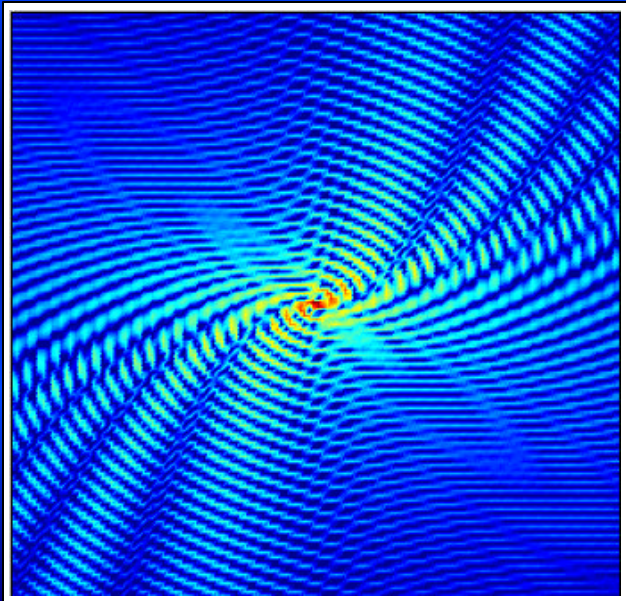
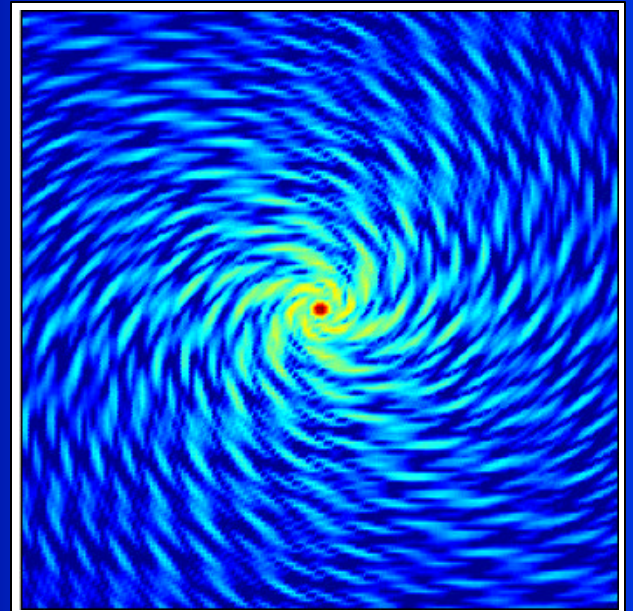


Spiral Fractal Arrays



Héctor E. Dimas
NSF/SUNFEST '00

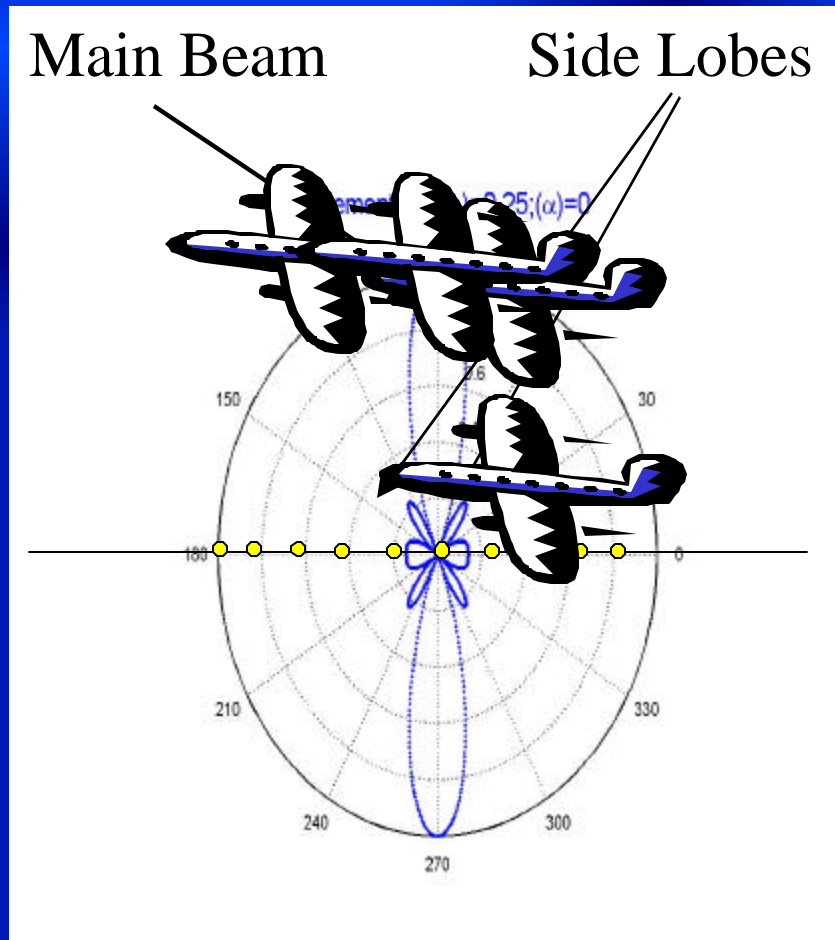
Advisors: Dr. Dwight L. Jaggard
Aaron Jaggard



