

# An Algorithm to Simulate Two-Dimensional Scattering Patterns of Particles for Use in Holography

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# Overview

- Holography is
  - Relatively new
  - Lots of effort
  - Perfect to use for tiny things that move
- Will be used with a drone for agricultural research



# My Project

- To create an algorithm that will make the scattering pattern for any particle
- Basically to make a library to match a scattering pattern to a particle

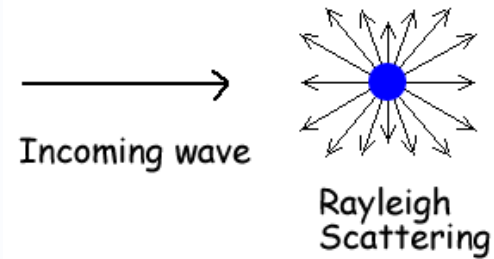


# Process

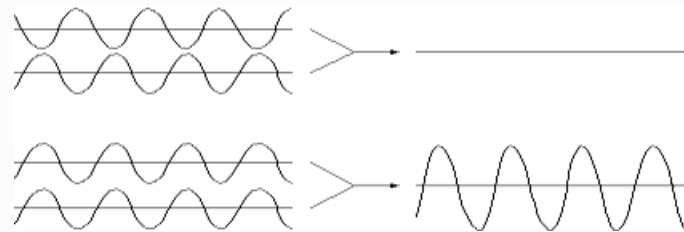
- Learn python/ theory
- Figure out algorithm by comparing the experimental and simulated pattern using trial and error
- Test and refine the algorithm
- Simulate the patterns of every particle I can

# Theory

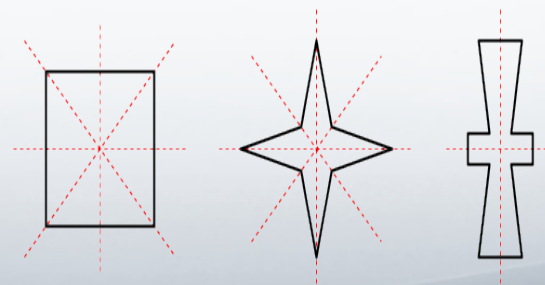
- Rayleigh Scattering



- Interference

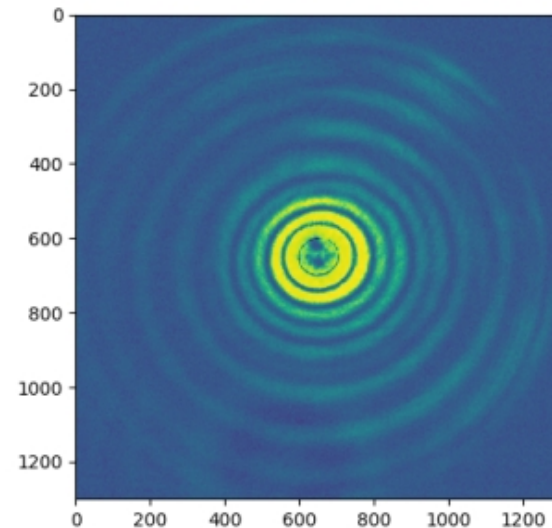
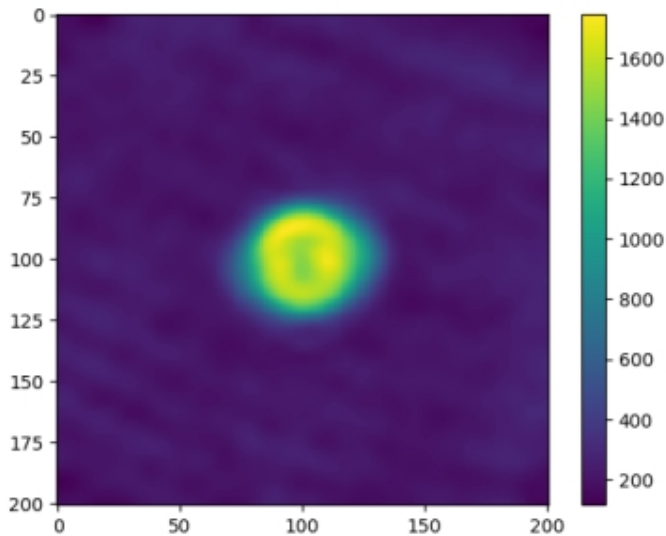


