# Paper Summary RTVD


## Abstract

a. Developing **light scattering equations**.

b. Discussing previous methods of solution. (What previous method?)

c. Presenting a new approximation solution to the full three-dimensional **radiative scattering problem** suitable for use in cg


## 1. Introduction

a. In almost all cases of natural phenomena, the description is given by a set of vector or scalar fields **defined on a uniform mesh in 3-space**.

b. Extend previous efforts in two ways:

I. Present an alternative to the **Blinn scattering model**, which models multiple radiative scattering against particle with high albedo.

II. Show how to ray trace these models.

III. It is possible to generate models of very high geometric complexity which are treated simply as volume densities.

## 2. The Scattering equation

a. Discussing the relevant physical parameters and set up an equation which describes the scattering of radiation in volume densities.

In a scattering problem, the quantity to be calculated is **energy per unit solid angle per unit area**

$$dE = I(x,\omega)sin(v)d\omega d\sigma$$

This quantity ($I$ maybe or not) is called **intensity** of radiation at a point $x$ in the direction of solid angle $d\omega$, and $d\sigma$ is the cross section of the cylinder.

Follow a pencil of radiation along the length of cylinder, the diff in intensity between the two ends is given by

$$dI = -absorted \ + \ emitted = k\rho dsd\sigma d\omega + j\rho dsd\sigma d\omega$$

where $\rho$ is **density of matter** in the volume element, $k$ is the absorbption coefficient, **optical depth per unit density**; and $j$ is the **emission coefficient**; and $ds$ is the length (of cylinder from derivation).

The **emission coef** can be broken into two terms:

$$j = j^{(e)} + j^{(s)}$$

where $j^{(e)}$ is the emission coef due to **pure emission of the medium**. Eg: black body term for flames or stellar interiors.

$j^{(s)}$ is the emission term due to **pure scattering** of incident radiation into the direction of interest.

$$j^{(s)} = \frac{1}{4\pi}\int_{||s||=1} p(s,\bar{s})I(x,\bar{s})d\bar{s}$$

The function $p(s,\bar{s})$ is called the *phase function* and gives **amount of light scattered from direction** $s$ to direction $\bar{s}$.

The above expression says that the light scattered in direction $s$ is a linear operator of the light incident upon the volume element from all angles.

In many situations, the medium is **isotropic**, in the case the phase fcn depends only on the **phase angle** $\theta$, the angle b/t $s$ and $\bar{s}$, and we assume $j^{(e)}$ is zero in this paper.

By dividing both side of equation of $dI$ by $-k\rho ds$, but the derivative along the cylinder is simply a directional derivative along $s$.

$$\frac{dI}{ds} = s \cdot \nabla_x I$$

This gives us the scattering equation:

$$\frac{-1}{k\rho}s \cdot \nabla_x I(x,s) - I(x,s) + \frac{1}{4\pi}\int_{||s||=1} p(s,\bar{s})I(s,\bar{s})d\bar{s} = 0$$

## 3 Solving the Scattering Equation