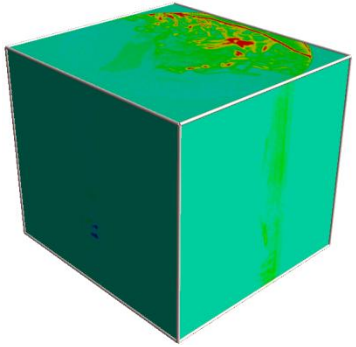
CDS 301
Spring, 2013

# Volume Visualization



Visualize a 3D Scalar Dataset

# Outline



**10.1. Motivation**

**10.2. Volume Visualization Basics**

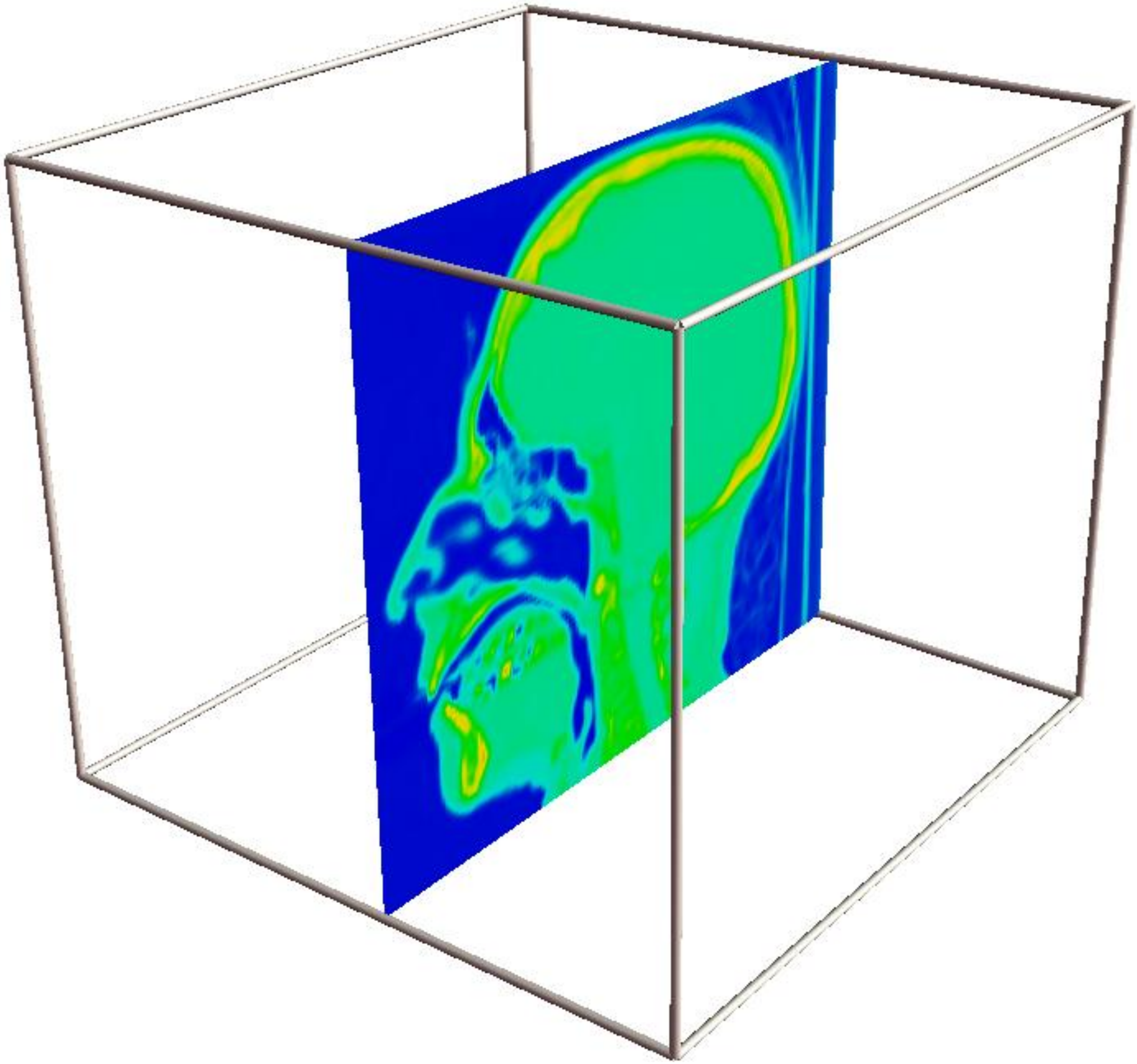
- **Ray function and Classification Transfer function**
- **Maximum Intensity Projection**
- **Average Intensity Function**
- **Isosurface Function**
- **Compositing Function**
- **Volume Shading**