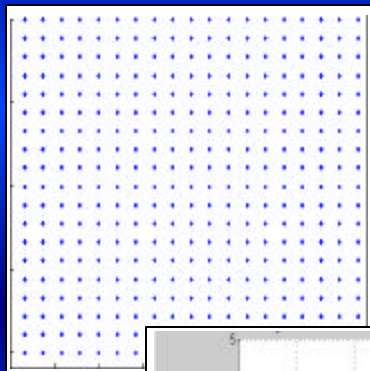
Antenna Arrays

Radiation Pattern

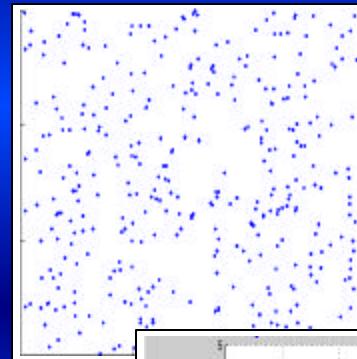
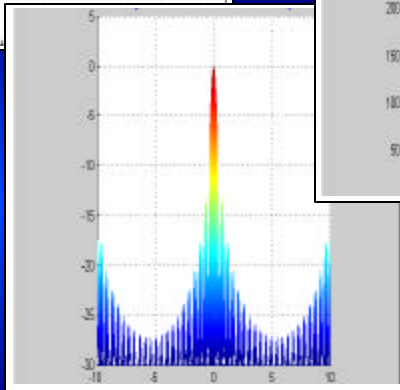
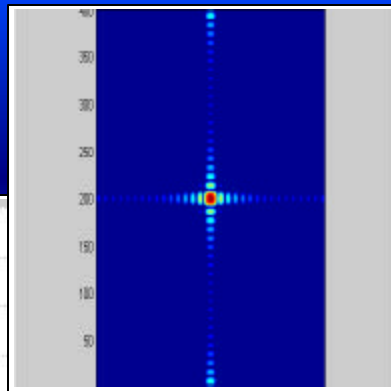
- Dependent on distance between elements in array
- Characterized by constructive/destructive interference
- Main two structures:
 - Main Beam (Directivity)
 - Side Lobe Level



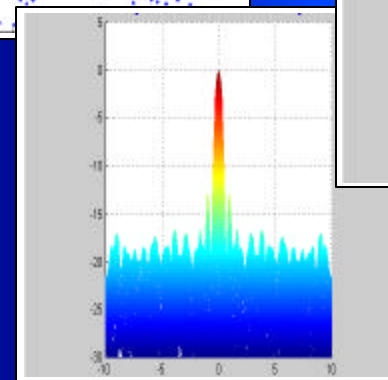
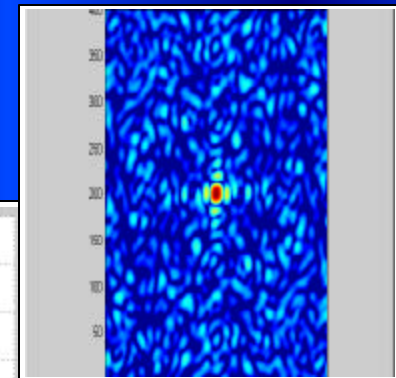
How Can We Combine the Properties of Two 2-Dimensional Planar Arrays?



Periodic



Random



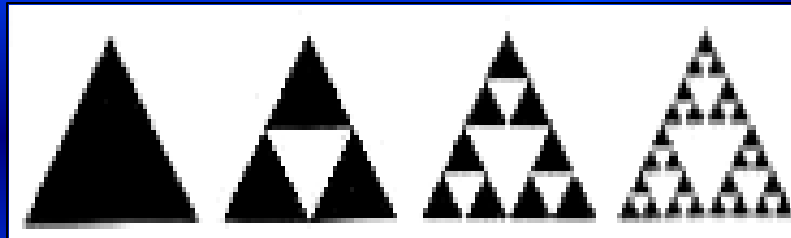
- Better main beam
- Relatively low side-lobes

- Lower side-lobes
- Robust with respect to:
 - position
 - element failure

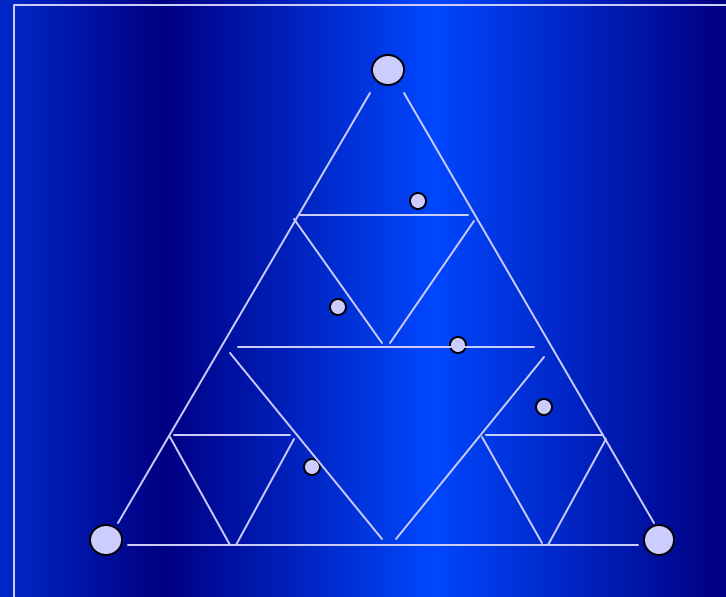
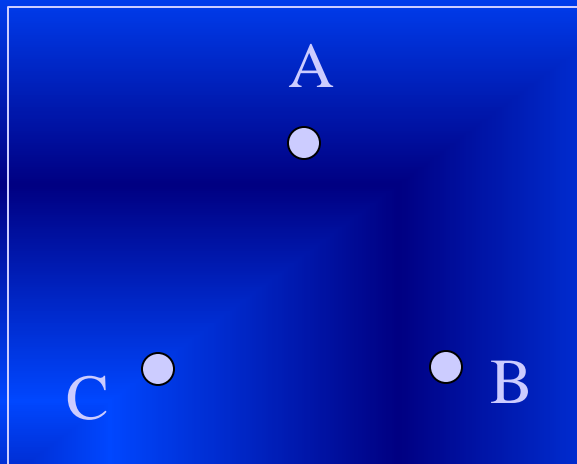
Fractals

