SIGGRAPH ASIA 2021 TOKYO LIVE

Beyond Mie Theory: Systematic Computation of Bulk Scattering Parameters based on Microphysical Wave Optics

Yu Guo[1] Adrián Jarabo[2] Shuang Zhao[1]

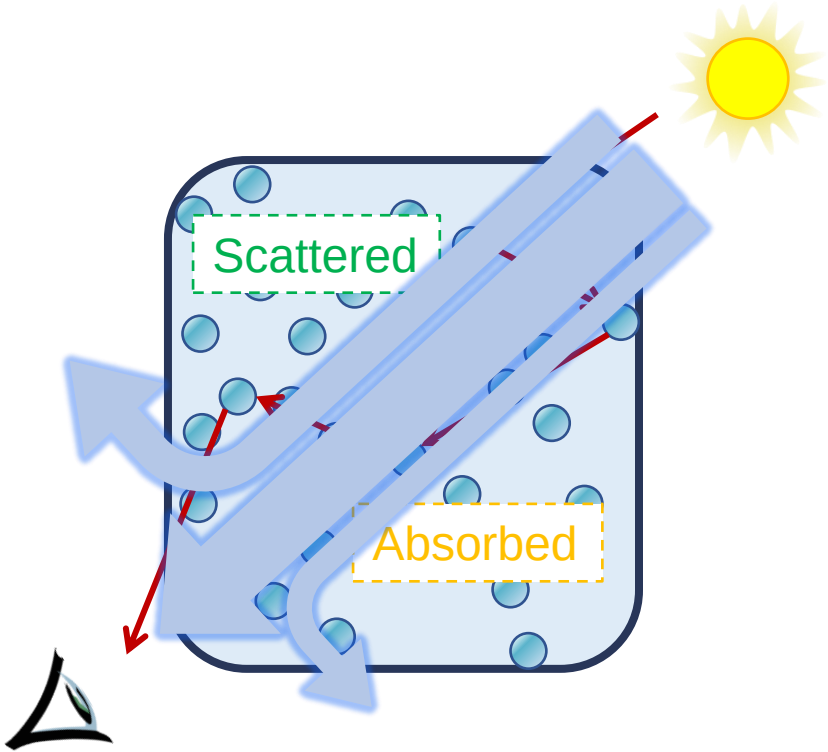
[1]University of California, Irvine

[2]Universidad de Zaragoza, I3A

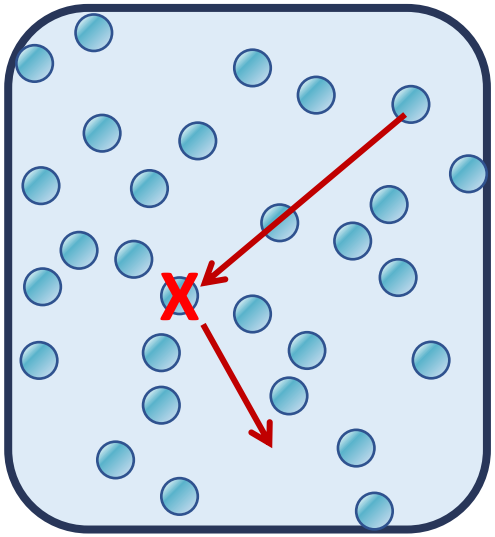
Participating media

Participating media - translucent materials

Radiative transfer theory (RTT)



Bulk scattering parameters



σ_t: Extinction coefficient

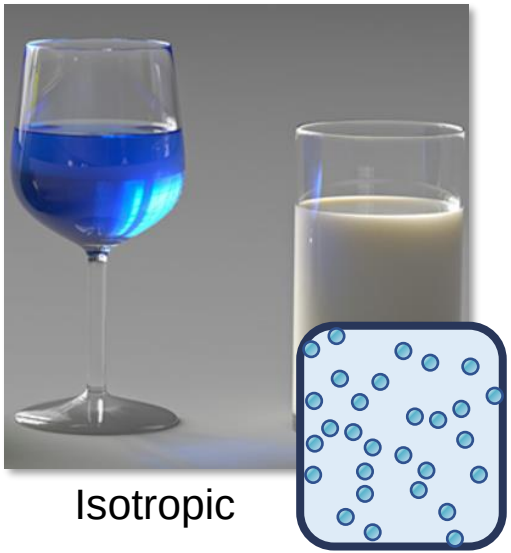
σ_s: Scattering coefficient

σ_a: Absorption coefficient

$(= \sigma_t - \sigma_s)$

f_p : Phase function

Types of media

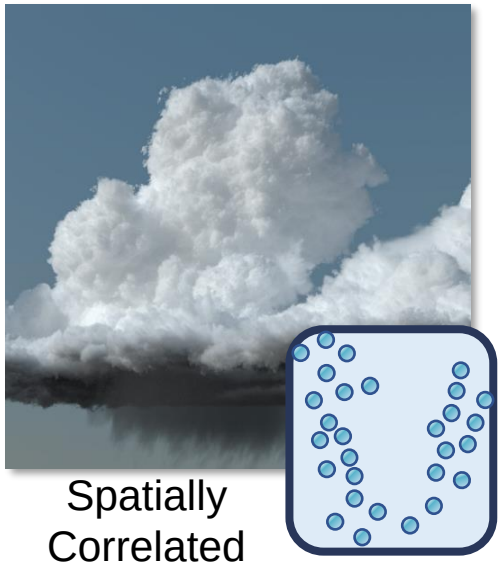


Isotropic

$\sigma_t \quad \sigma_s \quad f_p(\omega' \cdot \omega)$

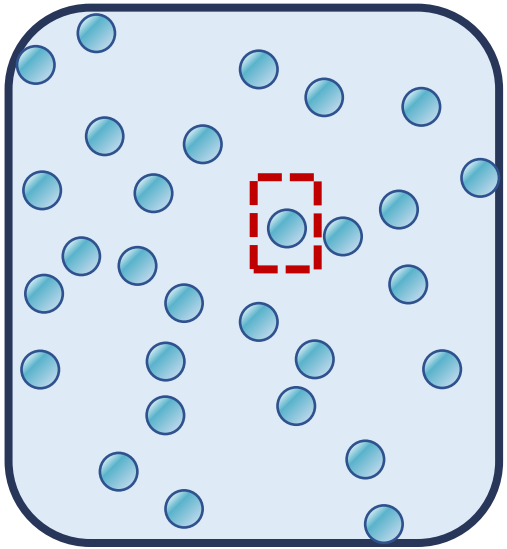
Anisotropic
[Jakob 2010]

