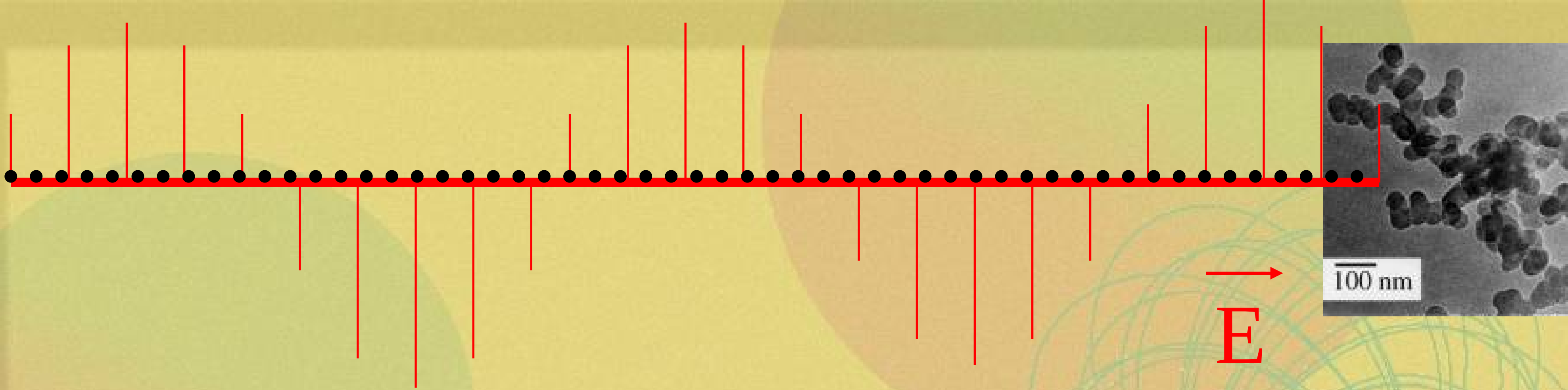

Electromagnetic Interactions with Small Particles

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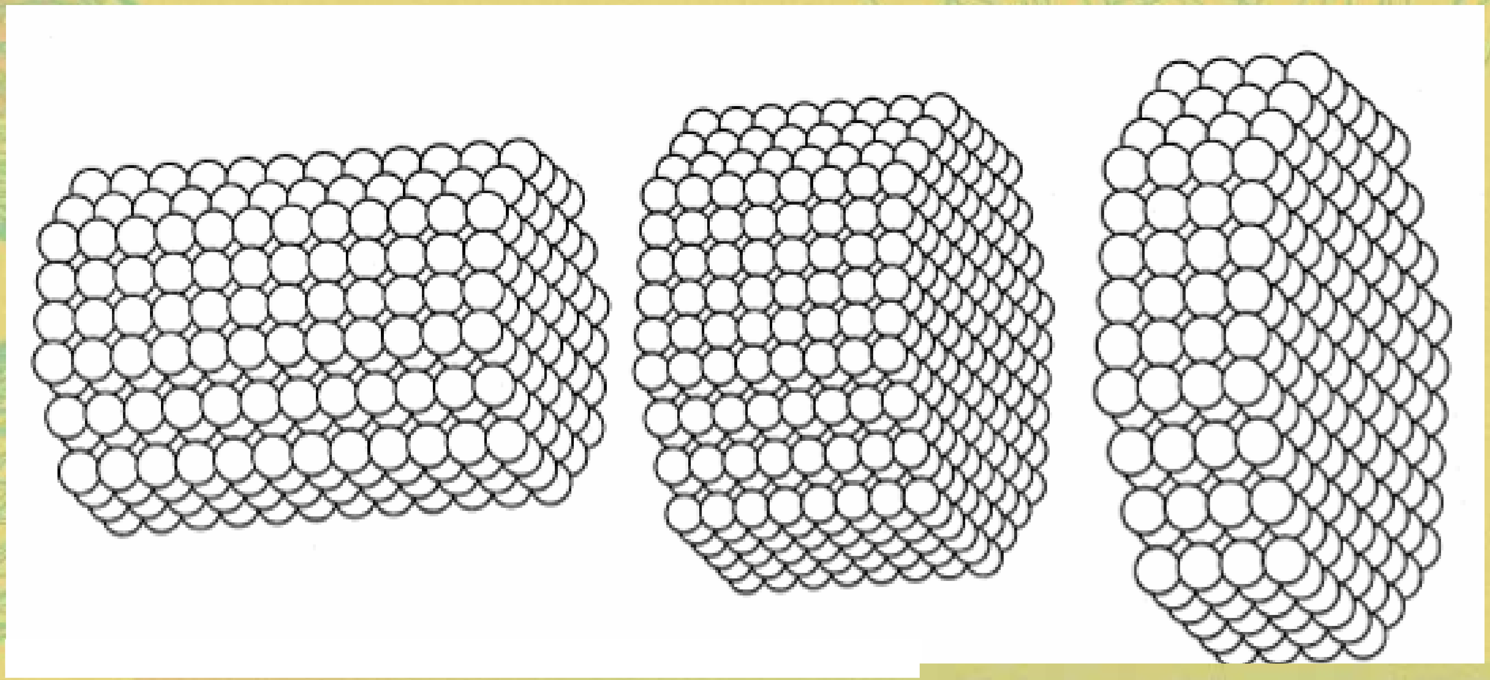
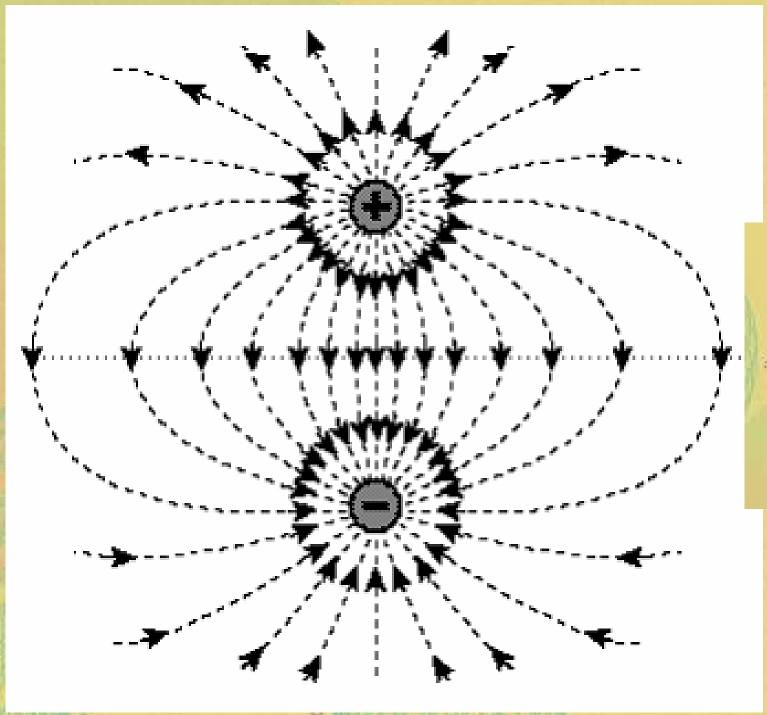
Professor Yong
Scientific Computing

Discrete Dipole Approximation

- Model complex geometries by discretizing space.



Electric Dipoles



$$\mathbf{p} = q\vec{d}$$

$$\mathbf{p} = \alpha \mathbf{E}$$

$$\mathbf{E}_{dip}(\vec{r}) = \frac{1}{4\pi\varepsilon_0}\frac{1}{r^3}\left[3(\mathbf{p}\cdot\hat{\mathbf{r}})\hat{\mathbf{r}} - \mathbf{p}\right]$$