- Generating Options

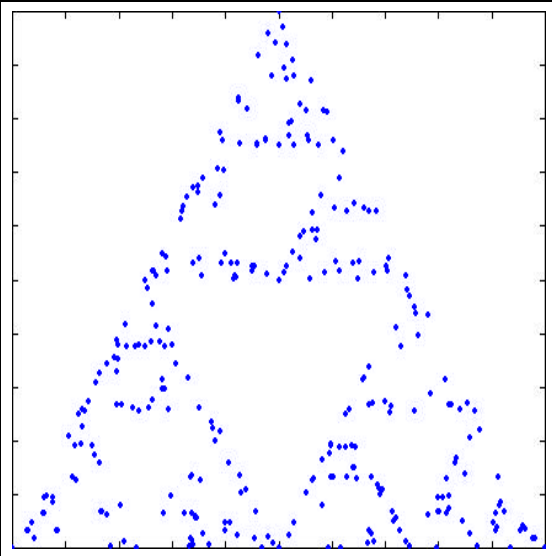
- Self Similar



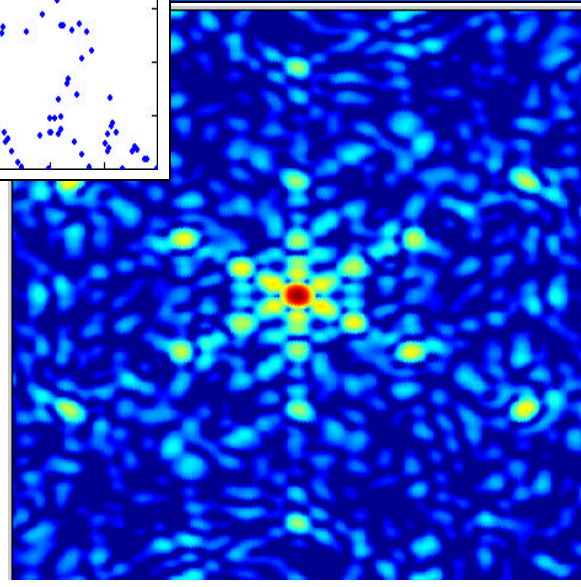
- Chaos Game



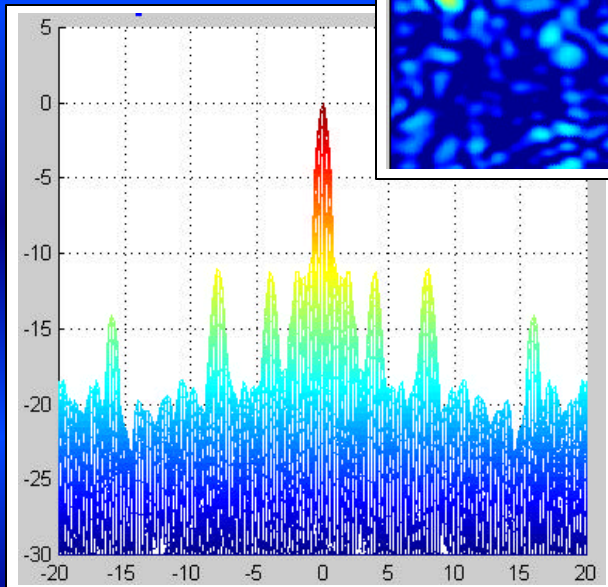
Fractals Bridge the Gap Between Periodic and Random Arrays



600 elements



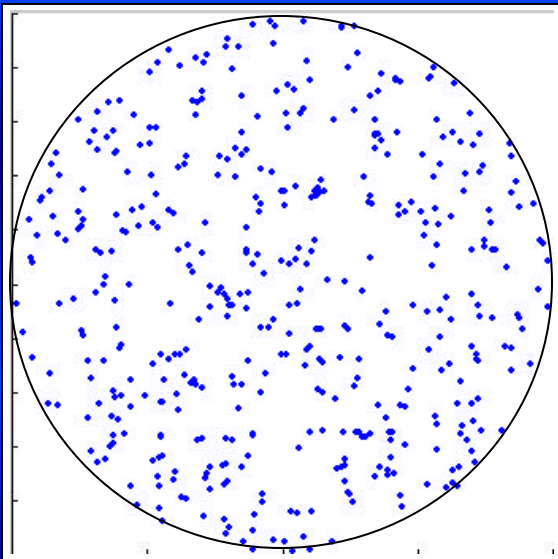
- Provide for more characteristic lengths
- Robust with respect to element failure and position