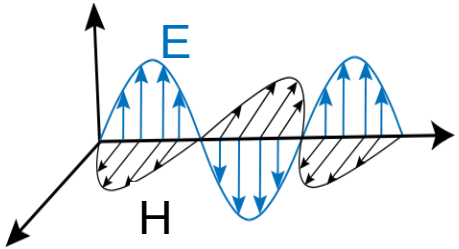
$\sigma_t(\omega) \; \sigma_s(\omega) \; f_p(\omega' \rightarrow \omega)$



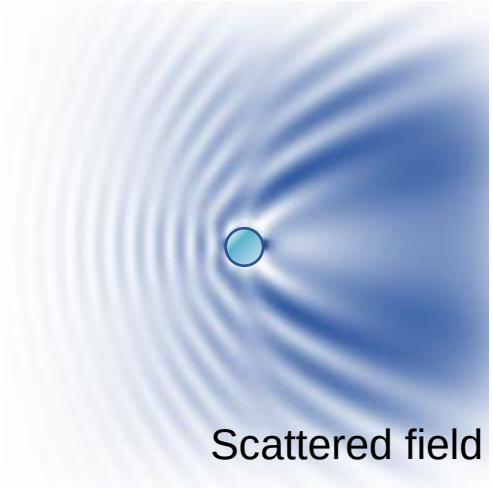
Spatially Correlated
[Jarabo 2018; Bitterli 2018]

Lorenz-Mie theory



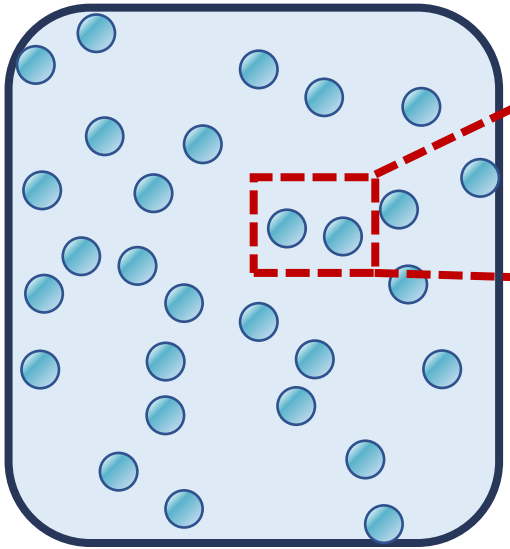


Electromagnetic plane wave



Scattered field

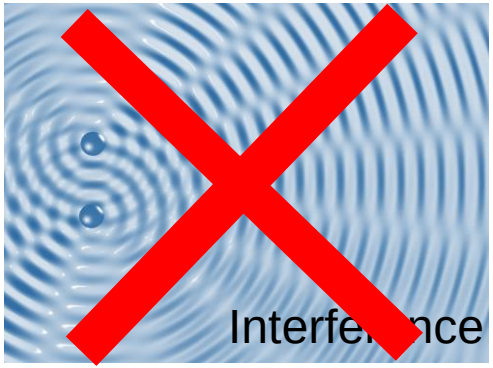
Lorenz-Mie theory



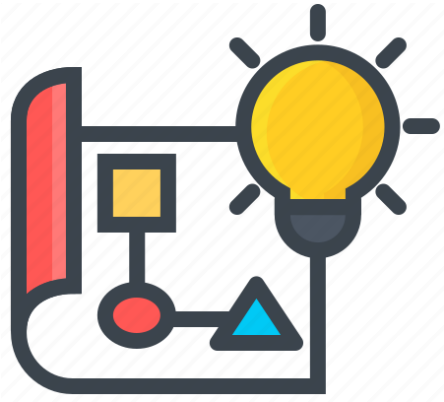
Far-field approximation

Assumption:

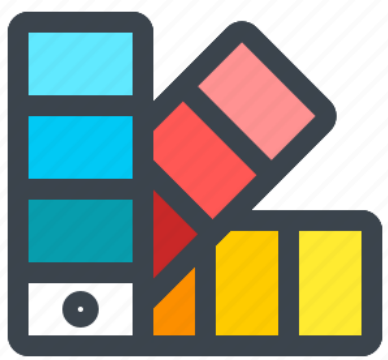
1. Far-field approximation (∞)
2. Independent scattering



Contribution



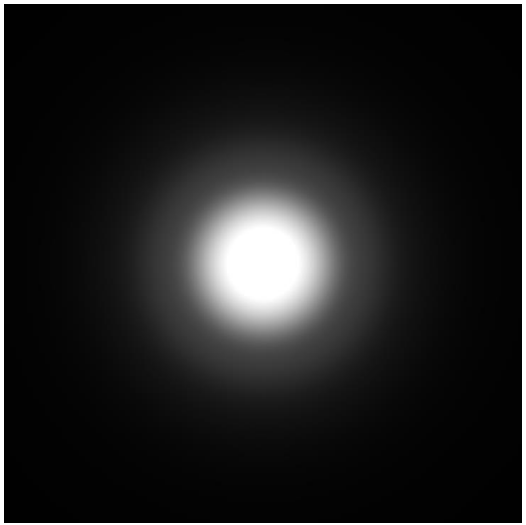
A computational framework for modeling light scattering beyond Lorenz-Mie theory.



Support wide range of participating media.