10.3. Image Order Technique

10.4. Object Order Technique

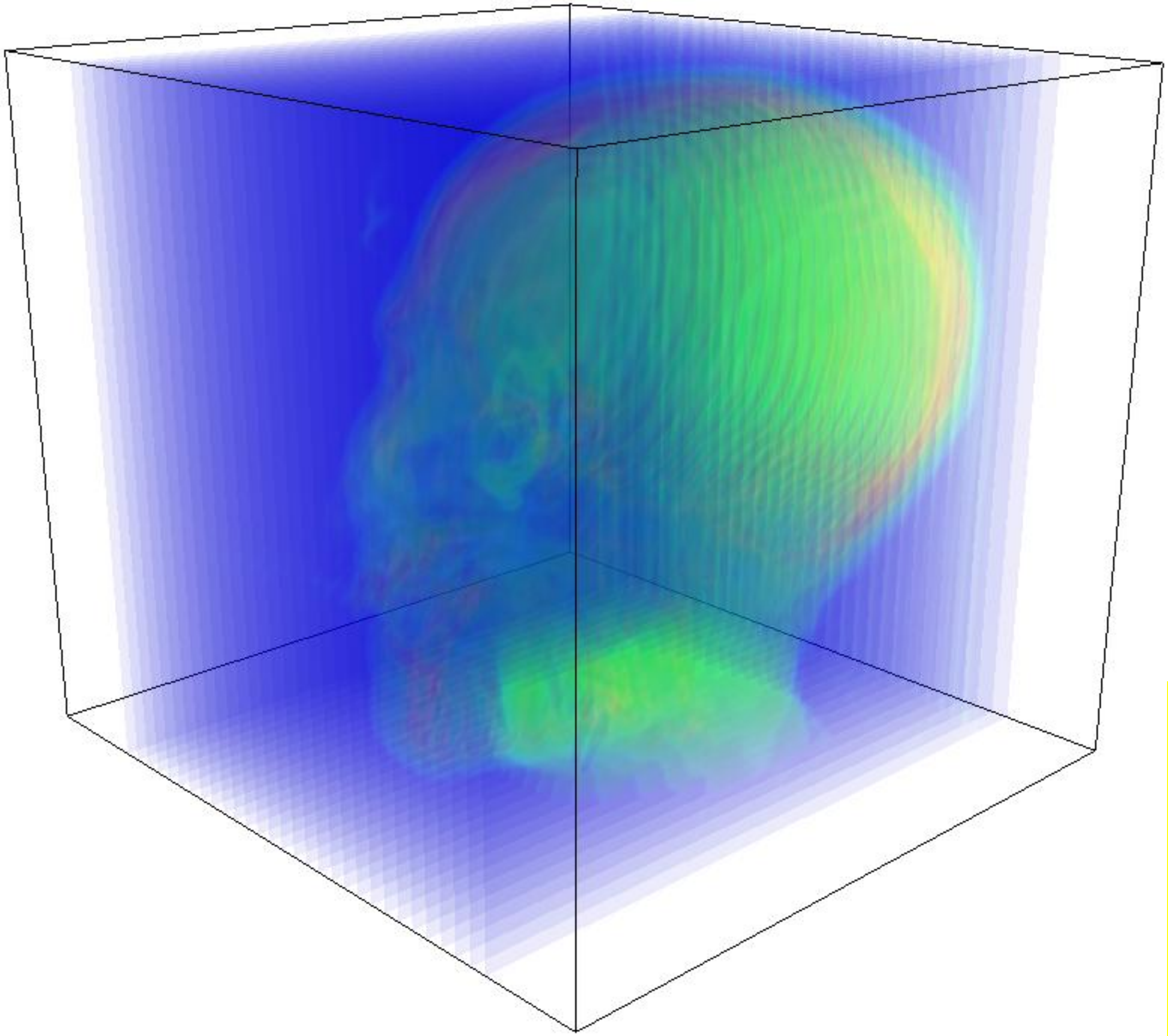
10.5. Volume Rendering versus Geometric Rendering