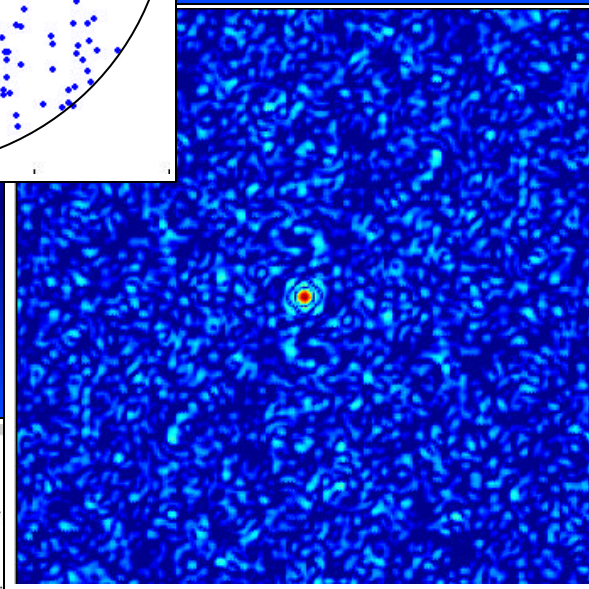
Qualities of good fractal arrays

- No preferred sides
- Many differences between points

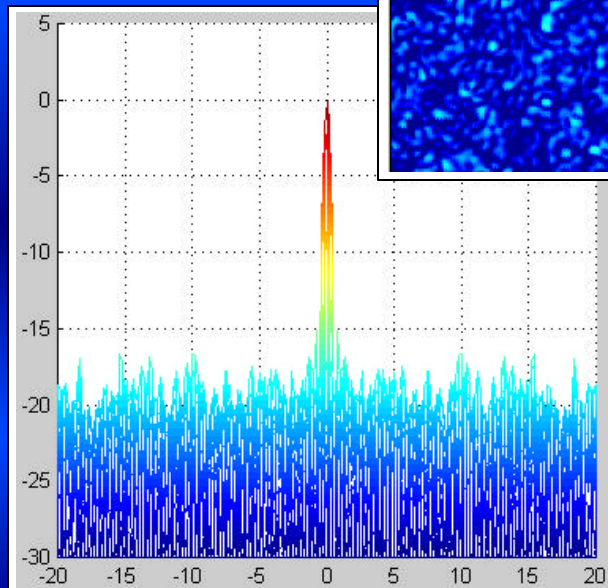
Random Circular Arrays



441 elements



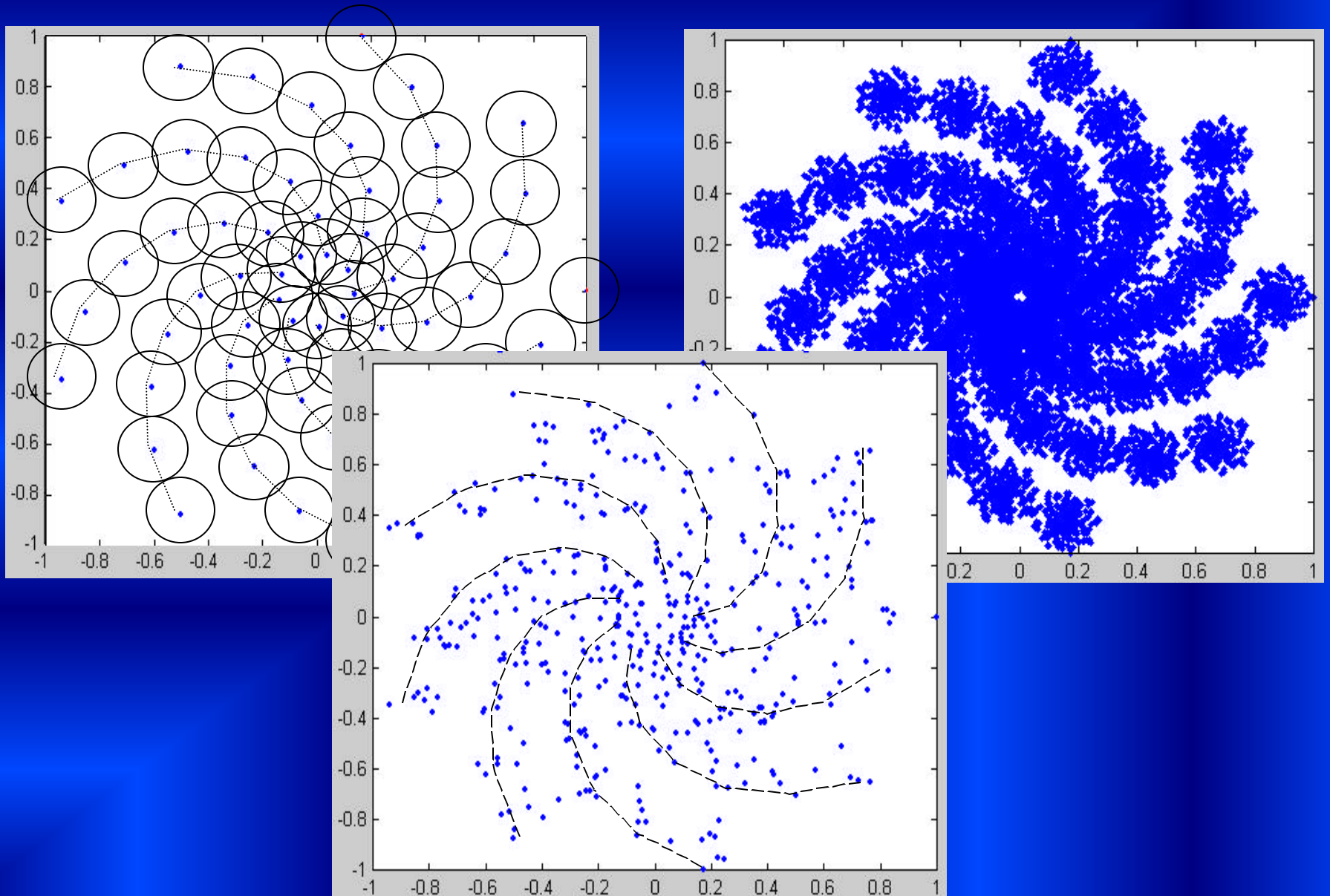
- Reduce the number of preferred sides to zero
- Relatively low side lobes
- Good directivity