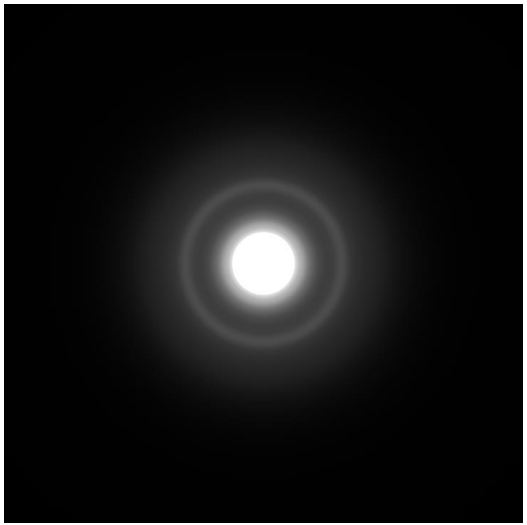
Result preview

Lorenz-Mie:



(Far-field assumption)

Ours:

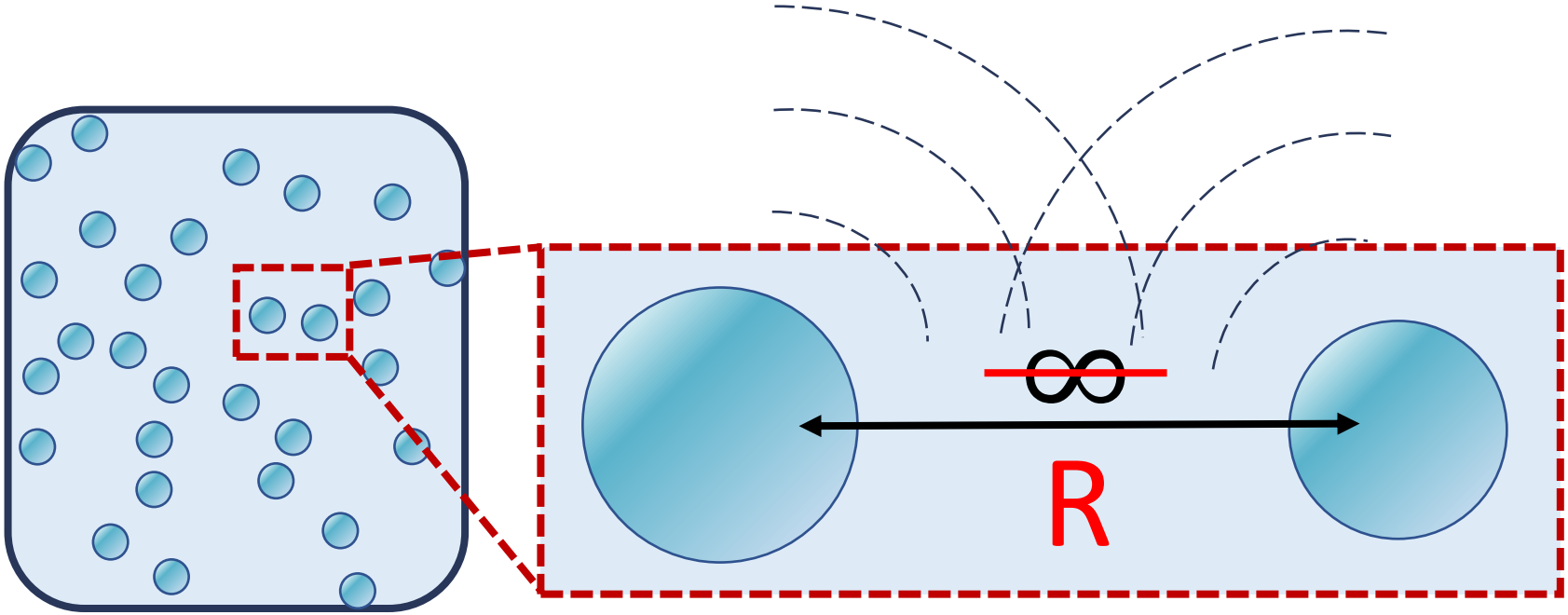


(Near-field interaction)

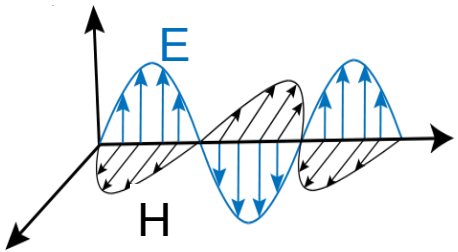
Wavelength = 700nm
Particle radius = 300nm