# Methods We Knew



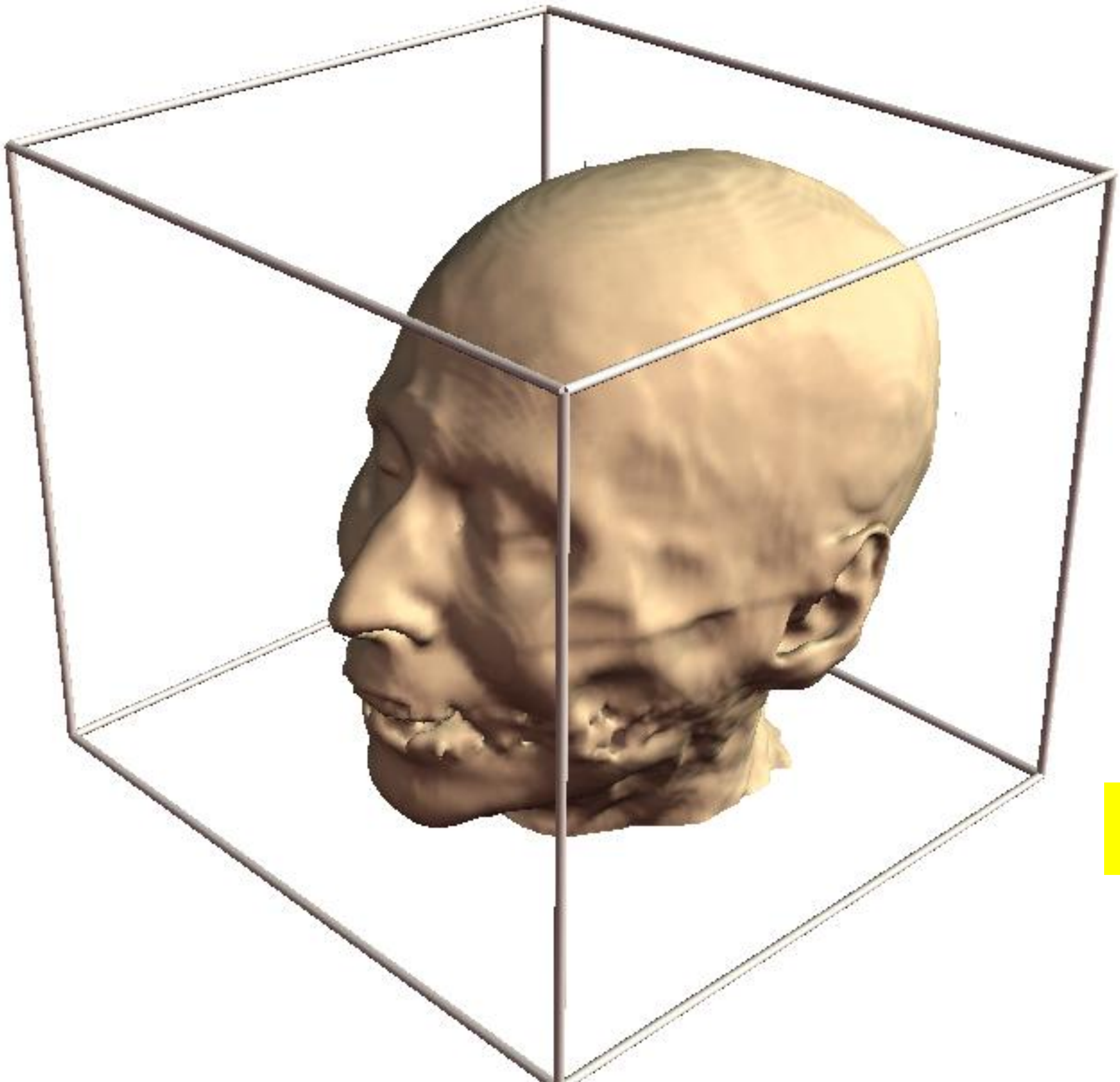
Slicing

# Methods We Knew



**Generalized Slicing: Multiple transparent slices**

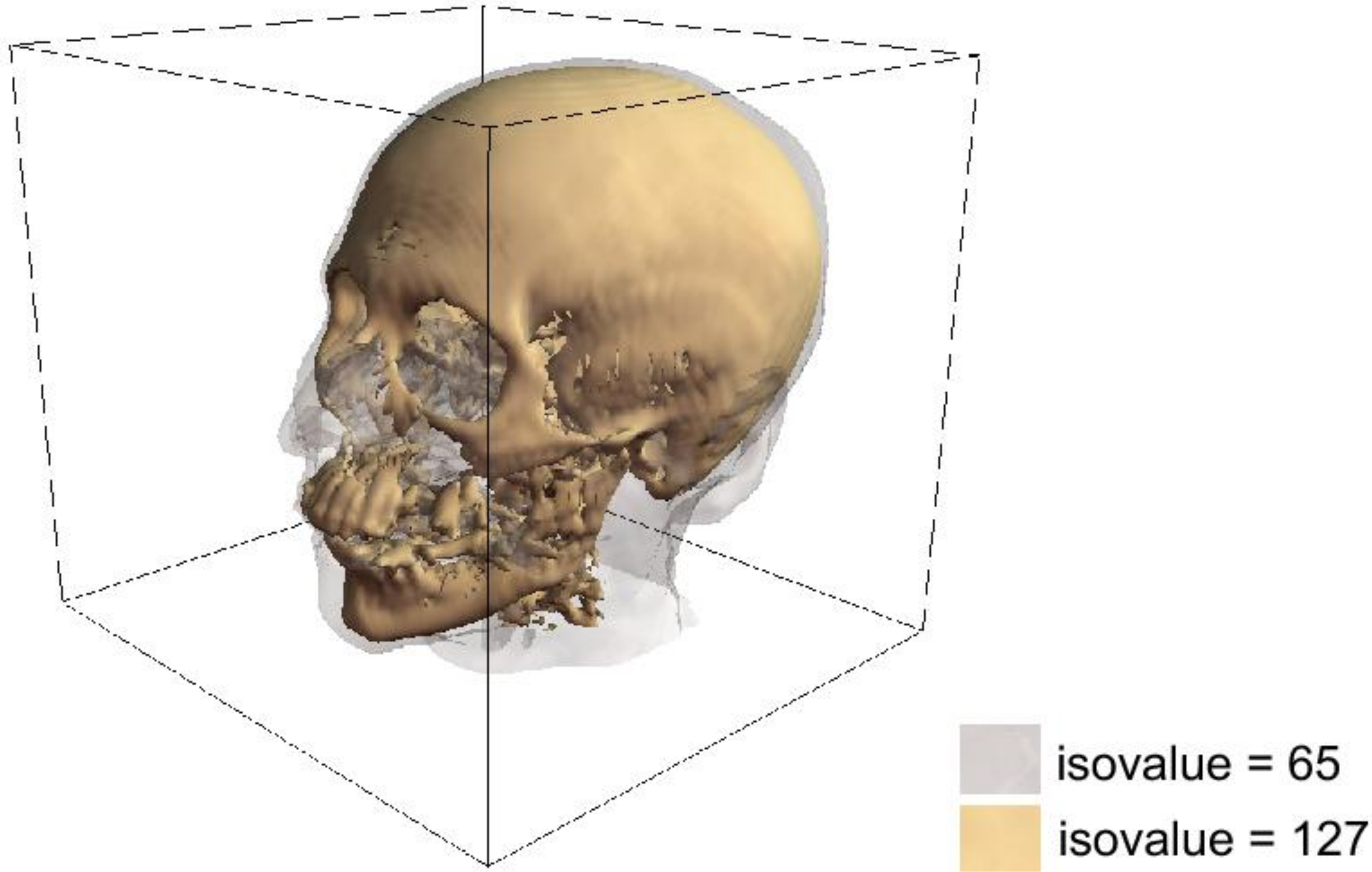
# Methods We Knew



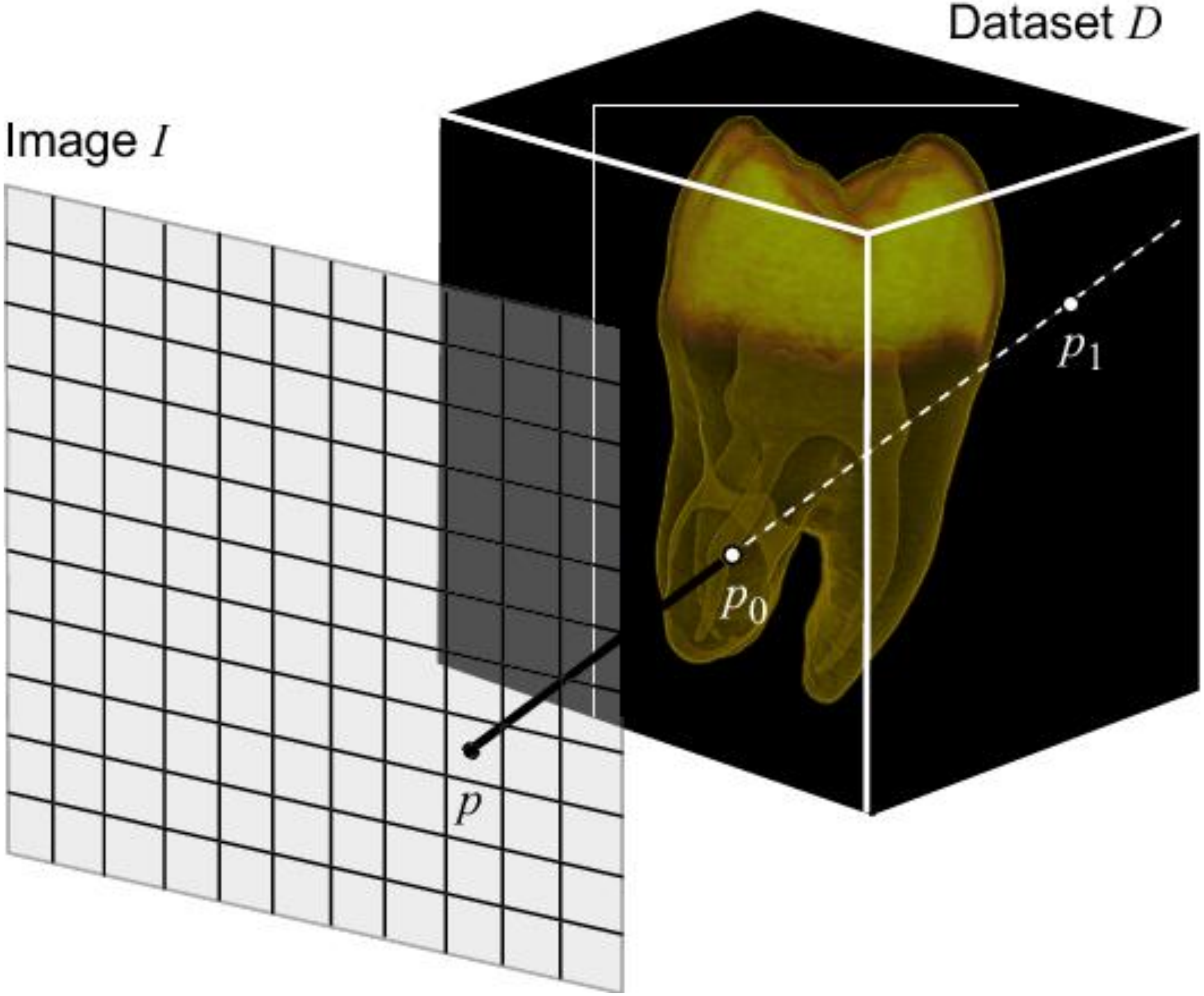
Isosurface

# Methods We Knew

**Generalized Isosurfaces**



# Principle of Volume Visual.




The Ray

# Principle of Volume Visual.

- Create a two dimensional image that reflects, at every pixel, the data along a ray parallel to the viewing direction passing through that pixel

# Principle of Volume Visual.

The design is to choose the following two functions:

- Ray function: synthesize the points along the ray

$$I(p) = F(s(t)), t \in [0,1]$$

- Transfer function: map the value of a data point on the ray to a color and opacity (RGBA) value; also called classification