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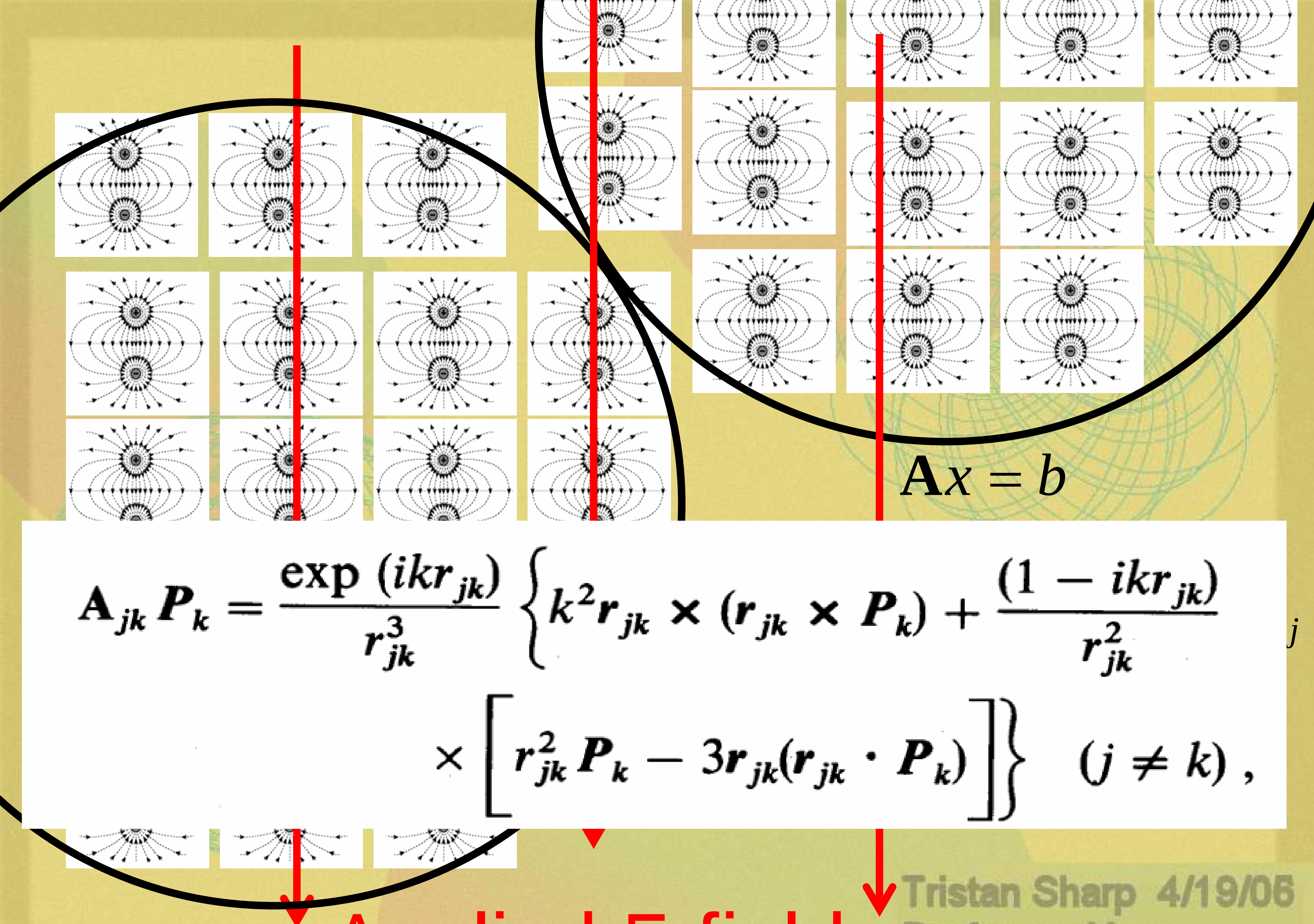

$$\mathbf{A}_{jk}\boldsymbol{P}_k = \frac{\exp(ikr_{jk})}{r_{jk}^3}\left\{k^2\boldsymbol{r}_{jk}\times(\boldsymbol{r}_{jk}\times\boldsymbol{P}_k) + \frac{(1-ikr_{jk})}{r_{jk}^2}\times\left[r_{jk}^2\boldsymbol{P}_k - 3\boldsymbol{r}_{jk}(\boldsymbol{r}_{jk}\cdot\boldsymbol{P}_k)\right]\right\} \quad (j\neq k),$$