- Symmetry



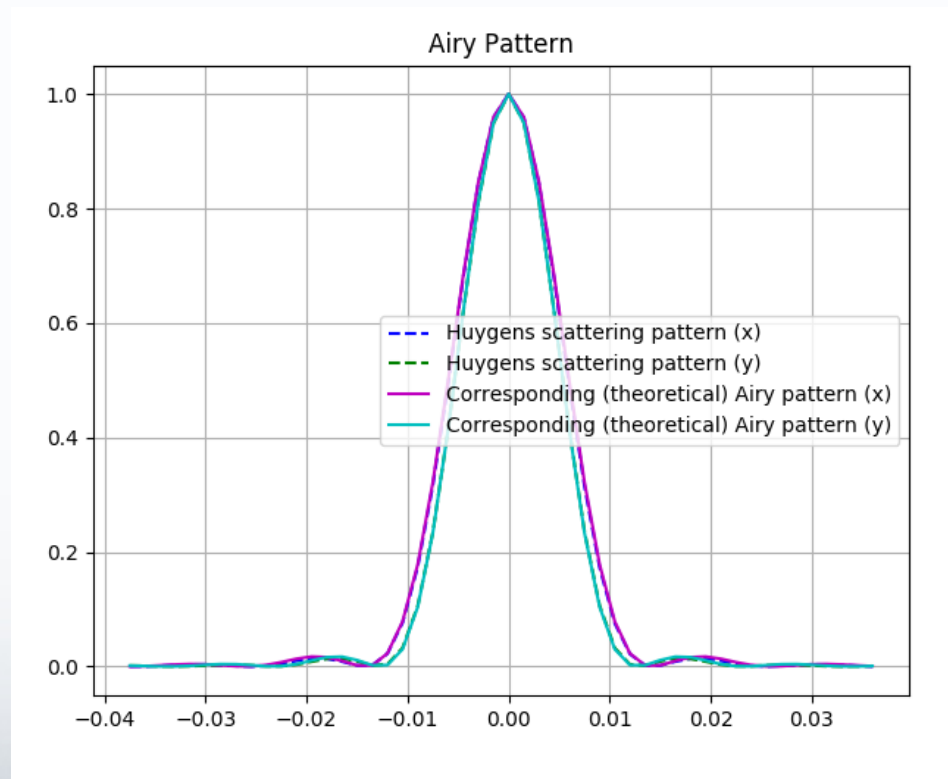
# Algorithm

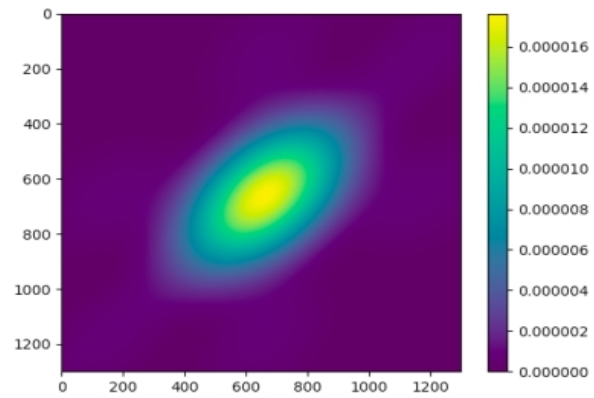
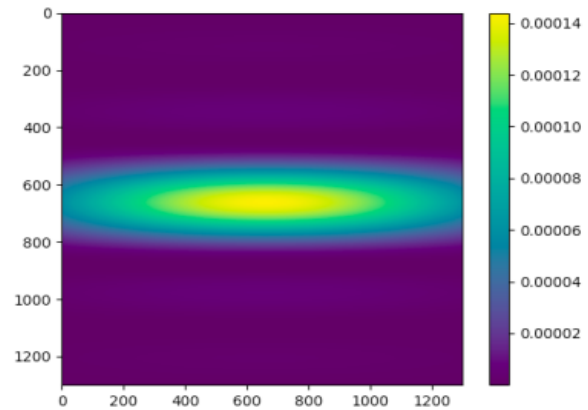
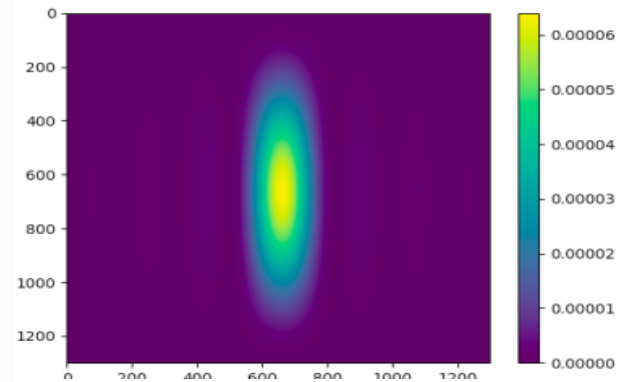
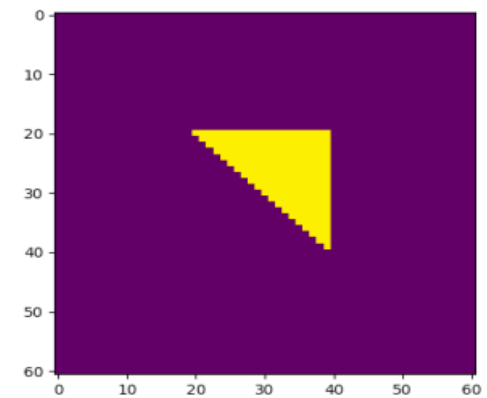
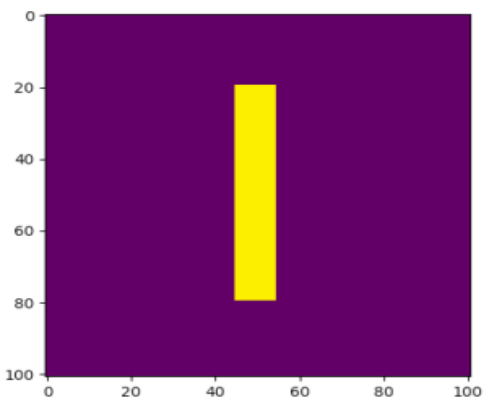
- Designed by starting with a silhouette of a particle and an experimental scattering pattern to see how similar I could get
- Now only need a silhouette



