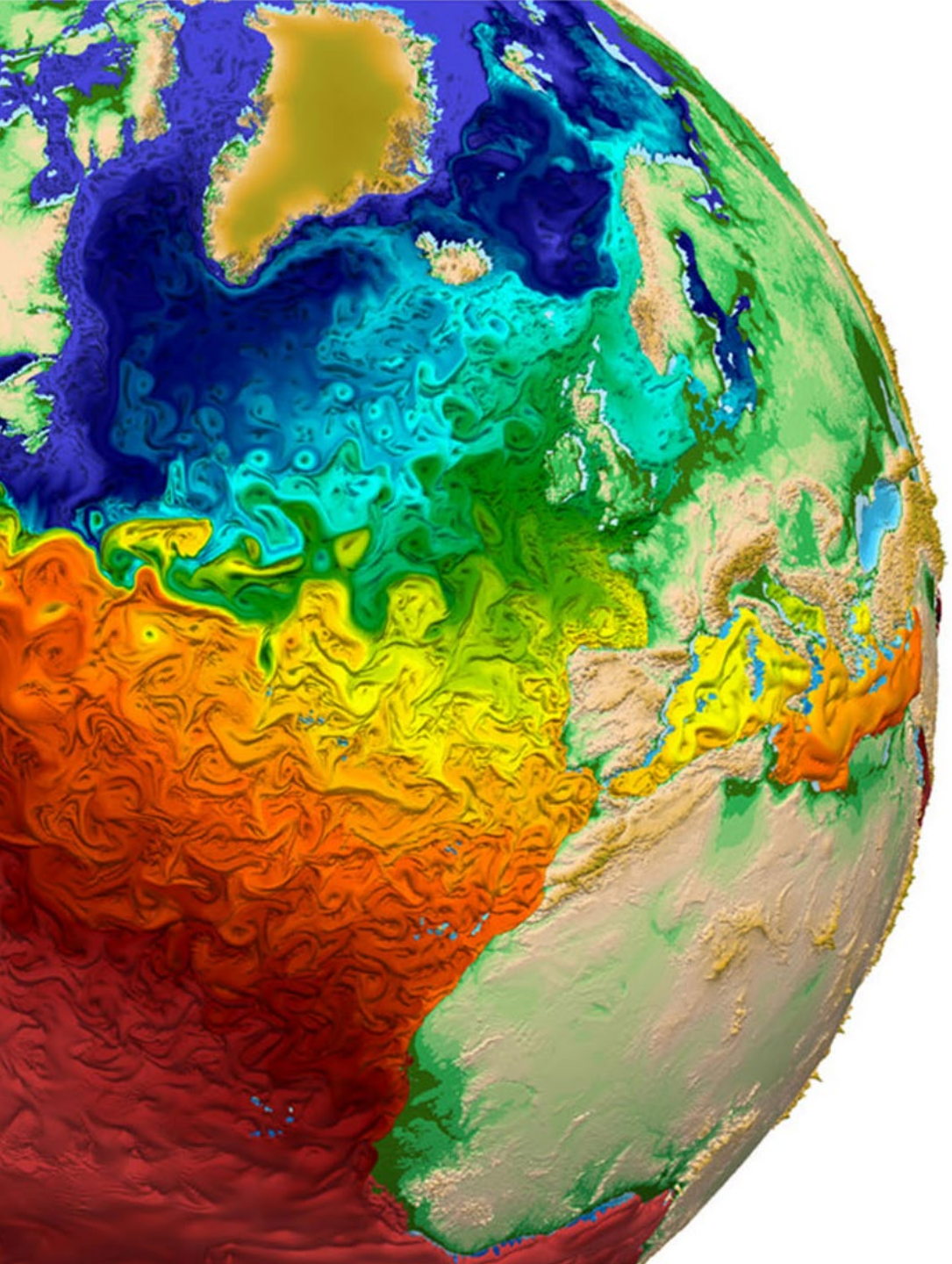

Volume Rendering

Ray Casting

Scientific Visualization

Professor Eric Shaffer

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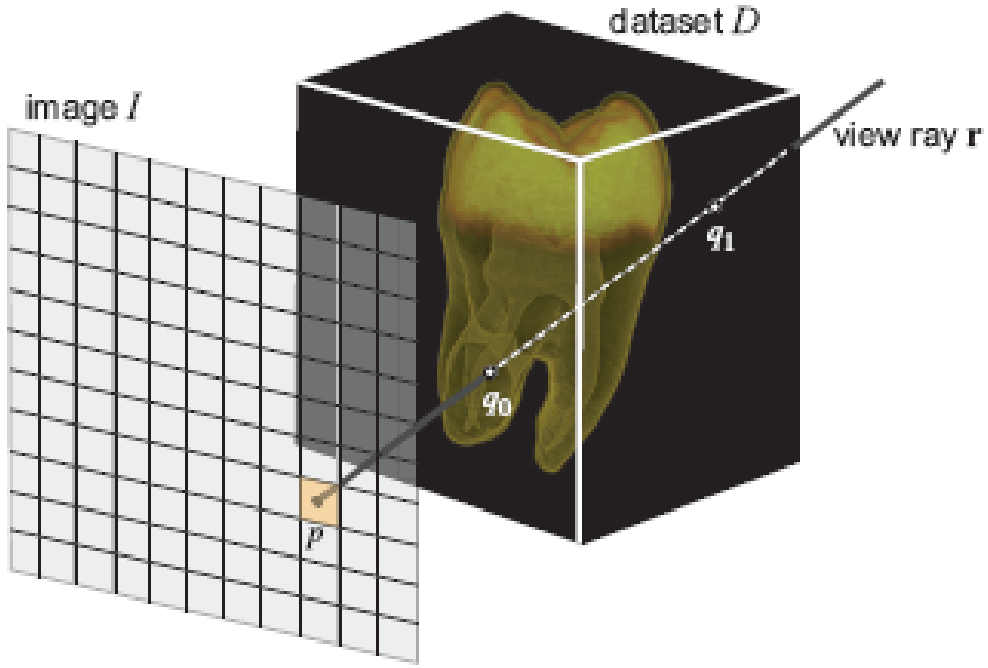
Basic Idea

- The data is considered to represent a semi-transparent light-emitting medium
- Approaches are based on the laws of physics (light emission, absorption, scattering)
- Model transport of light along rays through an image plane



Typically achieved through ray-casting or similar technique

Uses color and opacity to visualize data