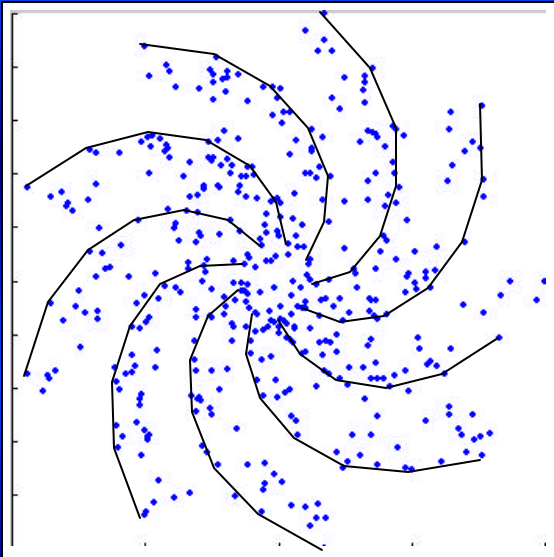
Drawback

- Main beam is slightly degraded
- Non-uniform distribution of side lobes

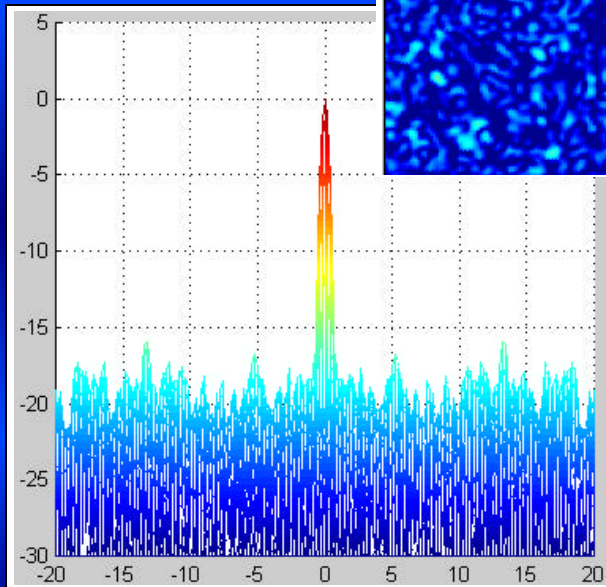
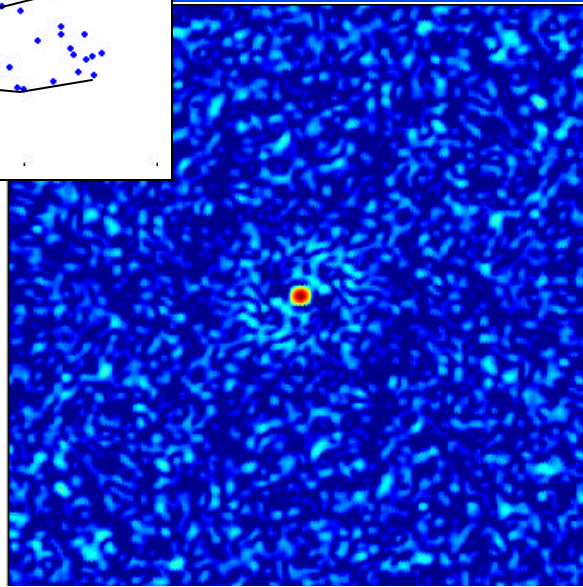
Construction of Spiral Arrays