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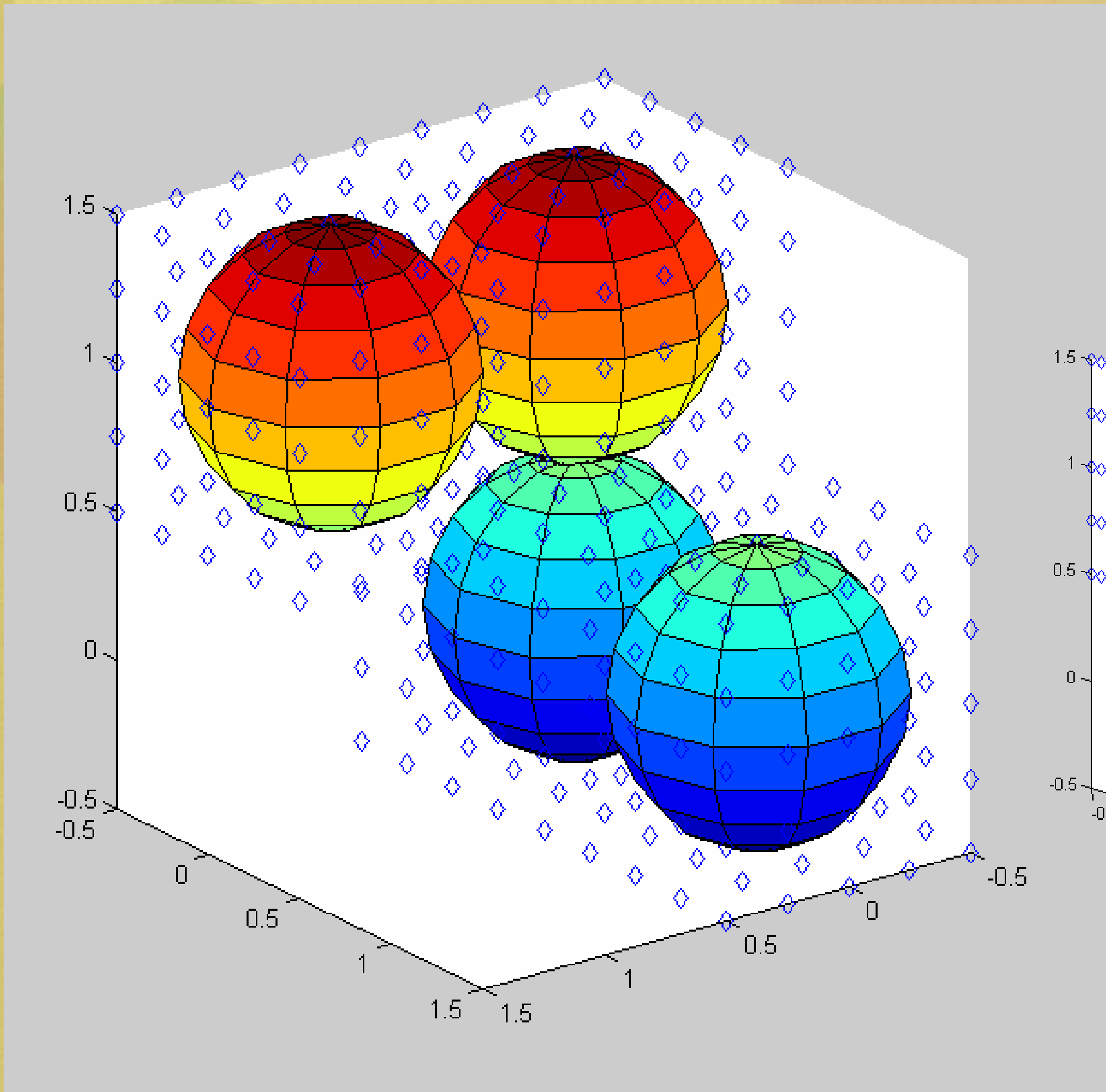