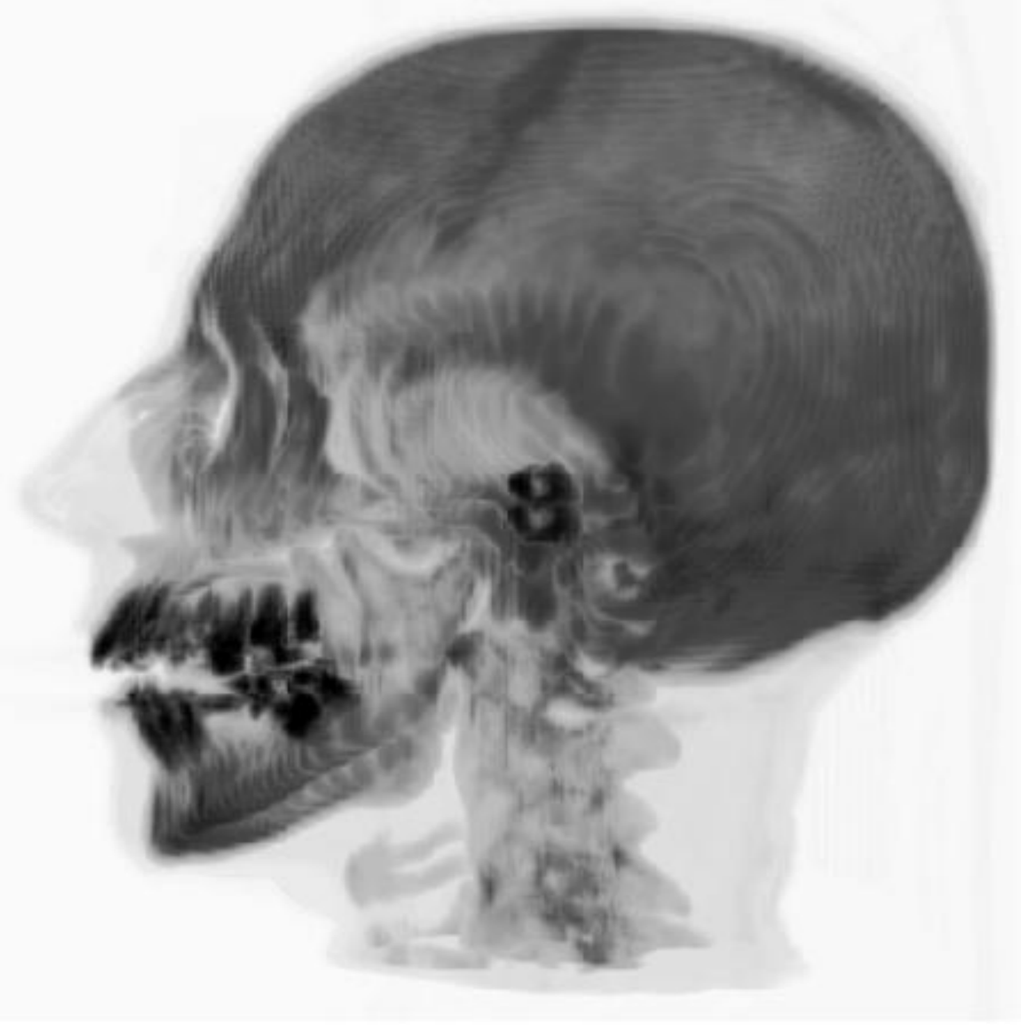
$$f : R \rightarrow [0,1]^4$$

# Maximum Intensity Projection Function (MIP)

- The ray function first computes the maximum scale value along the ray, and then maps this value to the color of pixel P

$$I(p) = f(max(s(t)))$$

# Maximum Intensity Projection Function (MIP)



a)

# Average Intensity Function

- The ray function is the average intensity

$$I(p) = f\left(\frac{\int_{t=0}^{T} s(t)\,dt}{T}\right)$$

Analogous to an X-ray image

# Compositing Function

- A general ray function
- The color C(p) of a given pixel p is a superposition of the contributions of the color c(t) of all voxels q(t) along the ray r(p)

$$\boldsymbol{C(p)} = \int_{t=0}^{T} C(t)\,dt$$

$\mathrm{C(t): contribution\ from\ voxel\ q(t)\ with\ value\ c(t)}$

# Compositing Function

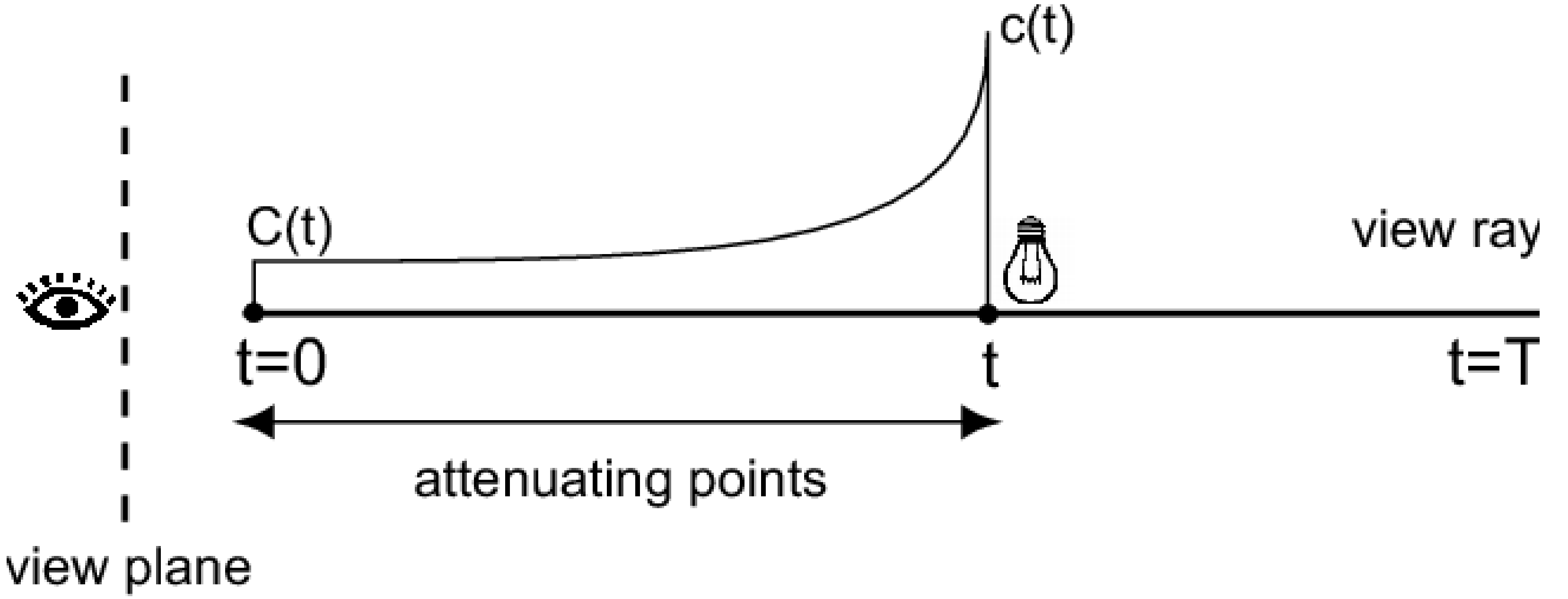
- Volumetric Illumination Model: color c(t) emitted at location q(t) is attenuated by the opacity of points situated between q(t) and the view plan

