Binomial Array

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The next step is to determine the values of the excitation coefficients .

- **Binomial Array**
- *Excitation Coefficients:*
- The function *be written in a series, using the binomial expansion, as*

$$(1+x)^{m-1}$$

$$(1+x)^{m-1} = 1 + (m-1)x + \frac{(m-1)(m-2)}{2!}x^2 + \frac{(m-1)(m-2)(m-3)}{3!}x^3 + \dots$$

The positive coefficients of the series expansion for different values of *m* *are :*

$m = 1$										1									
$m = 2$									1		1								
$m = 3$								1		2		1							
$m = 4$							1		3		3		1						
$m = 5$						1		4		6		4		1					
$m = 6$					1		5		10		10		5		1				
$m = 7$				1		6		15		20		15		6		1			
$m = 8$			1		7		21		35		35		21		7		1		
$m = 9$		1		8		28		56		70		56		28		8		1	
$m = 10$	1		9		36		84		126		126		84		36		9		1

- ***The coefficients of the expansion represent the relative amplitudes of the elements.***
- ***Since the coefficients are determined from a binomial series expansion, the array is known as a binomial array***.

Pascal's Triangle

1

1 1

1 2 1

1 3 3 1

1 4 6 4 1

1 5 10 10 5 1

(6-63)

$2a_1=6$

$a_1=3$

Design Procedure

- One of the requirements is the amplitude excitation coefficients for a given number of elements. This can be accomplished by using the Pascal triangle

- Other figures of merit are the directivity, half-power beam width and side lobe level.

- As it is known that *binomial arrays do not exhibit any minor lobes provided the spacing between the elements is equal or less than one-half of a wavelength and no grating for* $d < \lambda$.

- 1. Two elements *(2M = 2)=>a1 = 1*
- 2. Three elements *(2M + 1 = 3)*

  =>2a1 = 2⇨a1 = 1 and a2 = 1
- 3. Four elements *(2M = 4)*

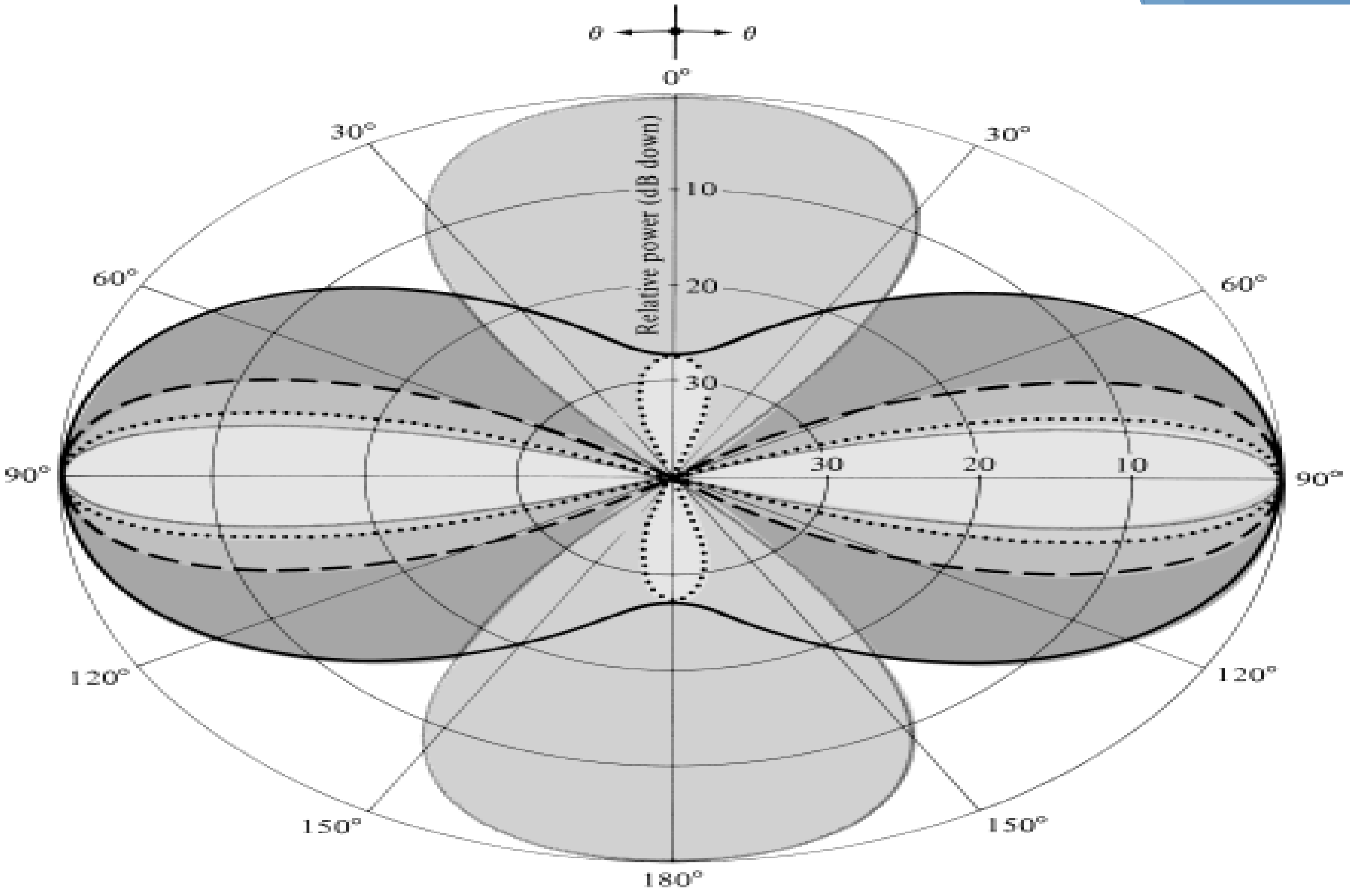
  =>a1 = 3 and a2 = 1

$$\text{HPBW}(d = \lambda/2) \simeq \frac{1.06}{\sqrt{N-1}} = \frac{1.06}{\sqrt{2L/\lambda}} = \frac{0.75}{\sqrt{L/\lambda}}$$

$$D_0 = \frac{2}{\int_0^{\pi} \left[\cos\left(\frac{\pi}{2}\cos\theta\right)\right]^{2(N-1)} \sin\theta \, d\theta}$$

$$D_0 = \frac{(2N-2)(2N-4)\cdots 2}{(2N-3)(2N-5)\cdots 1}$$

$$D_0 \simeq 1.77\sqrt{N} = 1.77\sqrt{1 + 2L/\lambda}$$



$d = \lambda/4$

$d = \lambda/2$

$d = 3\lambda/4$

$d = \lambda$

Figure 6.20 Array factor power patterns for a 10-element broadside binomial array wi
$N = 10$ and $d = \lambda/4, \lambda/2, 3\lambda/4$, and λ.

- **Design a three-element binomial array of isotropic elements positioned along the *z*-axis a distance *d* apart. Find the**
- **(a) Normalized excitation coefficients**
- **(b) Array factor**
- **(c) Nulls of the array factor for $d = \lambda/2$**
- **(d) Maxima of the array factor for $d = \lambda/2$**