Fractal Spiral Arrays



441 elements



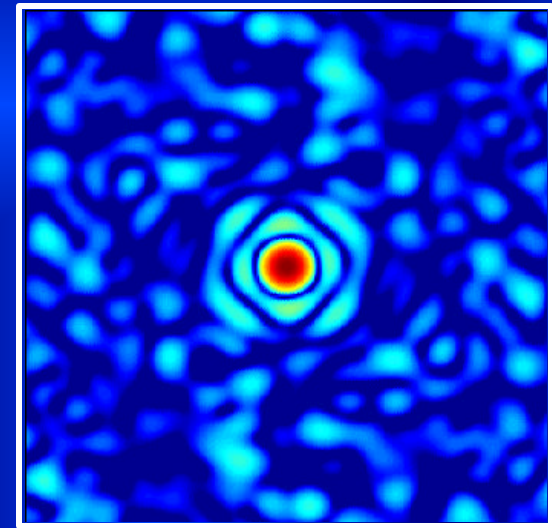
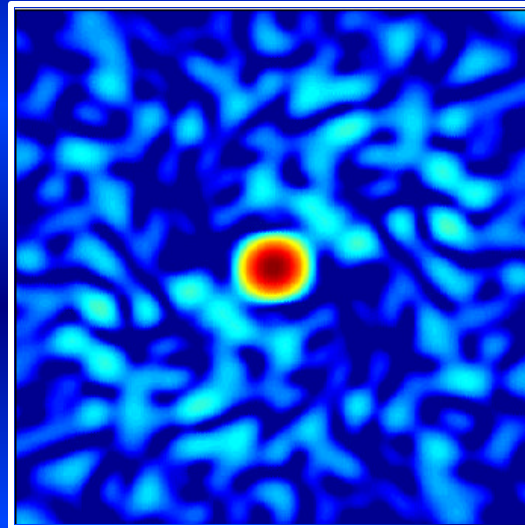
- Relatively low number of antenna elements needed
- Better performance than random Sierpinski arrays
- More uniform and lower side lobes
- Directivity is comparable to that of random arrays

Main Beam Comparisons

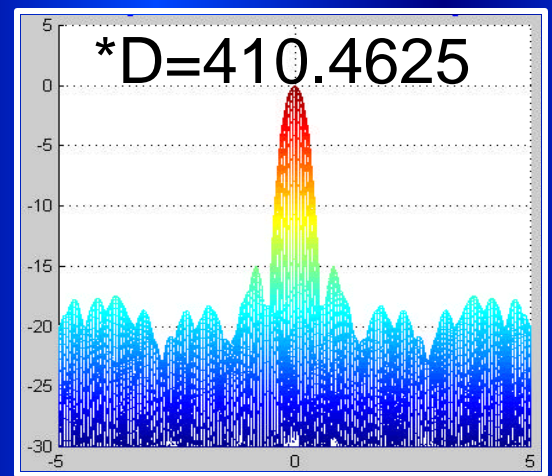
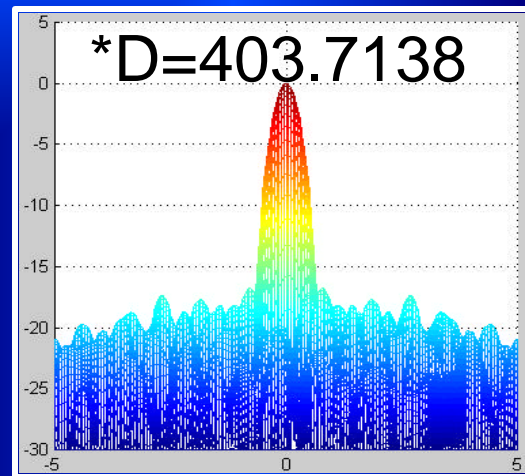
Fractal

Random

Top View

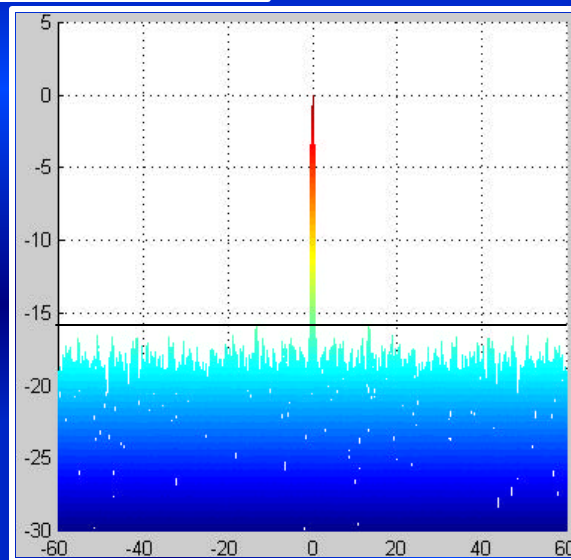
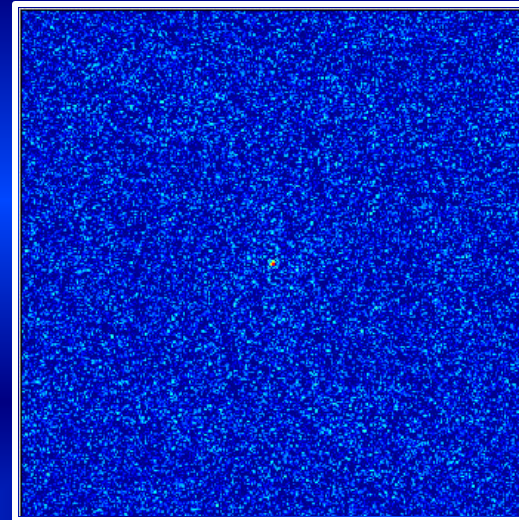
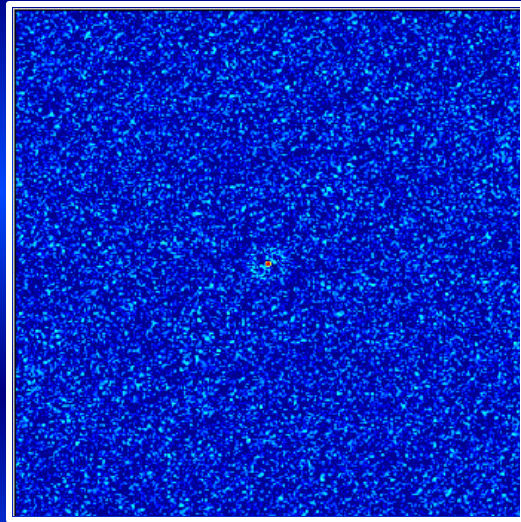