$$\mathbf{C}(t) = c(t) e^{-\int_0^t \tau(x)\,dx}$$

$$\tau(\mathrm{x}) : \mathrm{opacity\ at\ x}$$

# Compositing Function

Volumetric Illumination Model

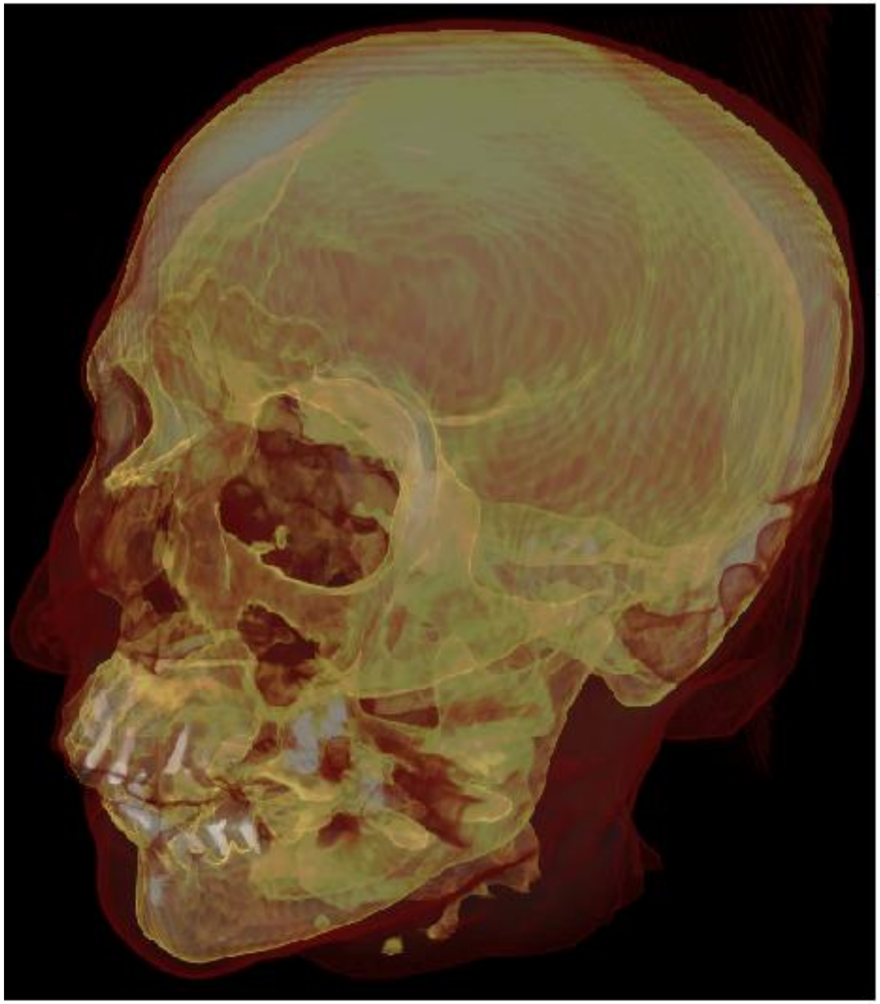


# Compositing Function

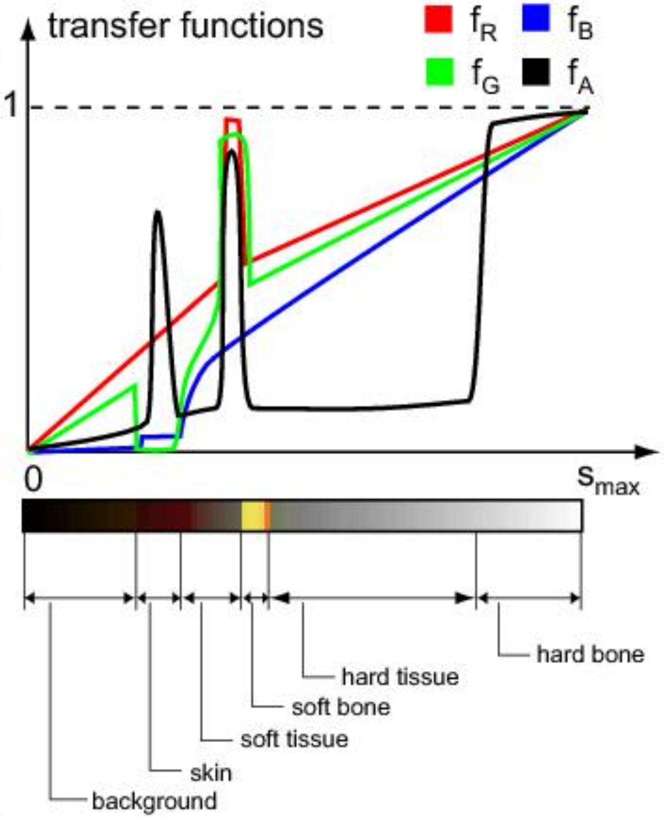
$$\boldsymbol{C}(p) = \int_{t=0}^{T} c(t)\, e^{-\int_0^t \tau(x)\,dx}\, dt$$