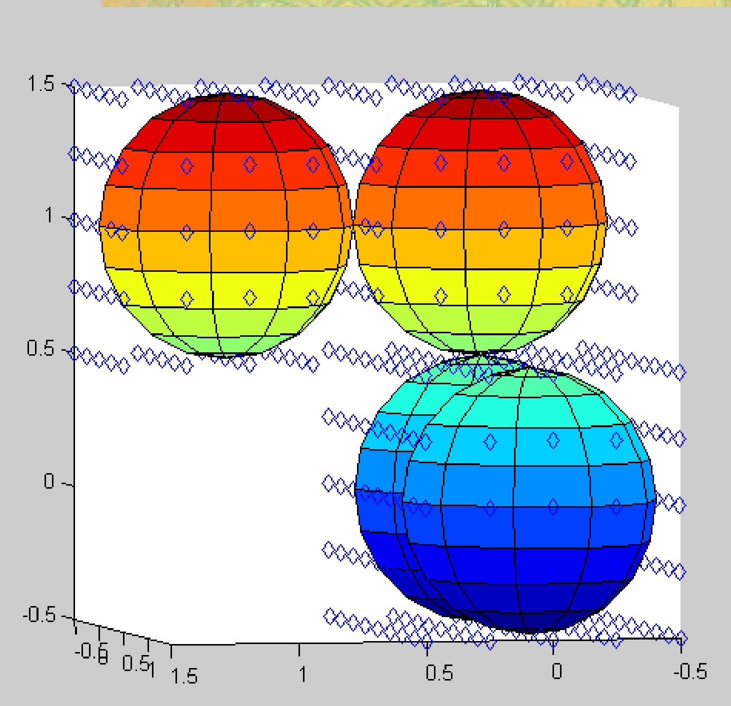

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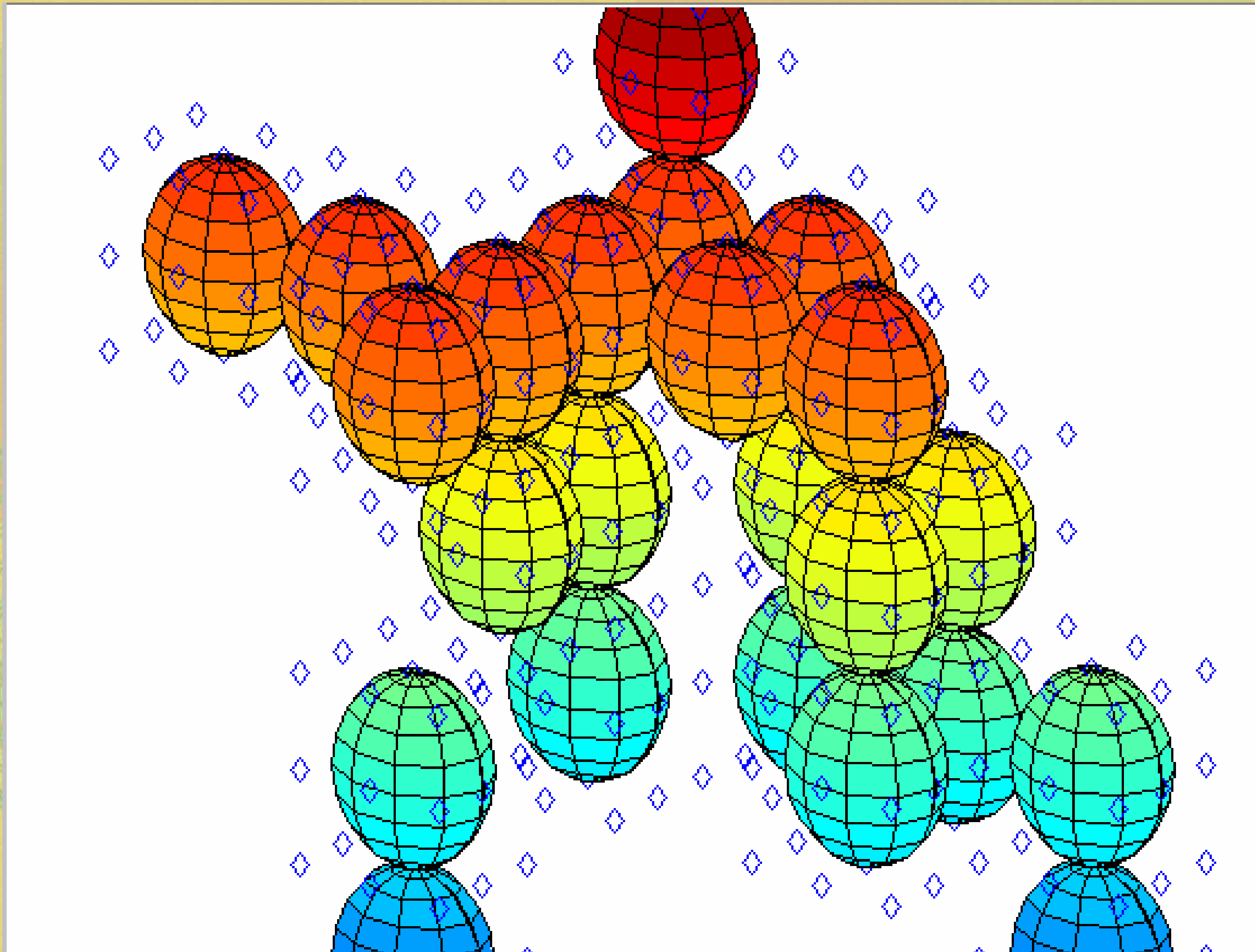