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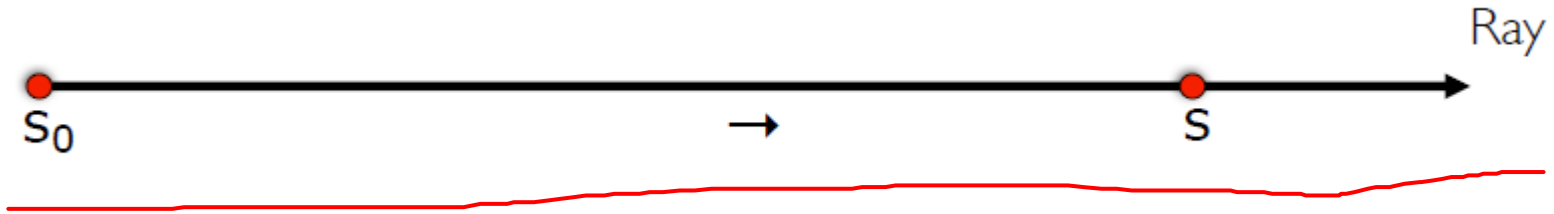
Volume Rendering Integral



$$c(\mathbf{R}) = \int_0^D c(s(x(t)))\mu(s(x(t)))e^{-\int_0^t \mu(s(u(t))du}dt$$

s: scalar value at x

c: color associated with value s

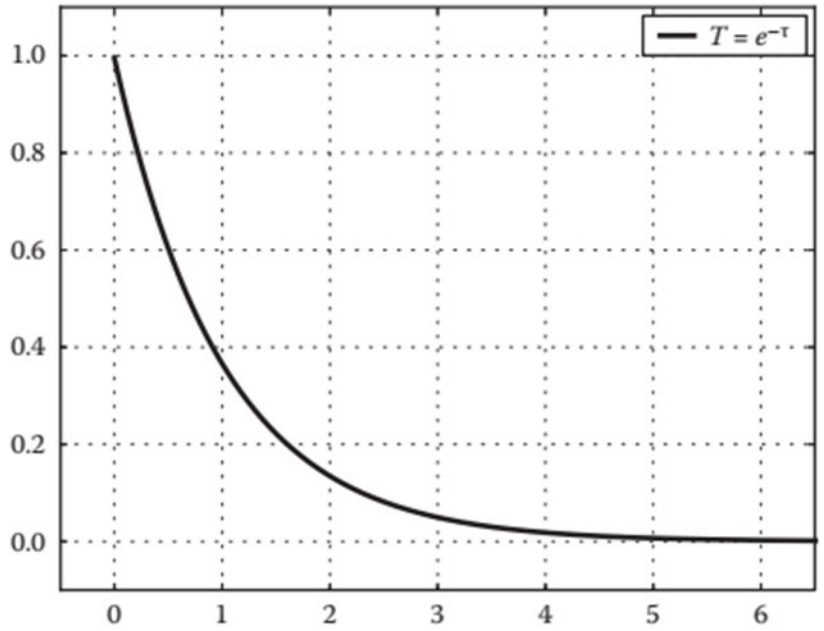
x: position along ray R

μ: density/opacity associated with that value

Physics – Beer's Law

$$c(\mathbf{R}) = \int_0^D c(s(x(t)))\mu(s(x(t)))e^{-\int_0^t \mu(s(u))du} dt$$

cumulative absorption



Transmittance T:
How much light can pass between two points in a medium?