**Yield high quality of volume rendering**

# Compositing Function



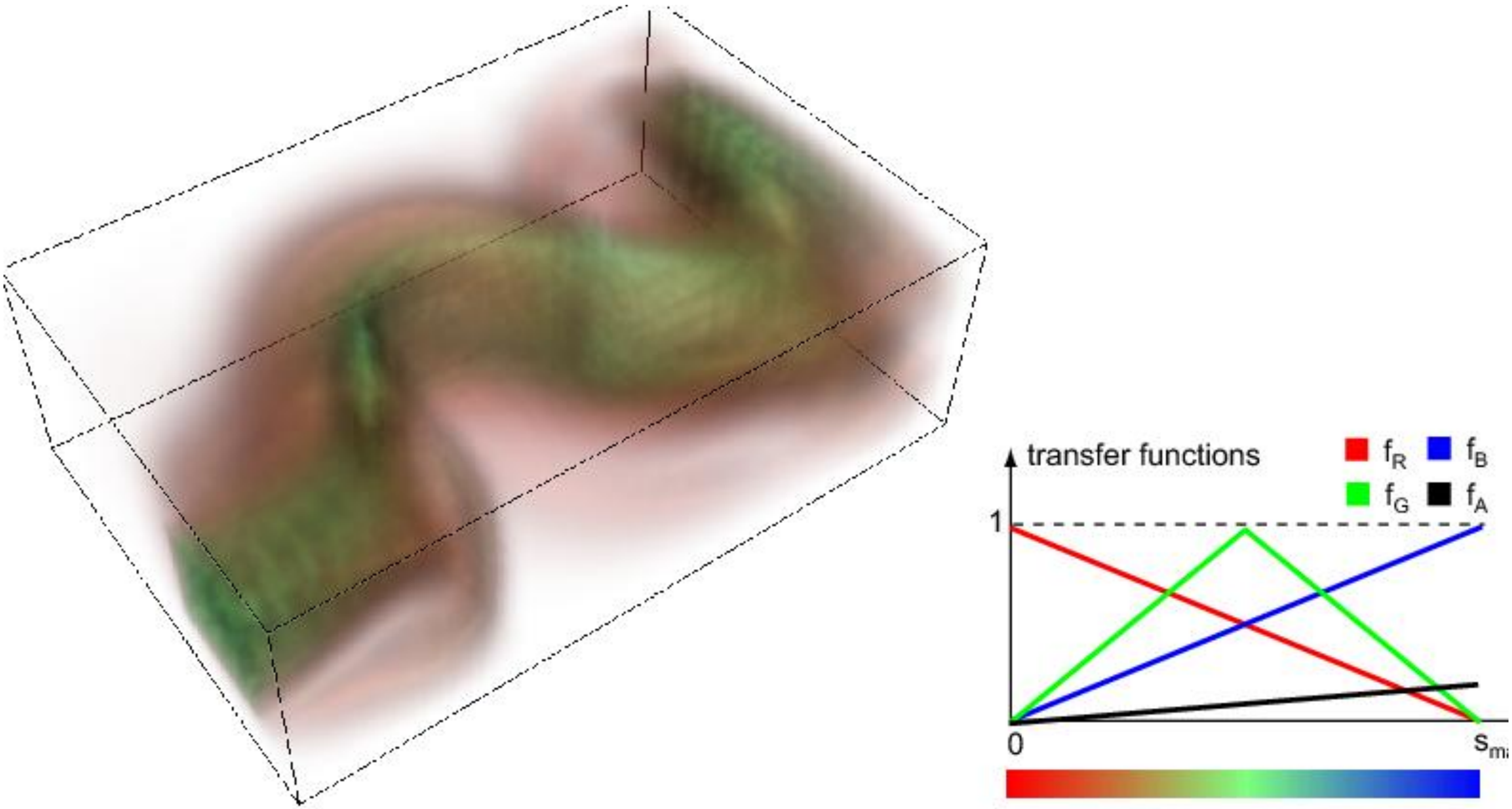
a)




b)

**Specify the transfer function for colors;**
**Specify the transfer function for opacity**

# Compositing Function




a) b)

**Volume data without sharp boundary: smooth transfer functions**

# End
# of Chap. 10

Note: All sections are covered except 10.3, 10.4 and 10.5