# Testing

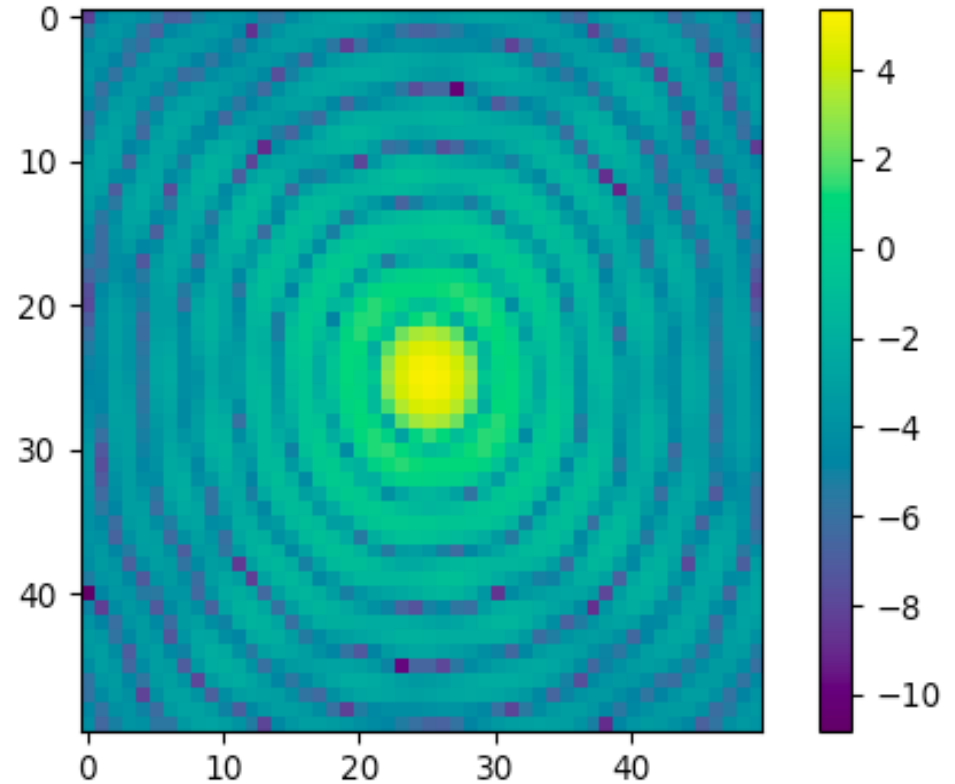
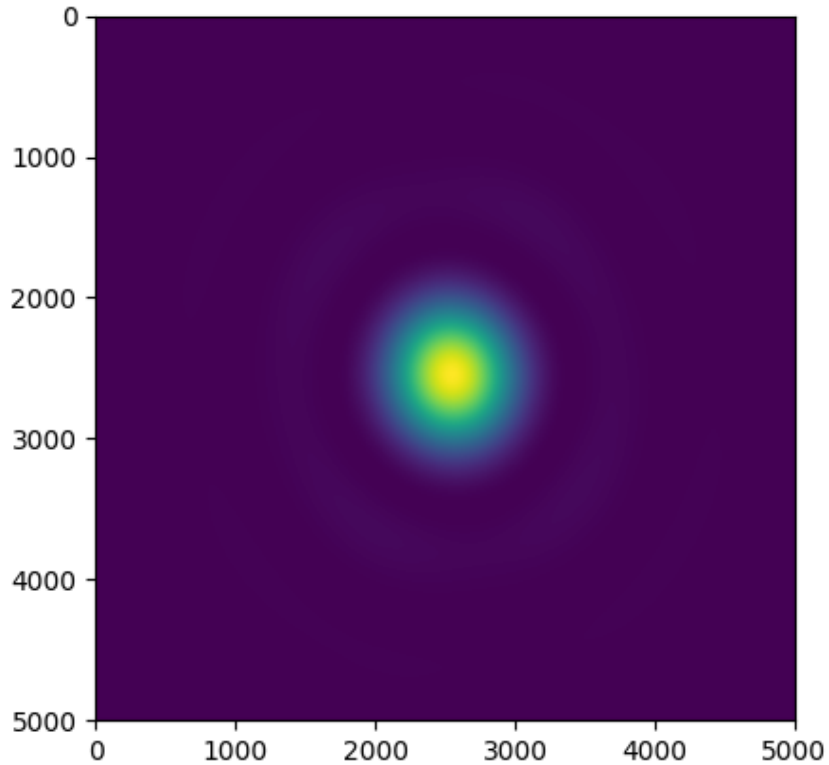
- Airy Curve