Our method

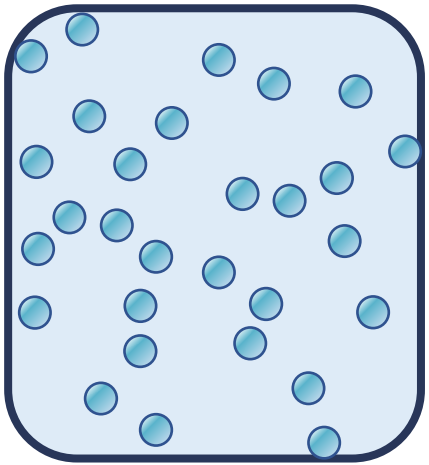
Going beyond far-field



Going beyond far-field



Incident wave



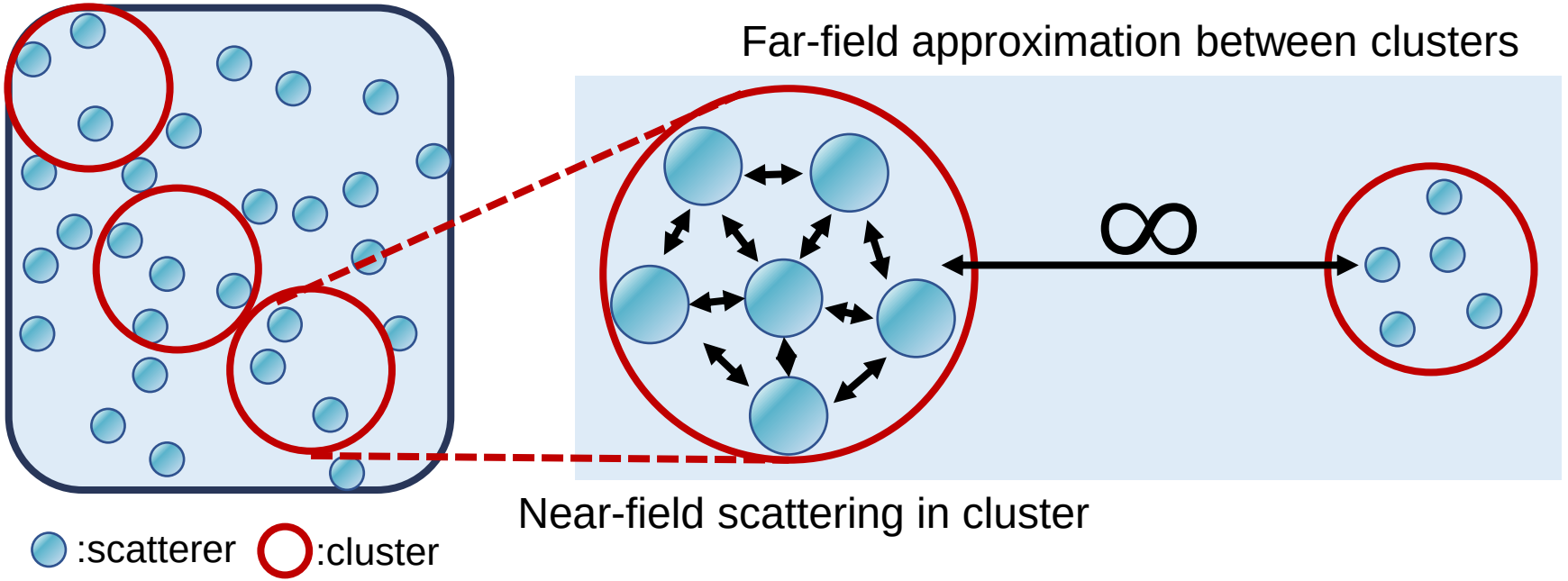
Wave Simulation

?

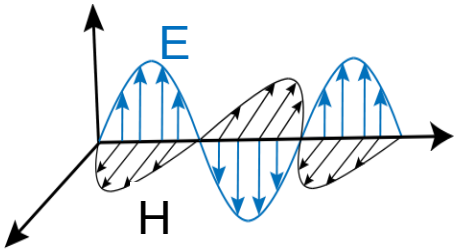
Scattered field

Too extensive to solve

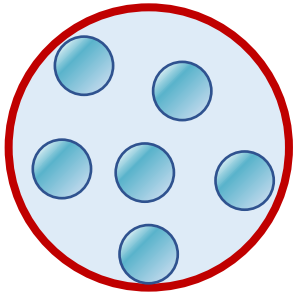
Our method


Far-field approximation between clusters
∞
Near-field scattering in cluster
:scatterer
:cluster

Our method



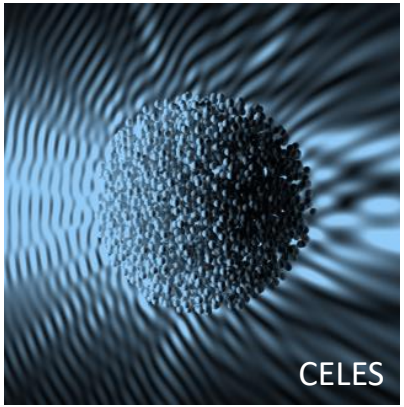
Incident wave



Cluster

(number of particles, distance between particles, particle radius, IOR)