Side View

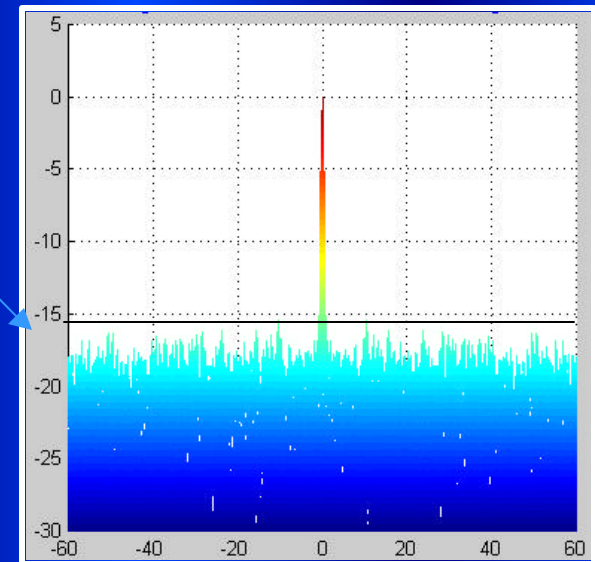


*Directivity calculated at a viewing area of 20 units

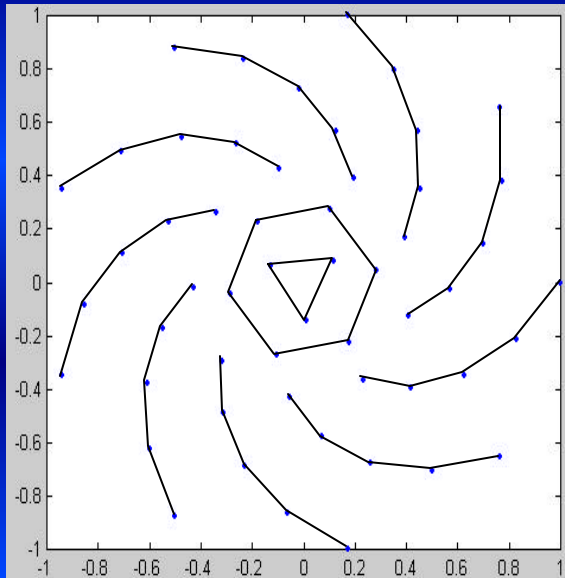
Side Lobe Comparisons



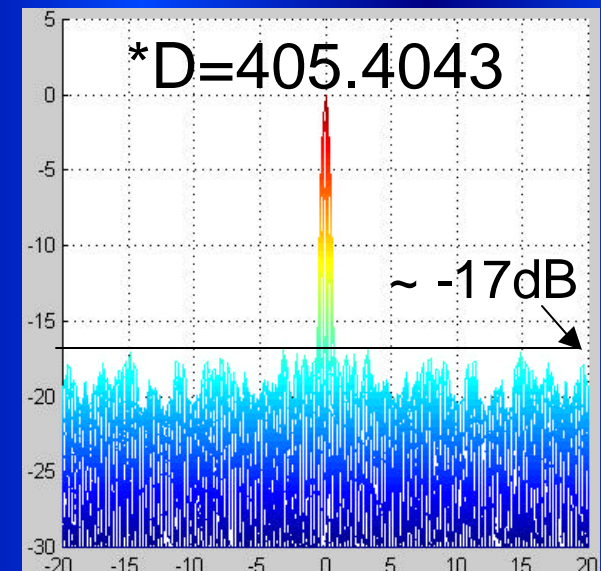
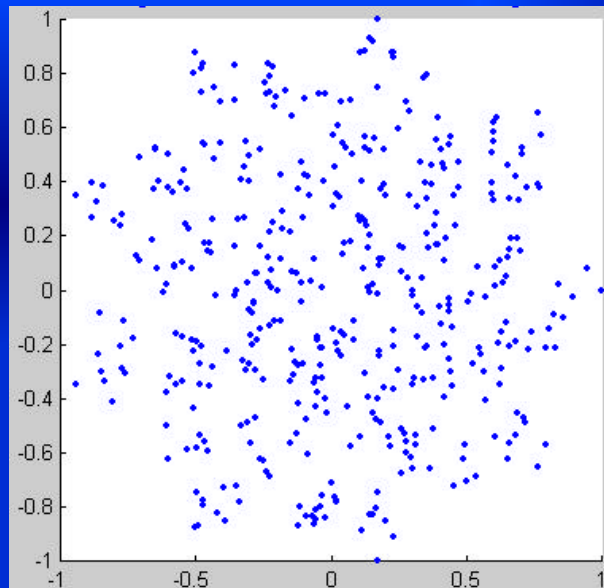
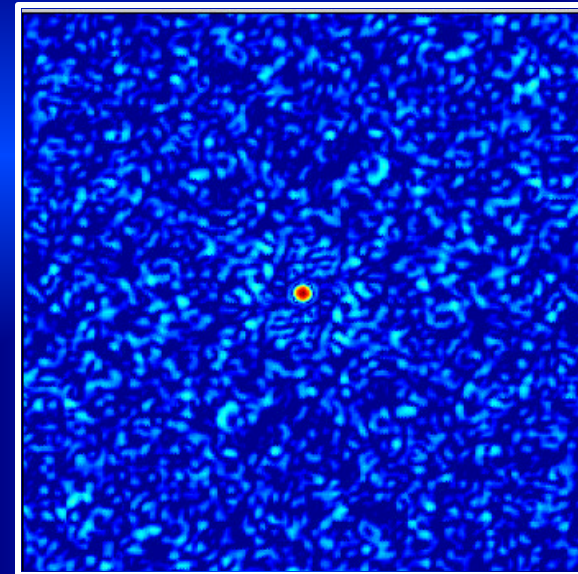
$\sim -17\text{dB}$



