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## An Ambiguity-Solving Method for DOA Estimation with Unfolded Co-prime Arrays

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# An Ambiguity-Solving Method for DOA Estimation with Unfolded Co-prime Arrays

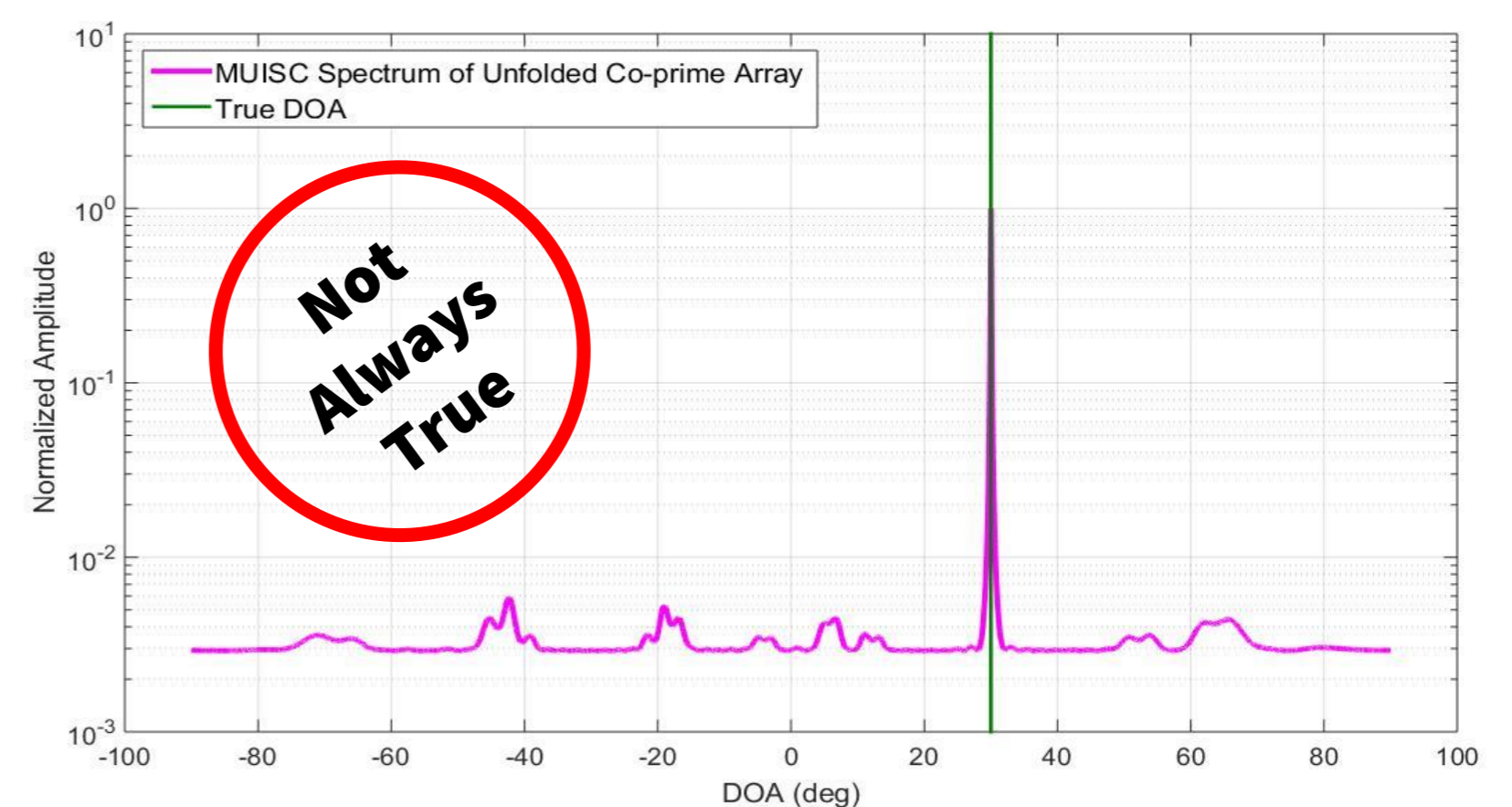
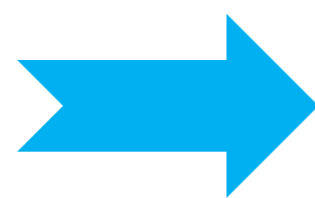
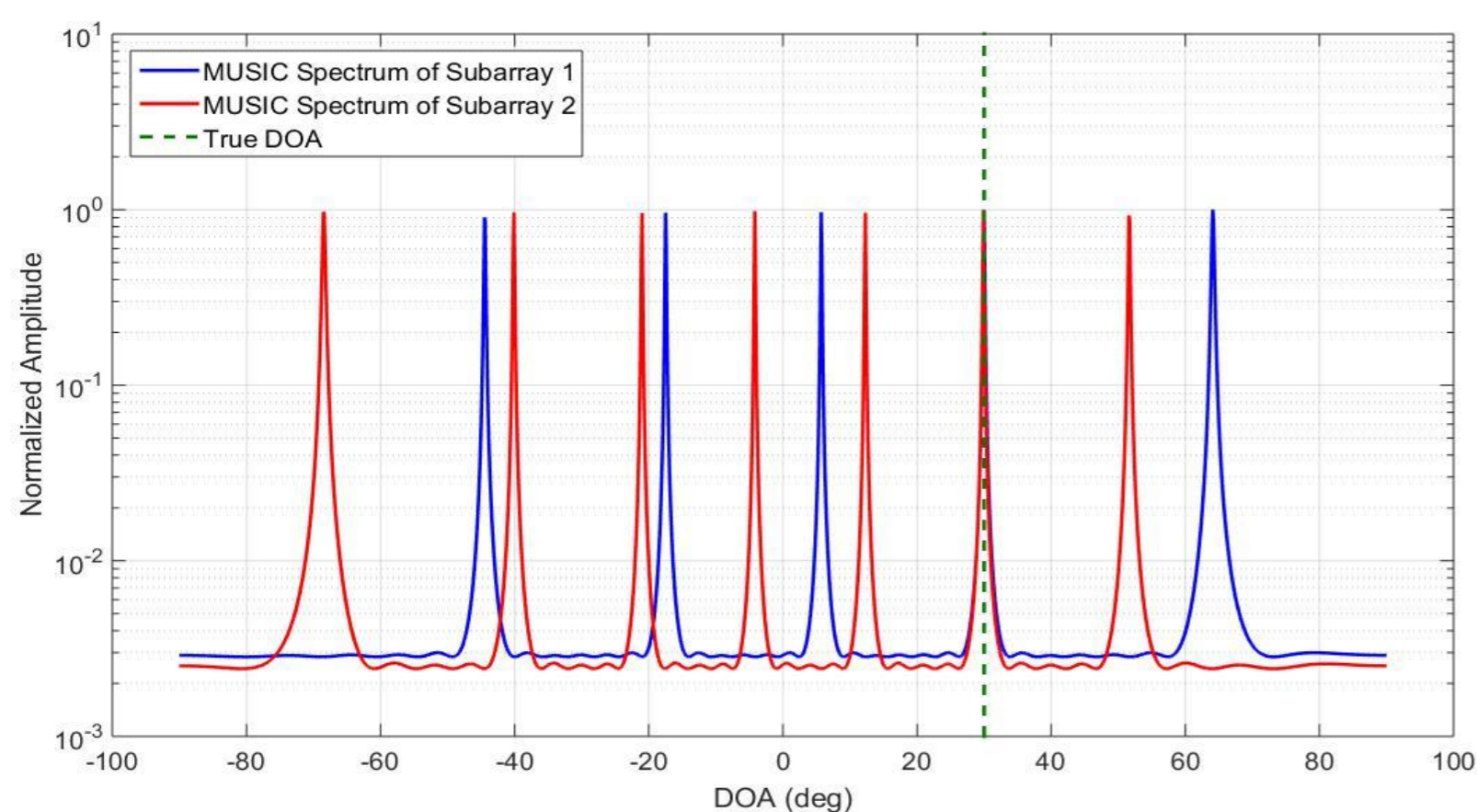