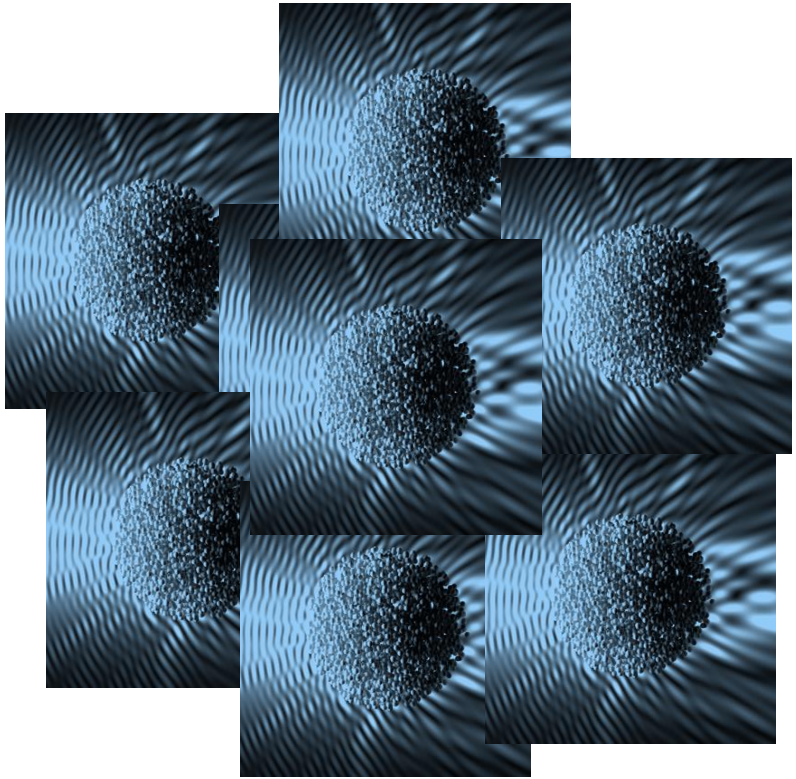
Wave Simulation



Scattered field

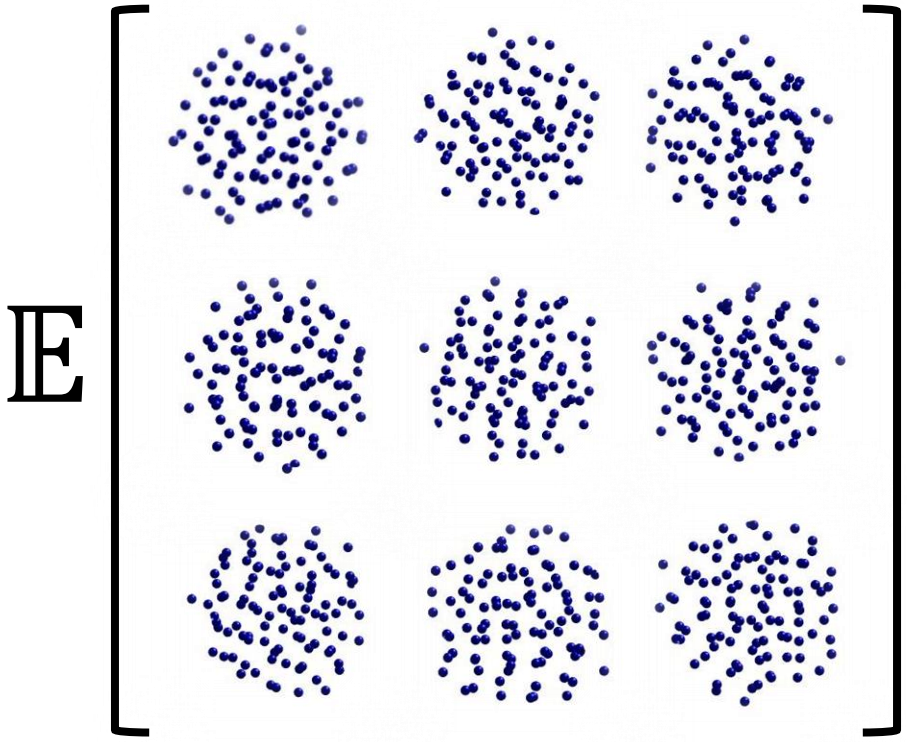
Our method

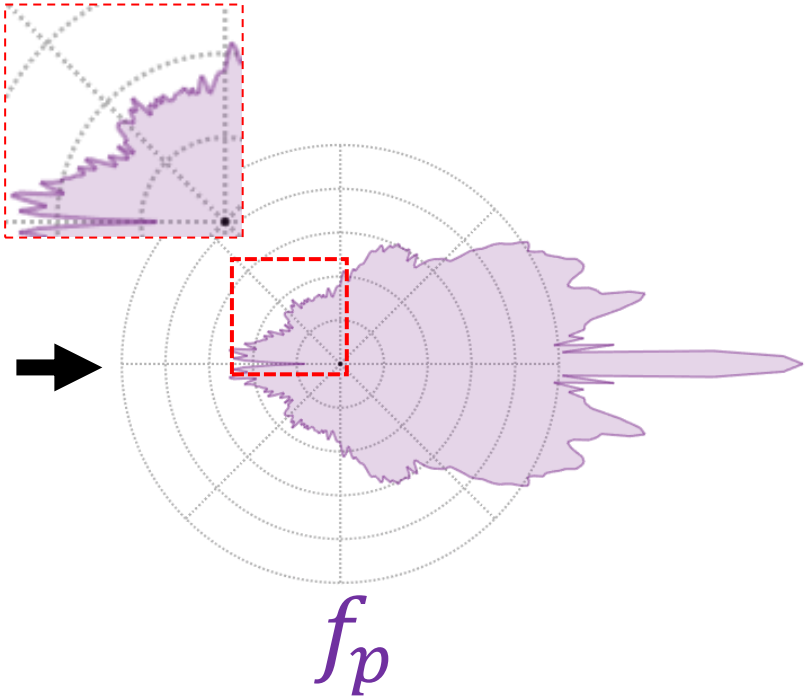
$$\mathbb{E}\left[\ \right] \rightarrow \sigma_t,\ \sigma_s,\ f_p$$



