Scattering from microbubble clouds: A fast multipole model with experimental validation

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Motivation

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However, the spectral response can be difficult to interpret

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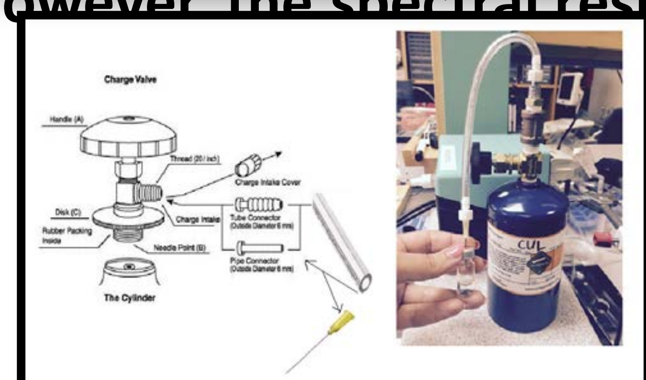


Simulation Approach
Fast Multipole Method (FMM)

Fast Multipole Method (FMM):

- ✓ Complexity reduced from $O(N^2)$ to $O(\log(1/u)N)$
- ✓ Single solution valid for arbitrary incident field

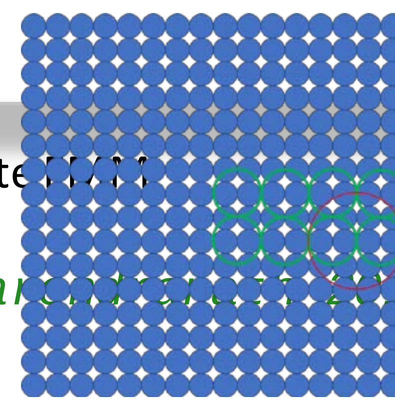
- ☹ Monochromatic
- ☹ Scatterers are non-compressible

Modified Rayleigh Plesset*:

- ✓ Accurate under controlled conditions
- ✓ Straightforward implementation

- ☹ Oscillations symmetric
- ☹ Bubbles don't translate
- ☹ Driven only by primary wave

Quasi static: Simulate FMM – Time step RP, update



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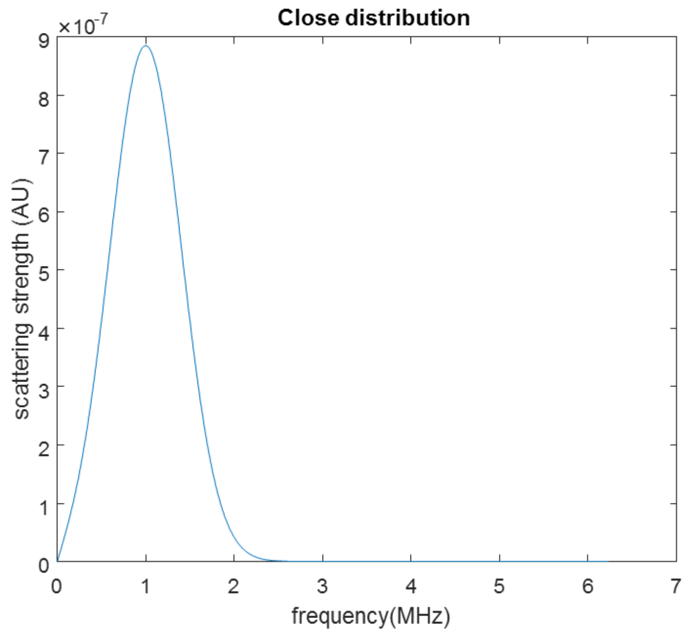
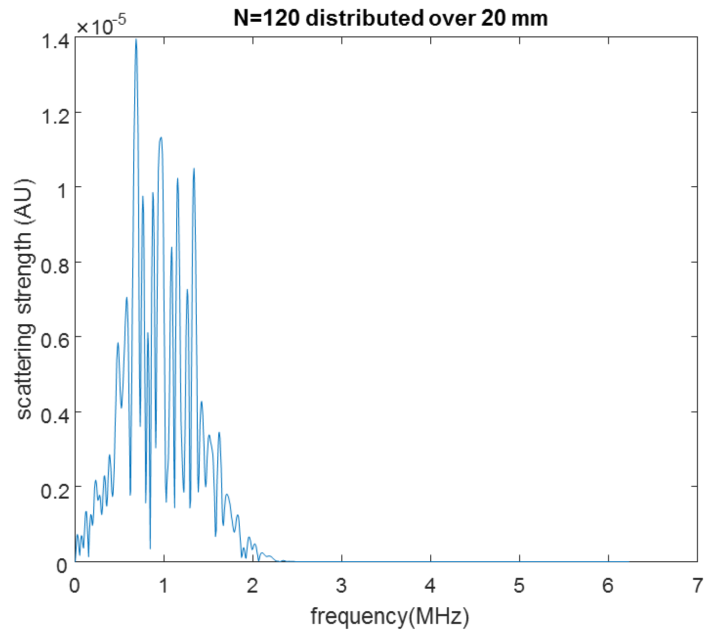
Example Application

Dependence on spatial distribution, uniform field





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Summary

- Simulations predict backscattering spectra that corelates with experiments over microbubble size and concentration
- Ongoing work seeks develop it the approach into a tool for interpreting signals for passive acoustic mapping of bubbles and others.
- FMM may find further utility in modeling general heterogeneous media

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