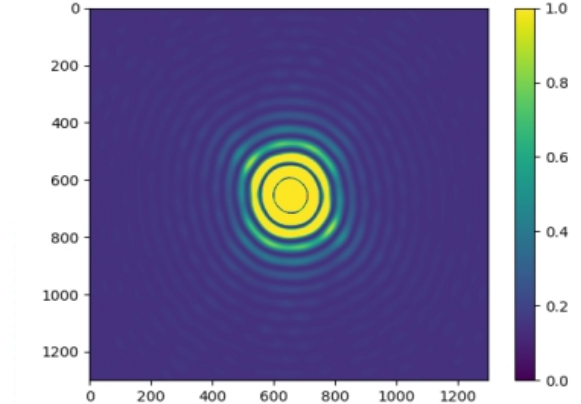
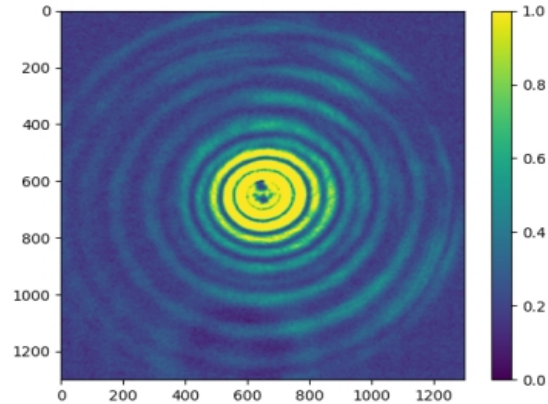
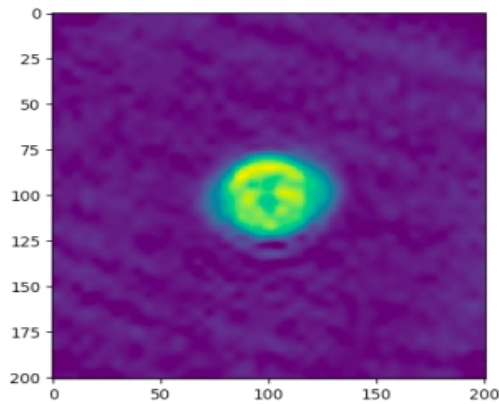
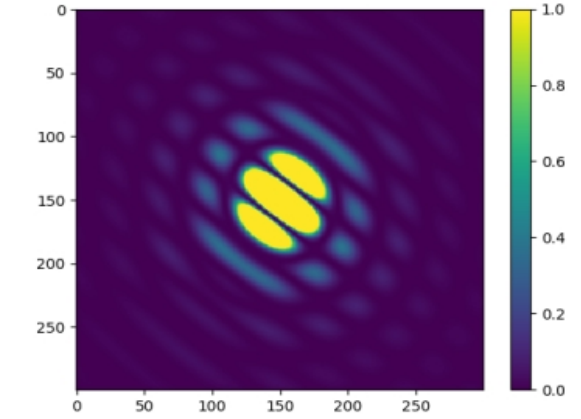
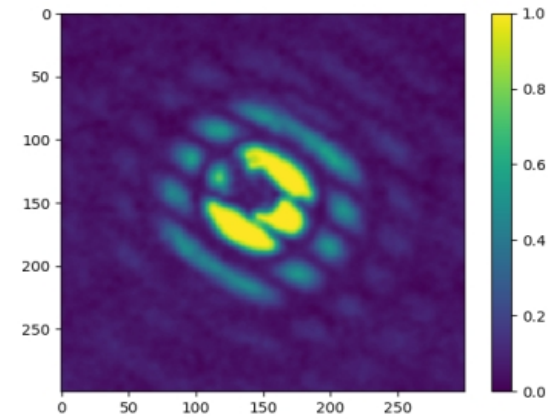