Bulk scattering parameters

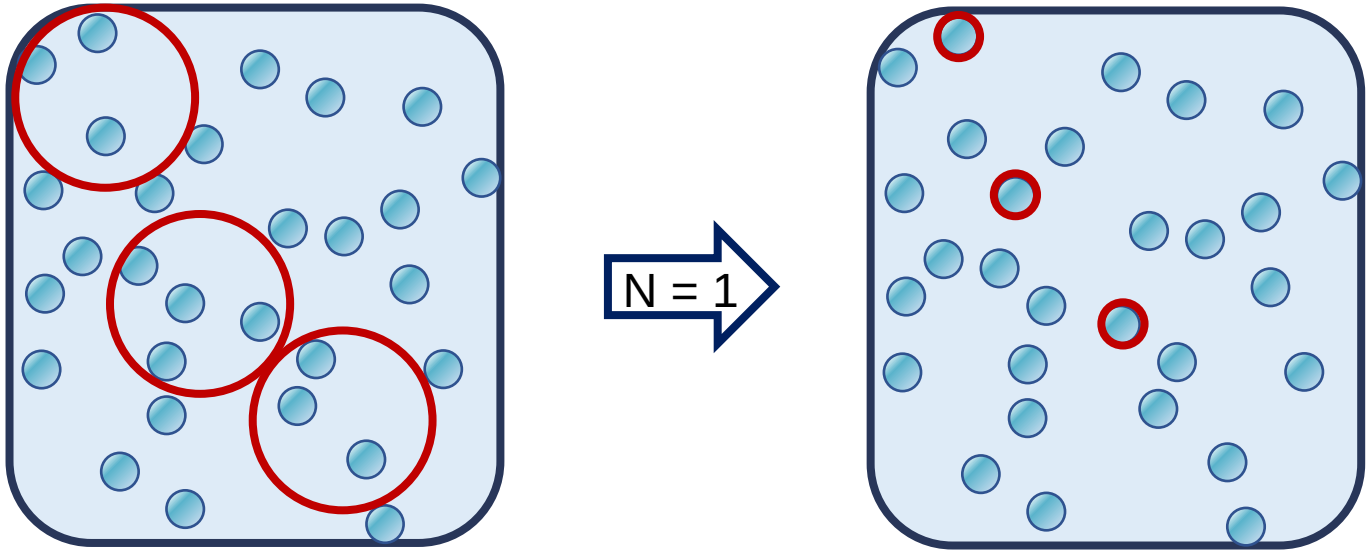
Different realizations





Validation

Validation



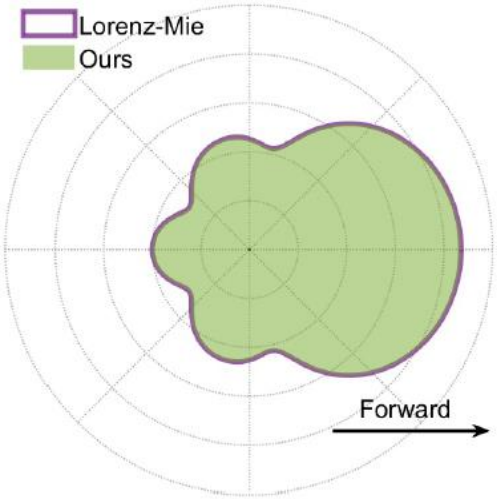
Clusters of particles

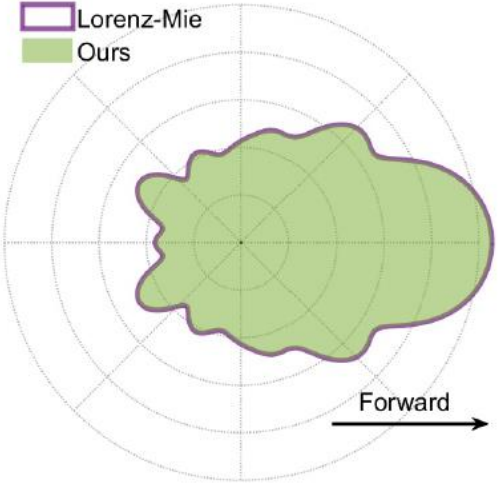
Independent particle

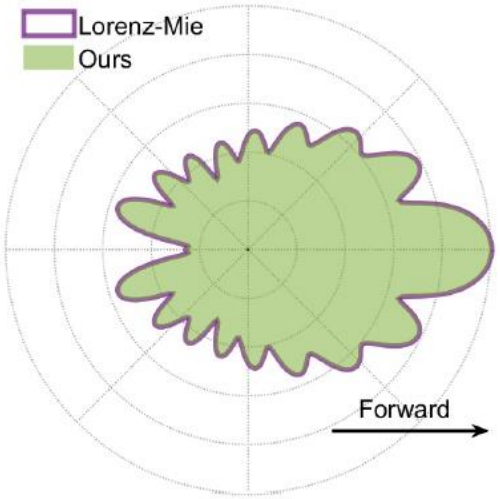
Validation

Phase function:

[Wavelength: 600nm]







Particle radius:

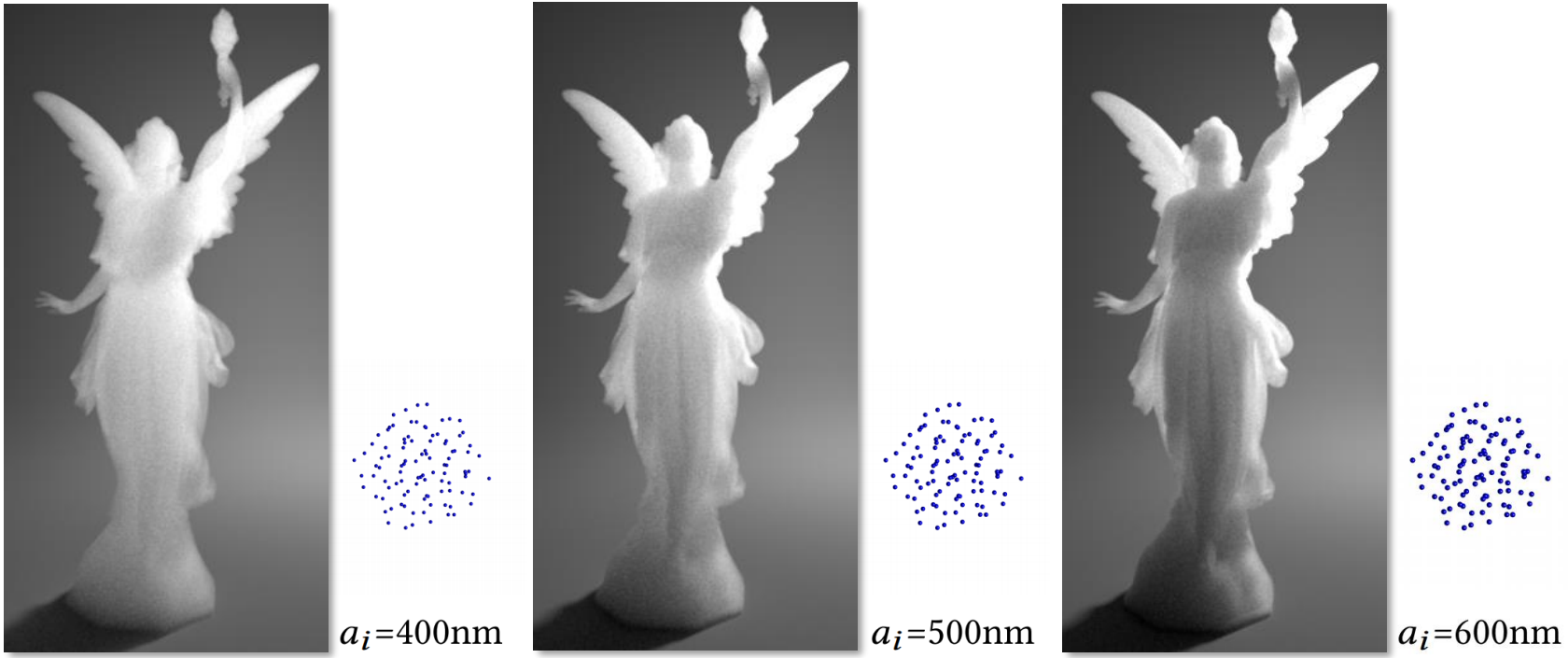
300nm

600nm

900nm

Experiments

Isotropic – particle size



Isotropic – cluster capacity

N=20

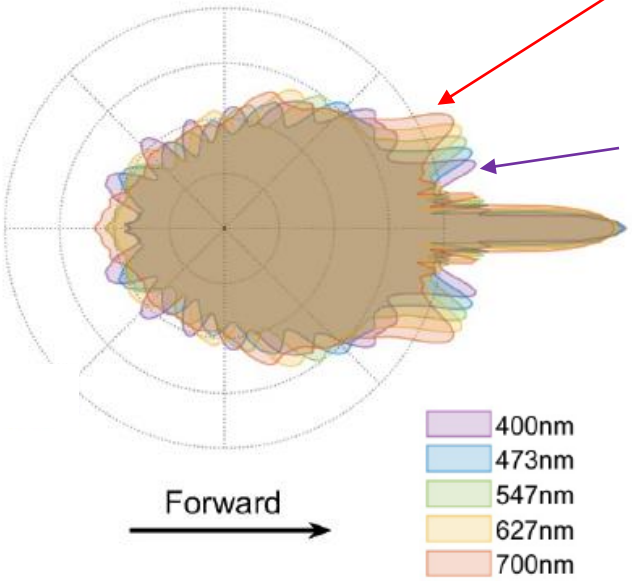
N=100

N=500

Transmittance

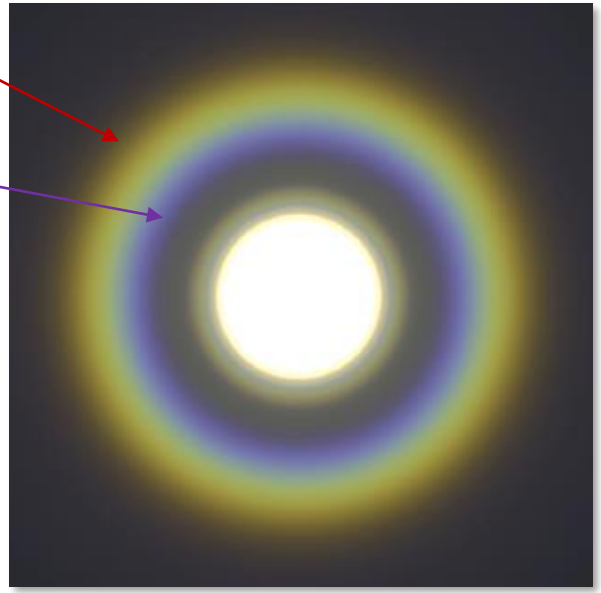
Multi-spectral

Phase function:



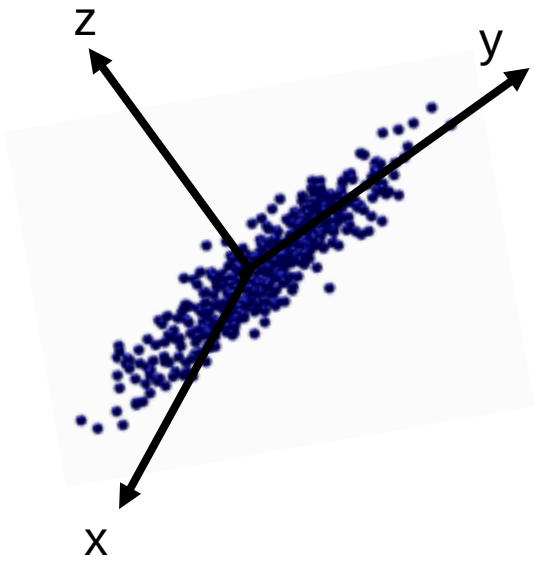
700nm

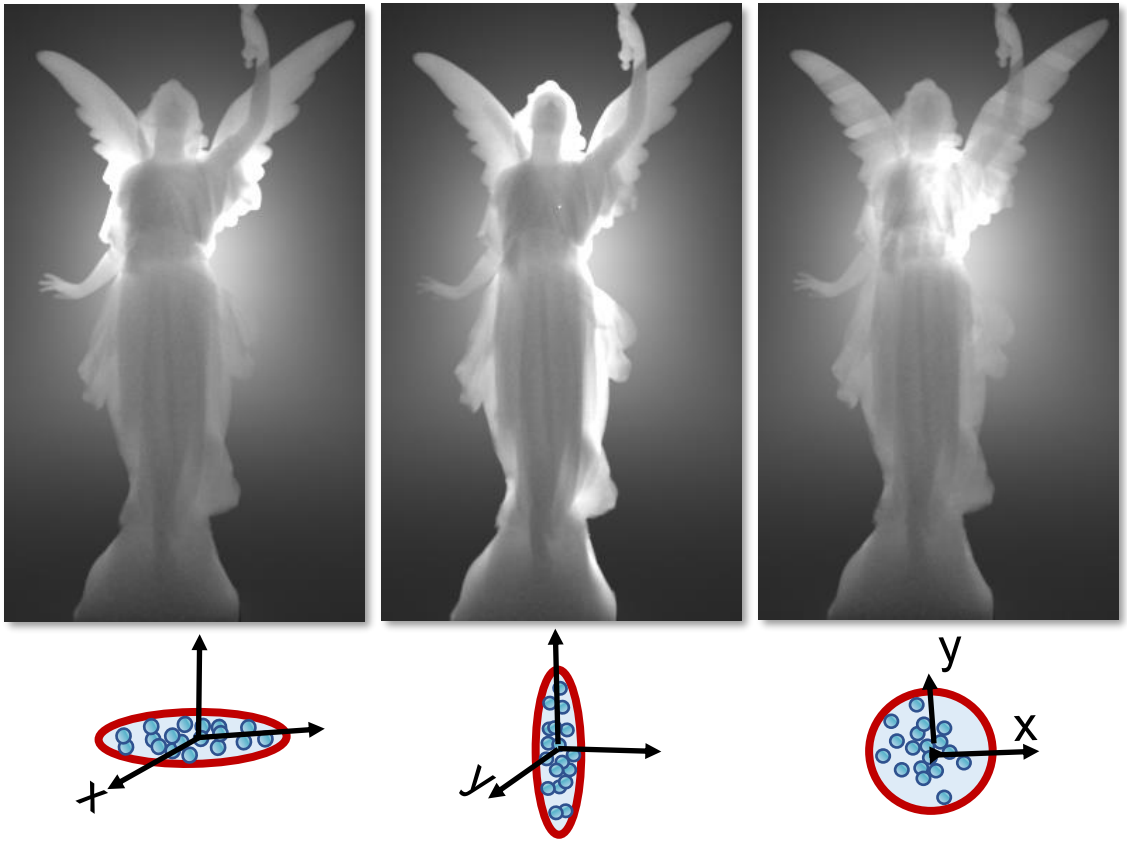
400nm



Thin-slab rendering

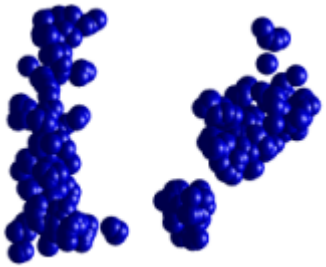
Anisotropic



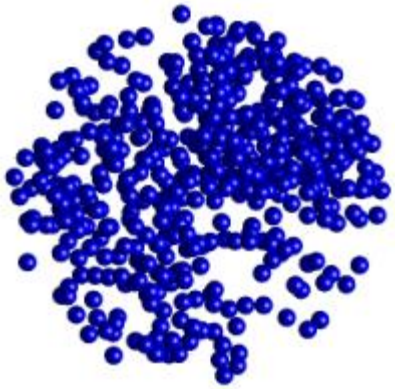


Spatially correlated

Positively correlated:

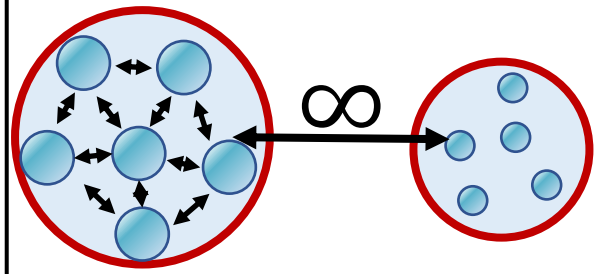


Negatively correlated:

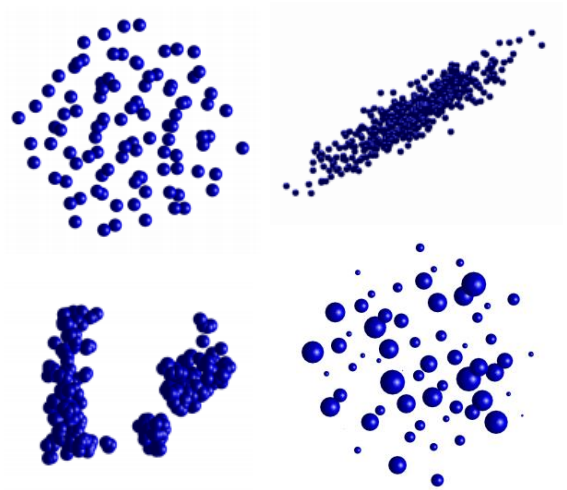


Summary

New framework



Type of media



Limitations & future works

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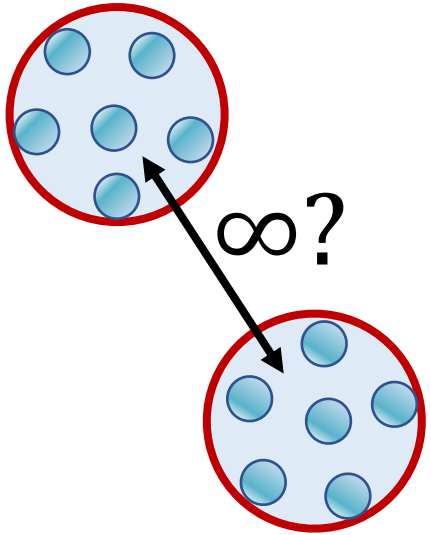
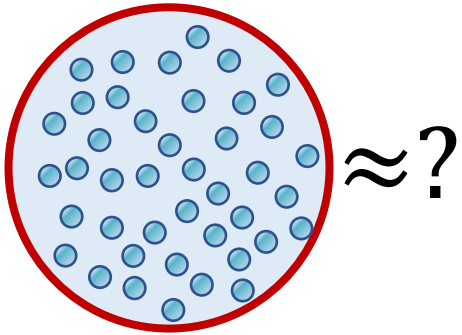
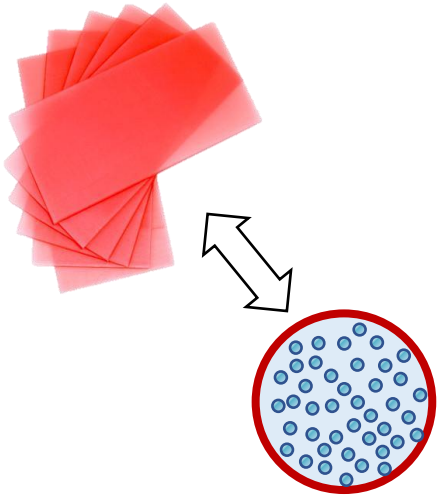
More general



More efficient



Model Fitting



Thank you!

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Project page