$$T = e^{-\tau}$$

τ Optical thickness…a measure of transparency

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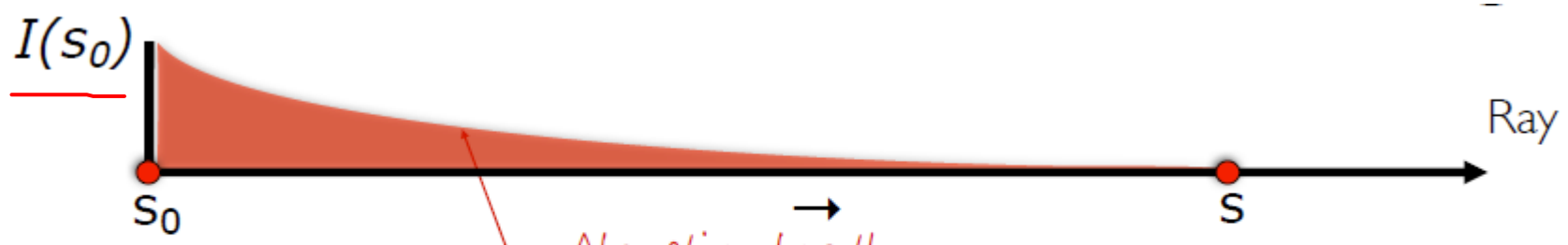
Emission and Absorption Along the Ray



Initial intensity (Emission) at s0

Absorption

$$I(s) = I(s_0)e^{-\tau(s_0,s)} \qquad \tau(s_1, s_2) = \int_{s_1}^{s_2} \kappa(s)ds$$

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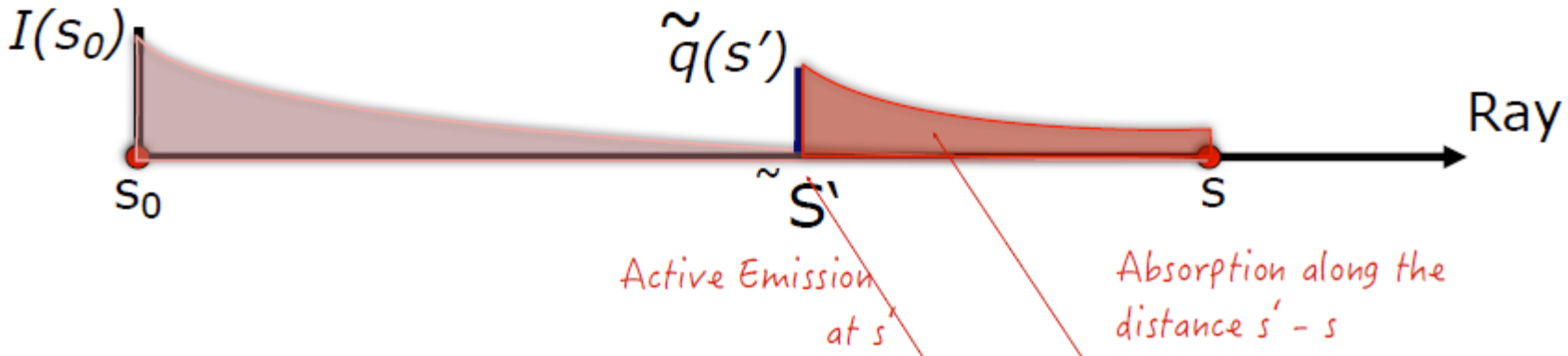
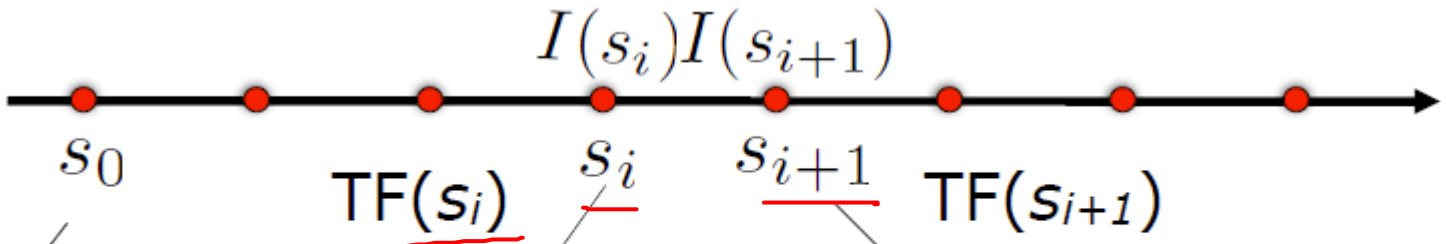
Emission and Absorption Along the Ray



$$I(s) = I(s_0)e^{-\tau(s_0,s)} + \int_{s_0}^{s} q(\acute{s})e^{-\tau(s,\acute{s})}d\acute{s}$$

Discrete Approximation



Back-to-front Compositing with $\alpha = A(s_{i+1})$

$$I(s_{i+1}) = \alpha q(s_{i+1}) + (1-\alpha) I(s_i)$$

$$= q(s_{i+1}) \text{ OVER } I(s_i)$$