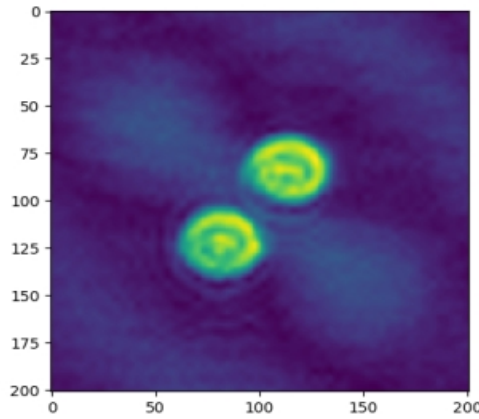
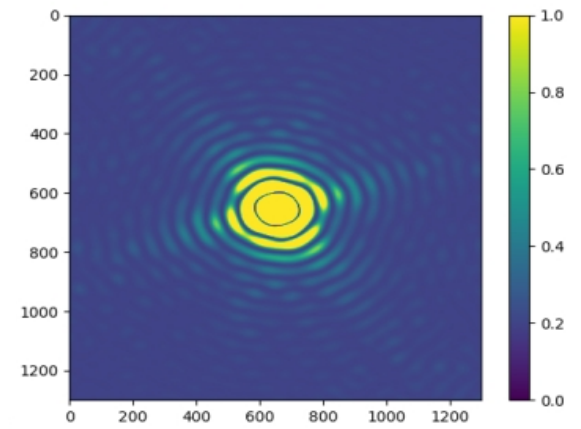
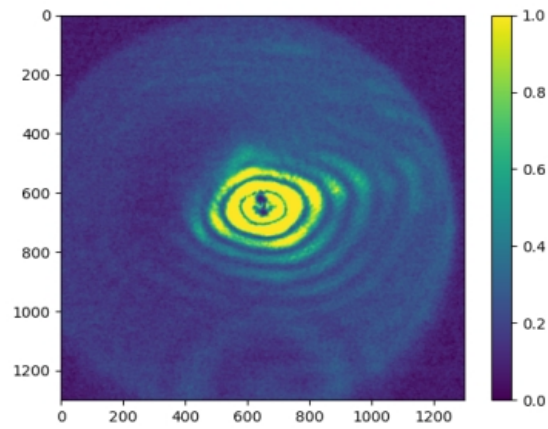
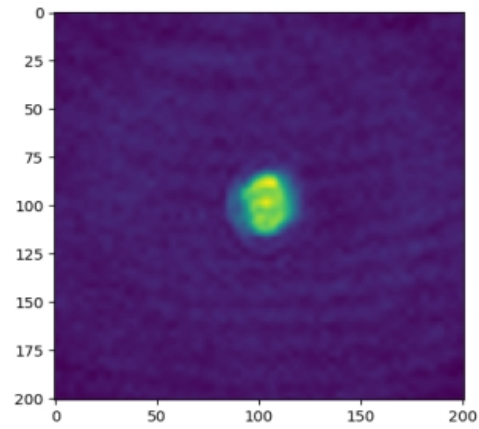


