A numerical study of Mie scattering and light propagation through scattering media using Monte Carlo simulations

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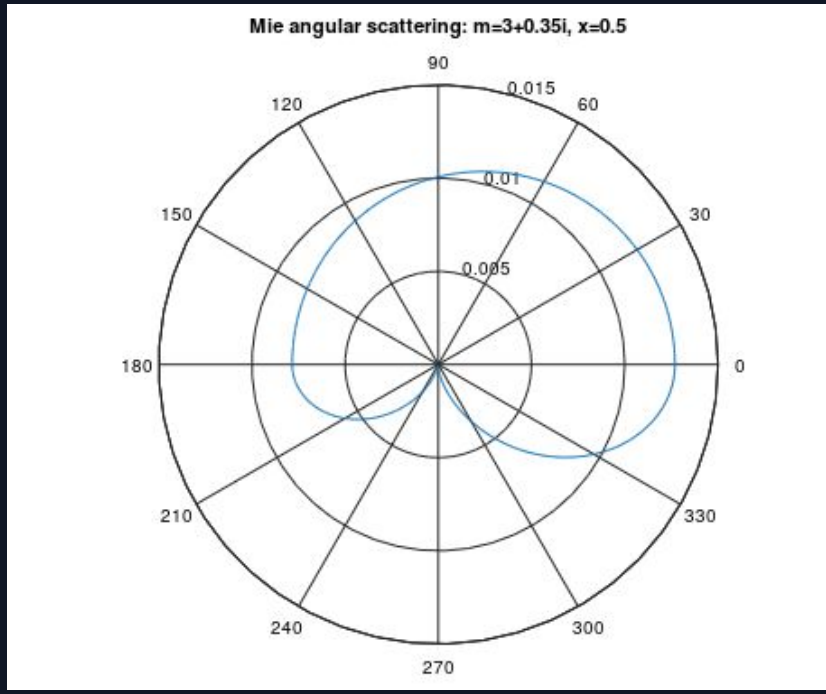
Introduction

- Mie scattering governs certain types of scatters with certain sizes/arrangements of particles
- Scatterers include atmospheric gases and mitochondria
- Limited simulation capacity



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Project Goals

- Goals
  - Efficient, versatile 3D network scattering simulations
  - Inputs: particle arrangement, radius, size parameter*
  - Outputs: different measurements of the light scattering distribution

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Timeline

- Original Timeframe
  - October: 2D single scatter
  - November: 3D single scatter
  - December: 3D network scatter
- Actual timeframe and goals deviated significantly

Code Overview

Inputs:

- Refractive index
- Size parameter
- Size of the x, y, and z ranges
- Number of divisions for x, y, z axes
- Precision parameters
- Number of photons

Outputs:

- Distribution of scatter locations
- Heatmap over time
- Mean scatter length

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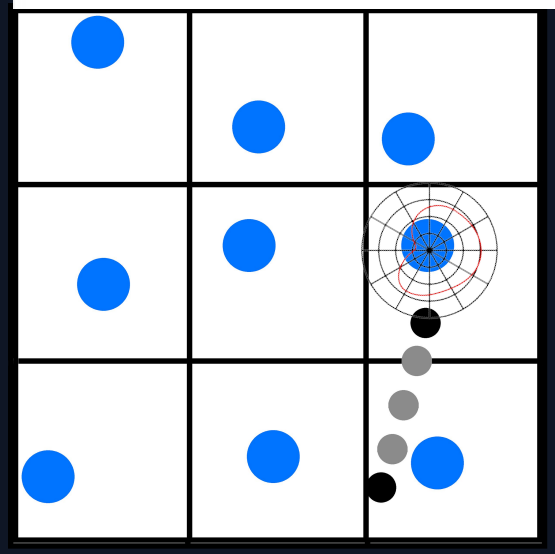
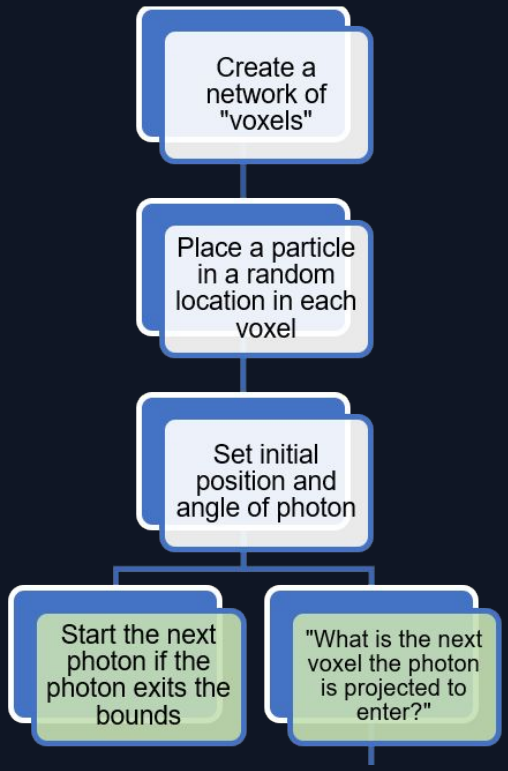
Code Structure

```
>> make_network2(x_range,x_reg,y_range,y_reg,z_range,z_reg,r)
ans =

 Columns 1 through 14:

   0.31977   1.46022   2.34759   0.58523   1.42195   2.40001   0.47826
   0.34421   0.48345   0.40136   1.42456   1.66027   1.67347   2.68666
   0.32598   0.39389   0.58608   0.58518   0.40653   0.41500   0.51461

 Columns 15 through 27:

   2.68180   0.32571   1.62735   2.56306   0.34494   1.31876   2.63621
   1.39654   2.69533   2.37531   2.55602   0.45848   0.51712   0.39414
   1.40768   1.45033   1.36578   1.50073   2.43834   2.38726   2.41413
```