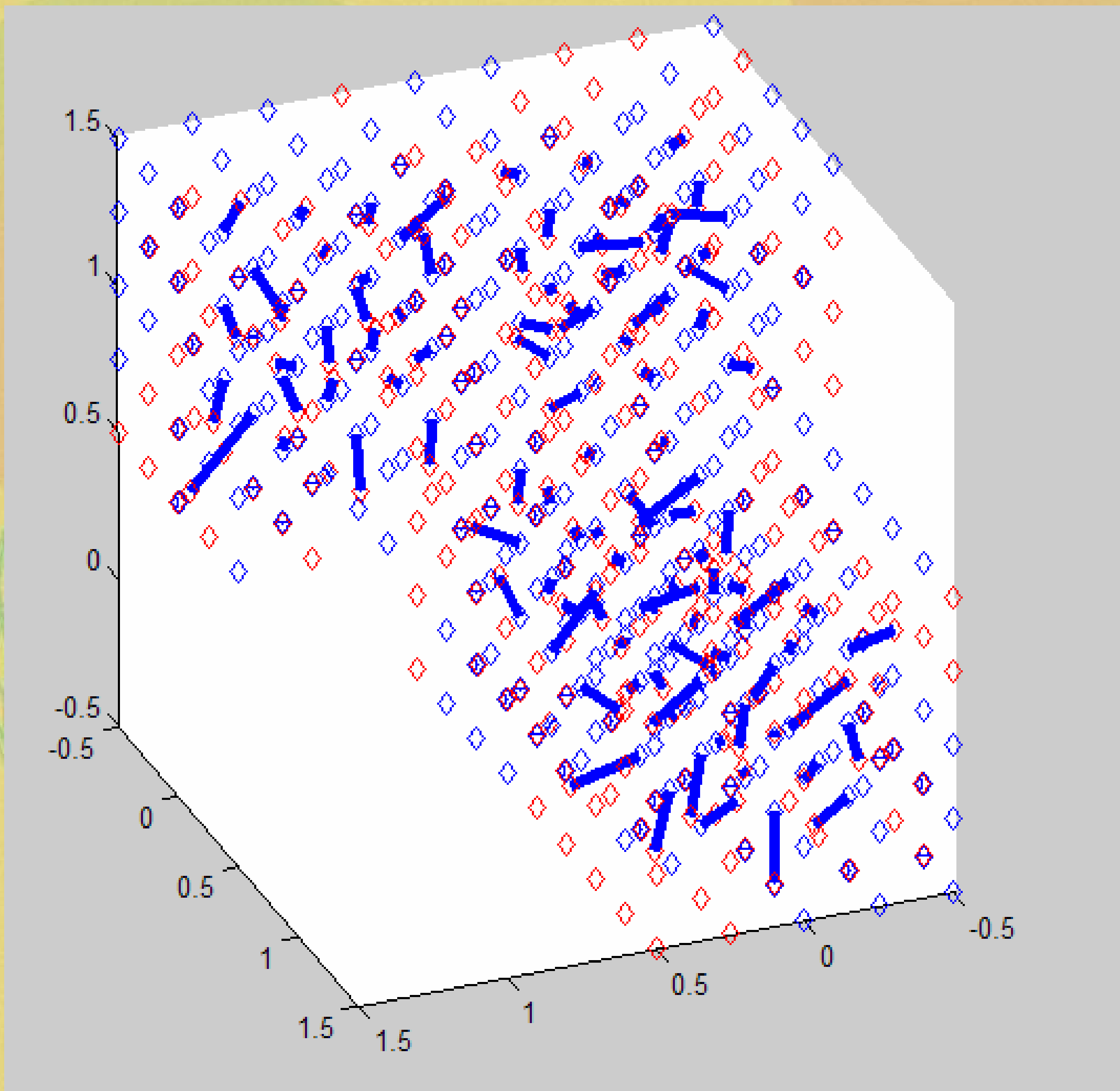

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Yay same results!