Where Do We Go From Here?

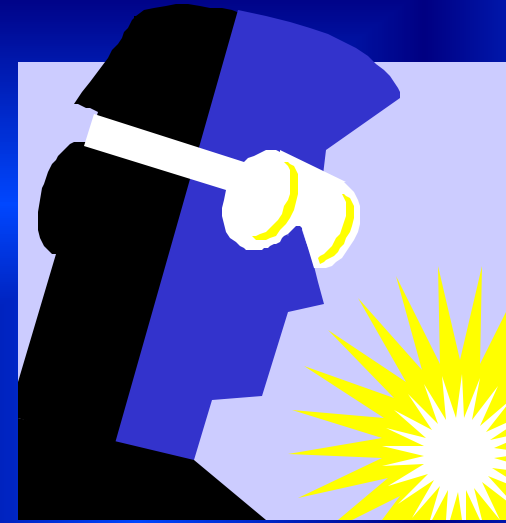


Multi-fractal
Structures

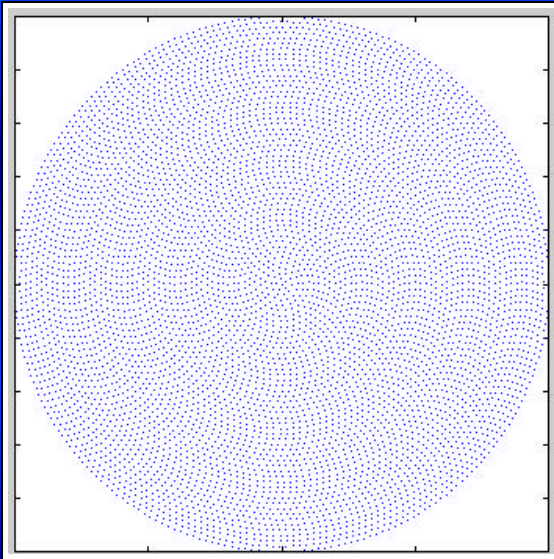


Conclusions/Recommendations

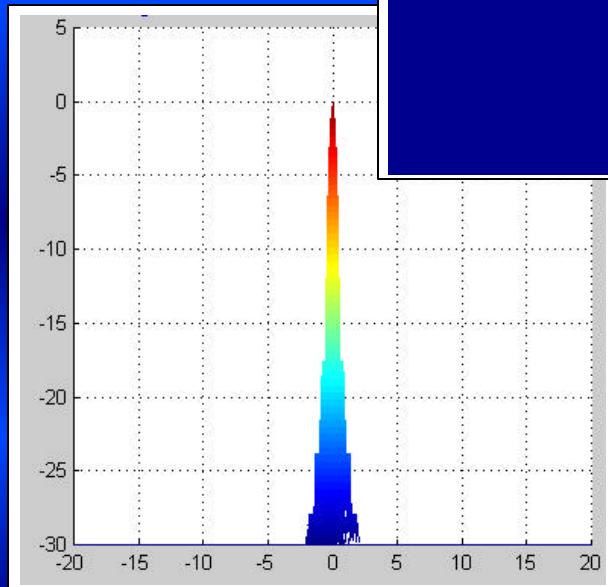
- Fractal arrays performed similarly to random arrays.
 - Directivity
 - Average sidelobe level
- Further exploration:
 - Testing more variations in number of arms and inner circles of spiral array
 - Making fractal array less tapered
 - Testing different circular structures



Disc Arrays



6,376 points



- Reduce the number of preferred sides to zero
- A filled disc allows for a large number of characteristic lengths

Drawback

- Too many elements (6,376)
- Almost become a random array in a circular field