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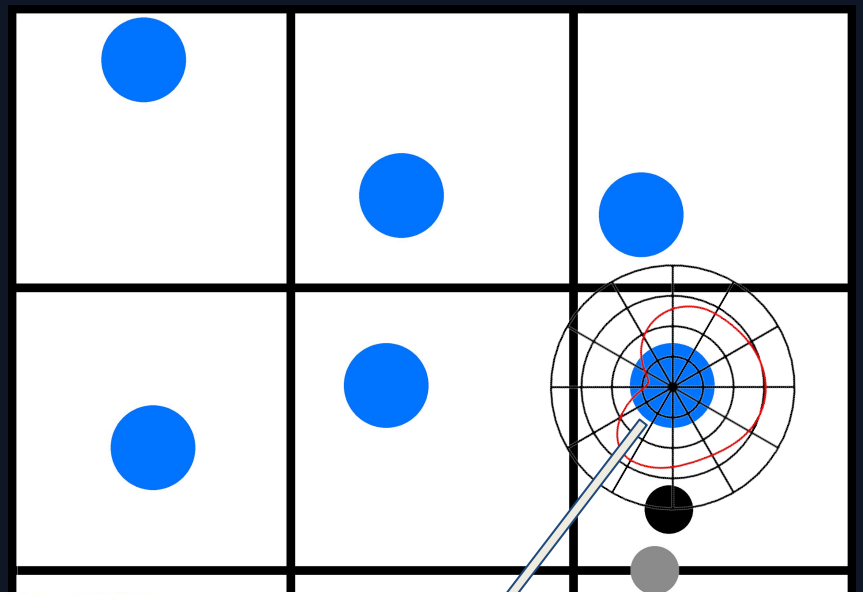
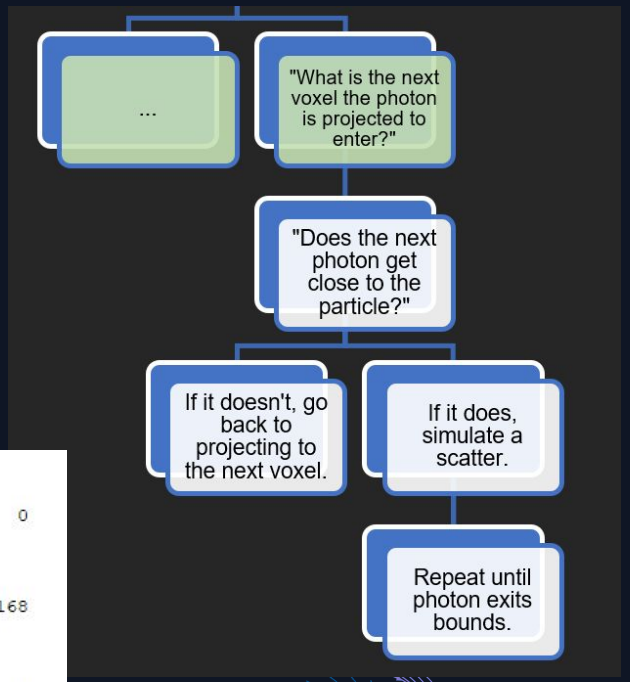
Code Structure, cont.






```
Columns 1 through 19:

    0   678     0     0     0   579     0   378     0     0     0     0     0   347   249     0    89     0     0

Columns 20 through 38:

    0     0     0     0   547     0     0     0   600     0     0     0    78     0     0     0   672   289   168

Columns 39 through 57:

    0     0     0     0     0     0     0     0     0   298     0     0     0     0     0     0     0     0     0

Columns 58 through 76:

    0     0     0     0   968     0     0     0     0     0     0   287     0   598     0     0     0     0     0

Columns 77 through 95:

    0     0     0     0     0     0     0     0    89     0     0    68     0     0     0     0   858   268     0

Columns 96 through 100:

    0     0     0     0     0
```

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What we accomplished

- Adjust primarily 2-dimensional code to 3 dimensions
- Create efficient simulations of random particle networks
- Host the ongoing code on a GitHub repository

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What went well? What could we have done differently?

- Setting up 2-dimensional code was straightforward and required few modifications
- Implementing and optimizing a 3-dimensional version was much more difficult

Code Packaging: GitHub Repository

- Document the code
- Define clear inputs and outputs
- Mention the current shortcomings of the code in a readme file
- Show the room for improvement so that future users could improve the code or tailor it to their specific needs