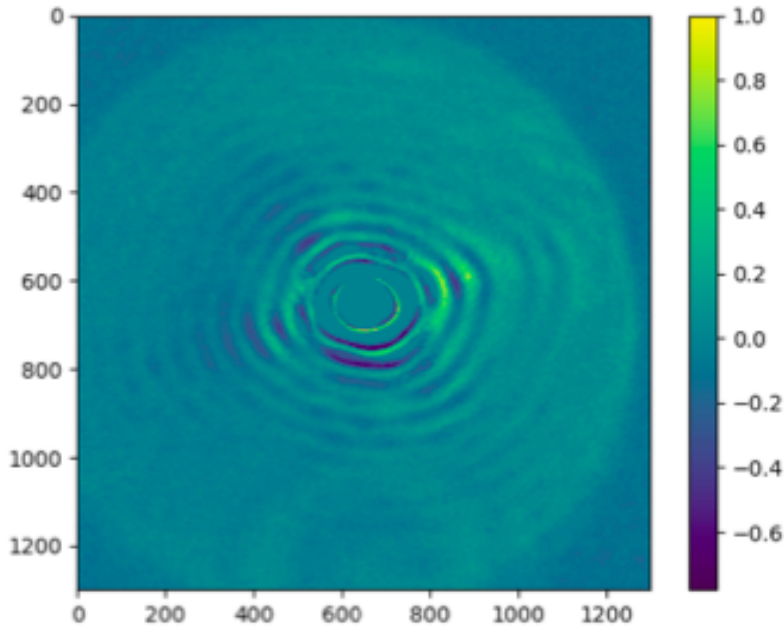


# From Huygens-Fresnel and Babinet Principles

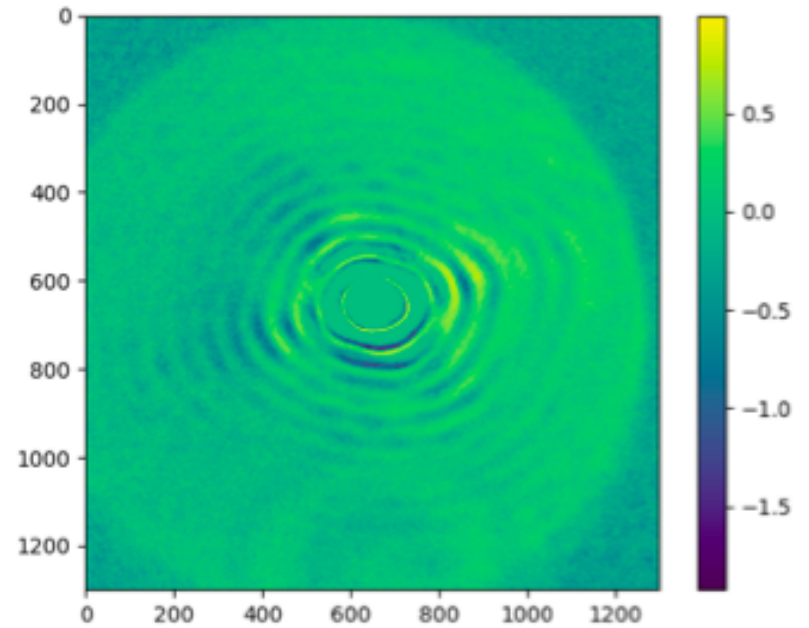


# Pecan Pollen

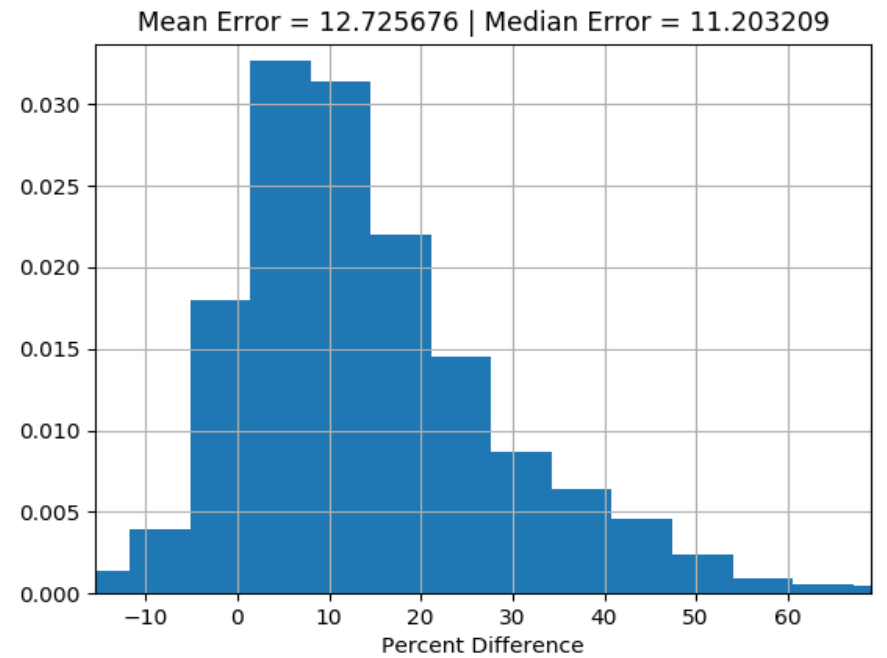
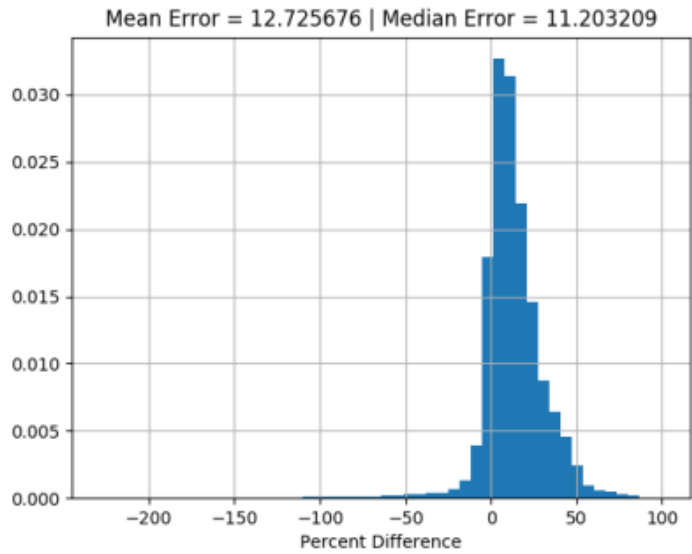
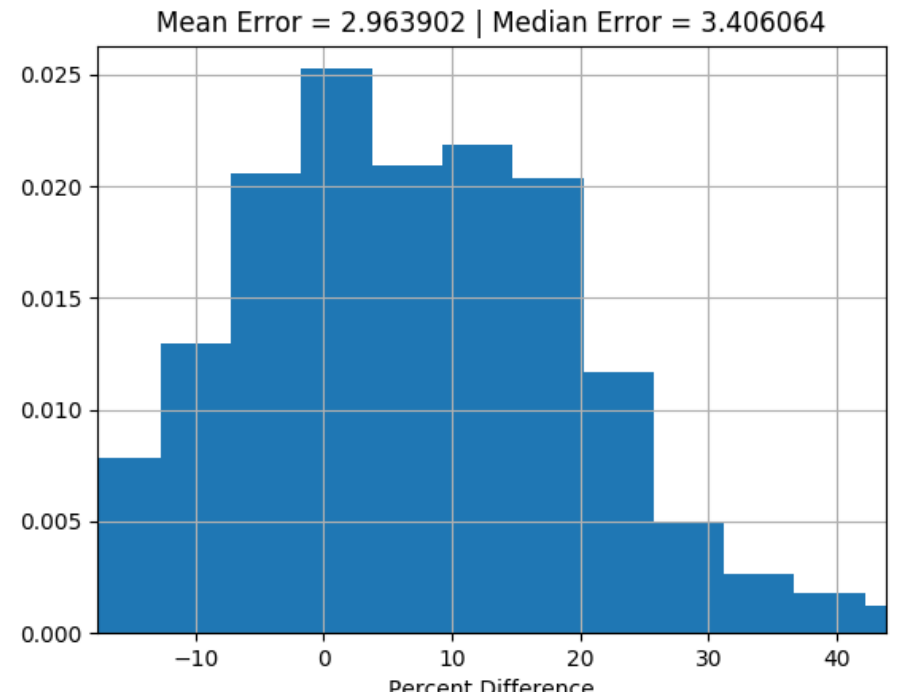
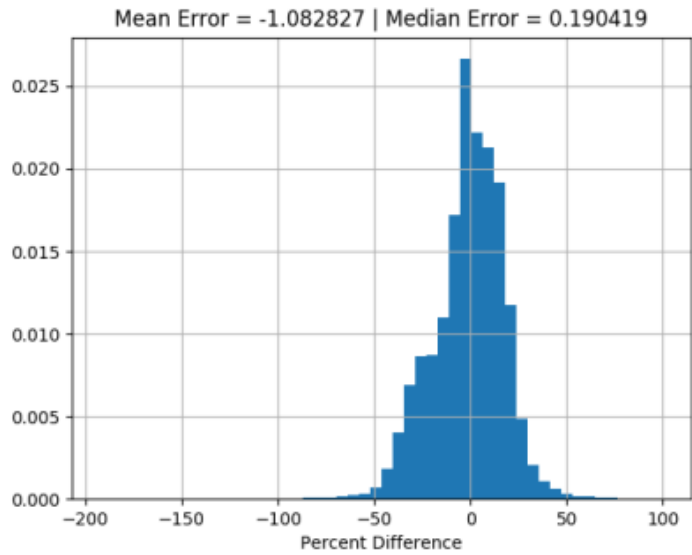




**Figure 3:** A difference pattern for the pecan pollen, produced by subtracting the simulated pattern from the experimental pattern.



**Figure 4:** A relative error plot for the pecan pollen, produced by dividing the difference pattern by the experimental pattern.



# Conclusion

- No one really knew how well this project would work
- Worked a lot better than anticipated
- Can now simulate 2-D scattering patterns of nearly any particle
- Future work will probably consist of making a library to match the scattering pattern to the particle
- Or 3D patterns

# References

1. M. J. Berg, S. Holler (2016). Simultaneous holographic imaging and light-scattering pattern measurement of individual microparticles (pdf). *Optics Letters*, 41, 3363-3366.
2. “Open-CV Python Tutorial.” *Open-CV*. Open Source Computer Vision, n.d. Web. 28 Jul. 2017.