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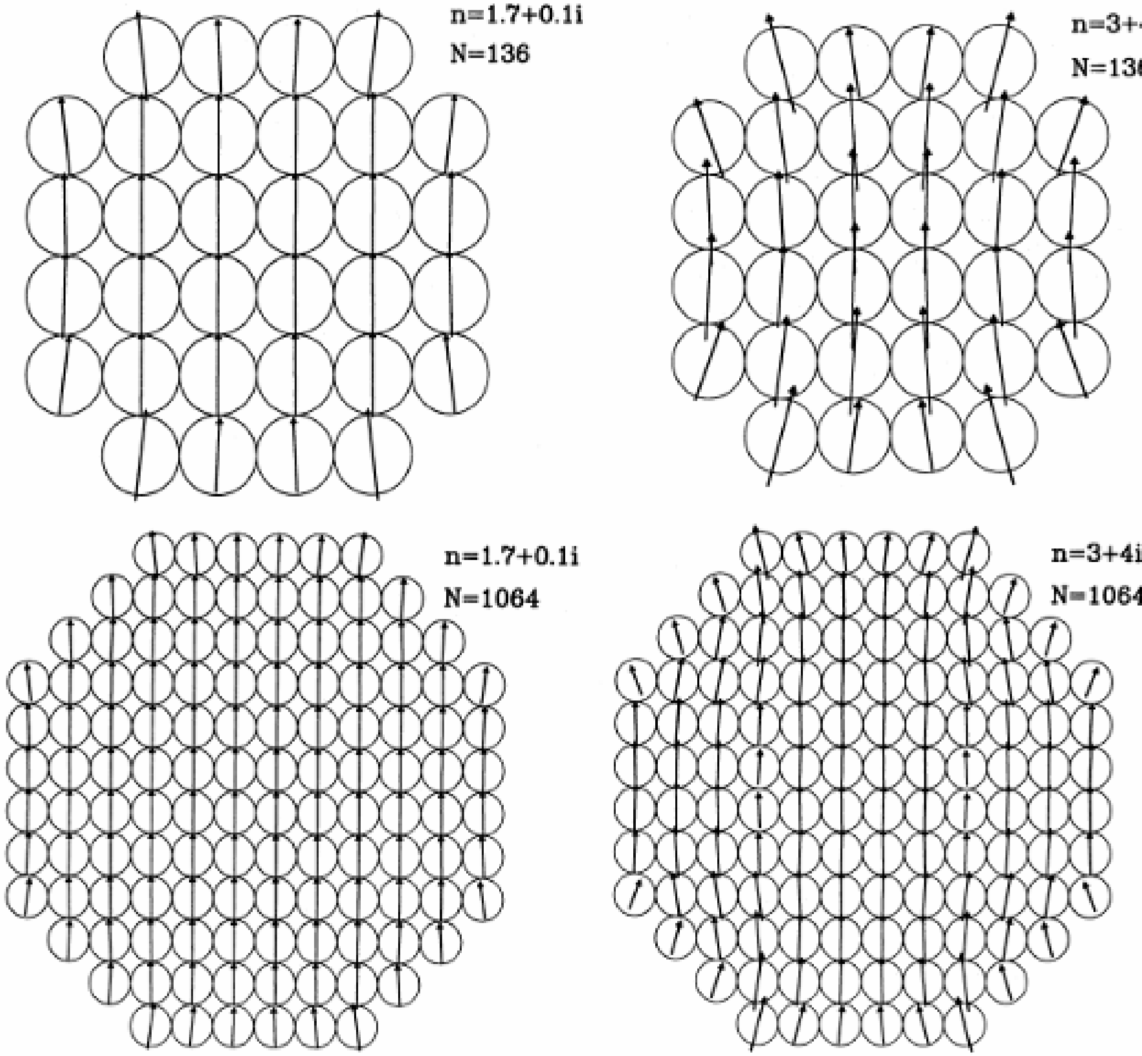
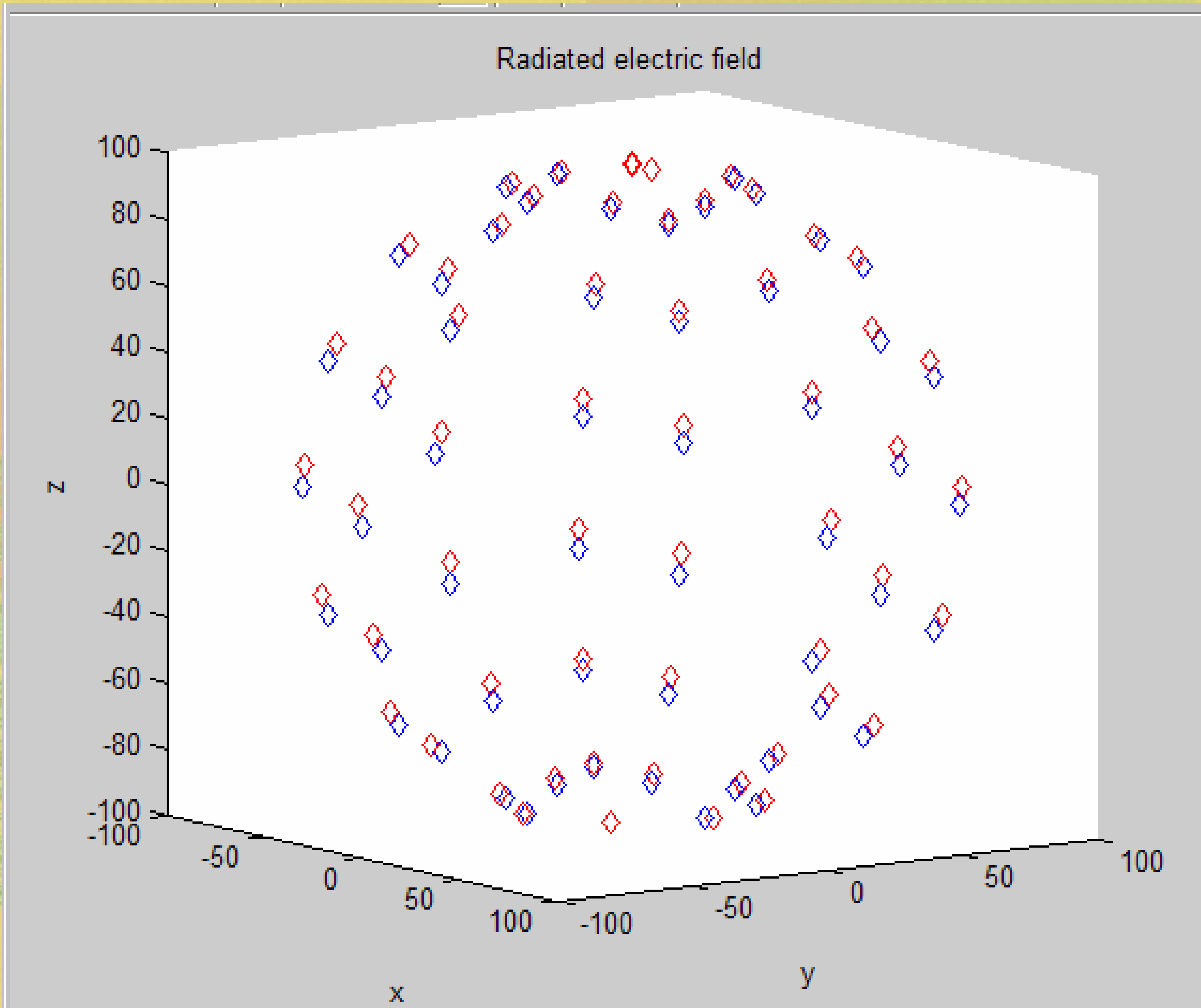


FIG. 2.—Dipole polarizations within "spheres" consisting of $N = 136$ and $N = 1064$ dipoles, in a static uniform applied electric field. The applied electric field is n the y-direction; shown are the dipoles lying on the $z = d/2$ plane. The four cases are labeled by the number N of dipoles and the complex refractive index n. The ndividual polarization vectors would be parallel and of length equal to d if the polarization per dipole were equal to the polarization within a continuum sphere (see ext). It is seen that significant departures from the continuum limit occur at "corners" along the sphere boundary; the fraction of the array elements located along he boundary decreases as $N^{-1/3}$. It is also seen that departures from the continuum limit are more pronounced for large values of the refractive index m. As discussed n the text, this surface "granularity" is a significant source of error for large values of the refractive index m; suppression of this error may require very large values


Radiated electric field
100
80
60
40
20
0
-20
-40
-60
-80
-100
z
-100
-50
0
50
100
x
-100
-50
0
50
100
y

More!

- Make faster so can solve for more dipoles
  - LU
  - FFT spectral methods
- Add new substances to soot particles
- Average over many soot geometries, as if many particles in the air
- Average over time and calculate scattered intensity.

References

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