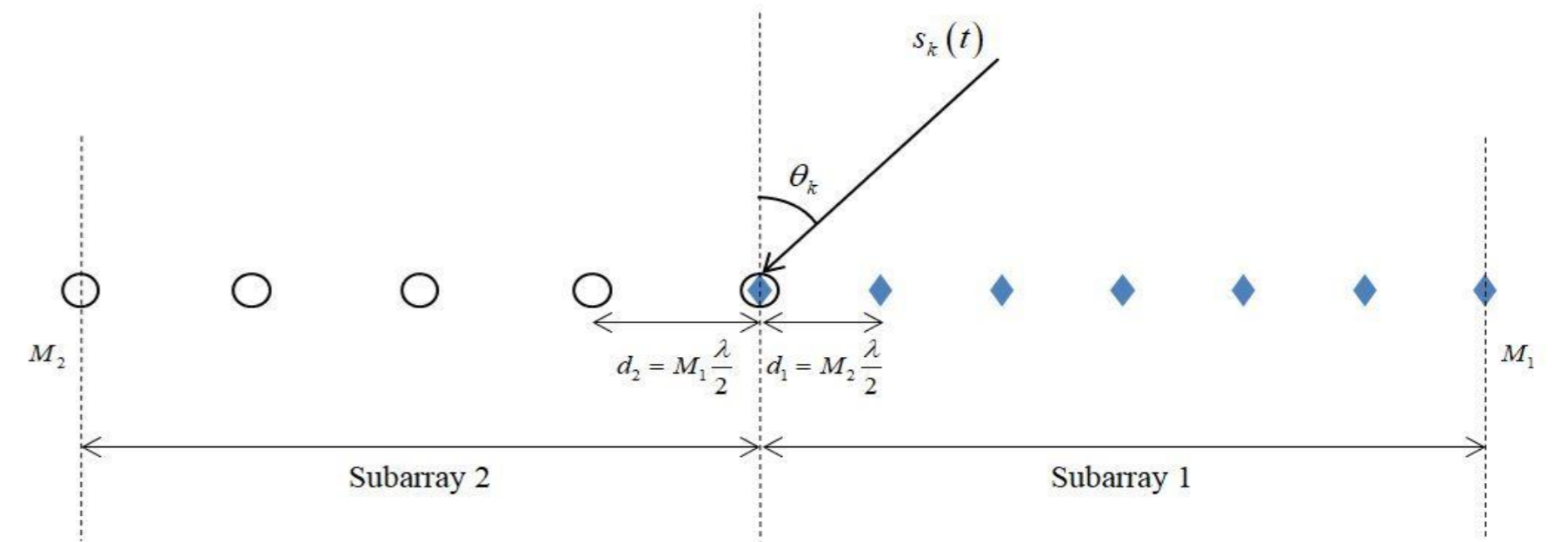
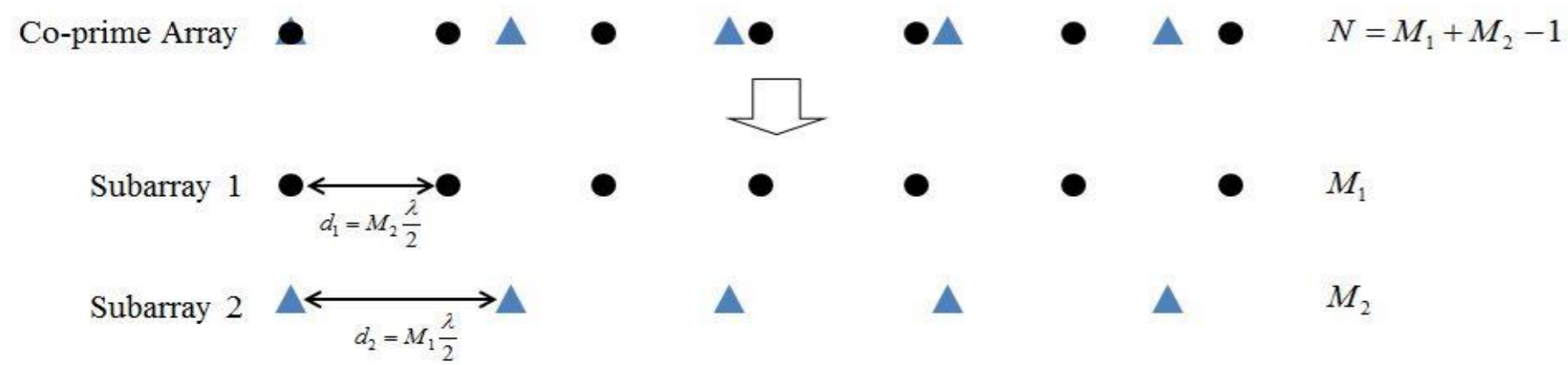
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## General Co-prime Linear Array

## Unfolded Co-prime Linear Array



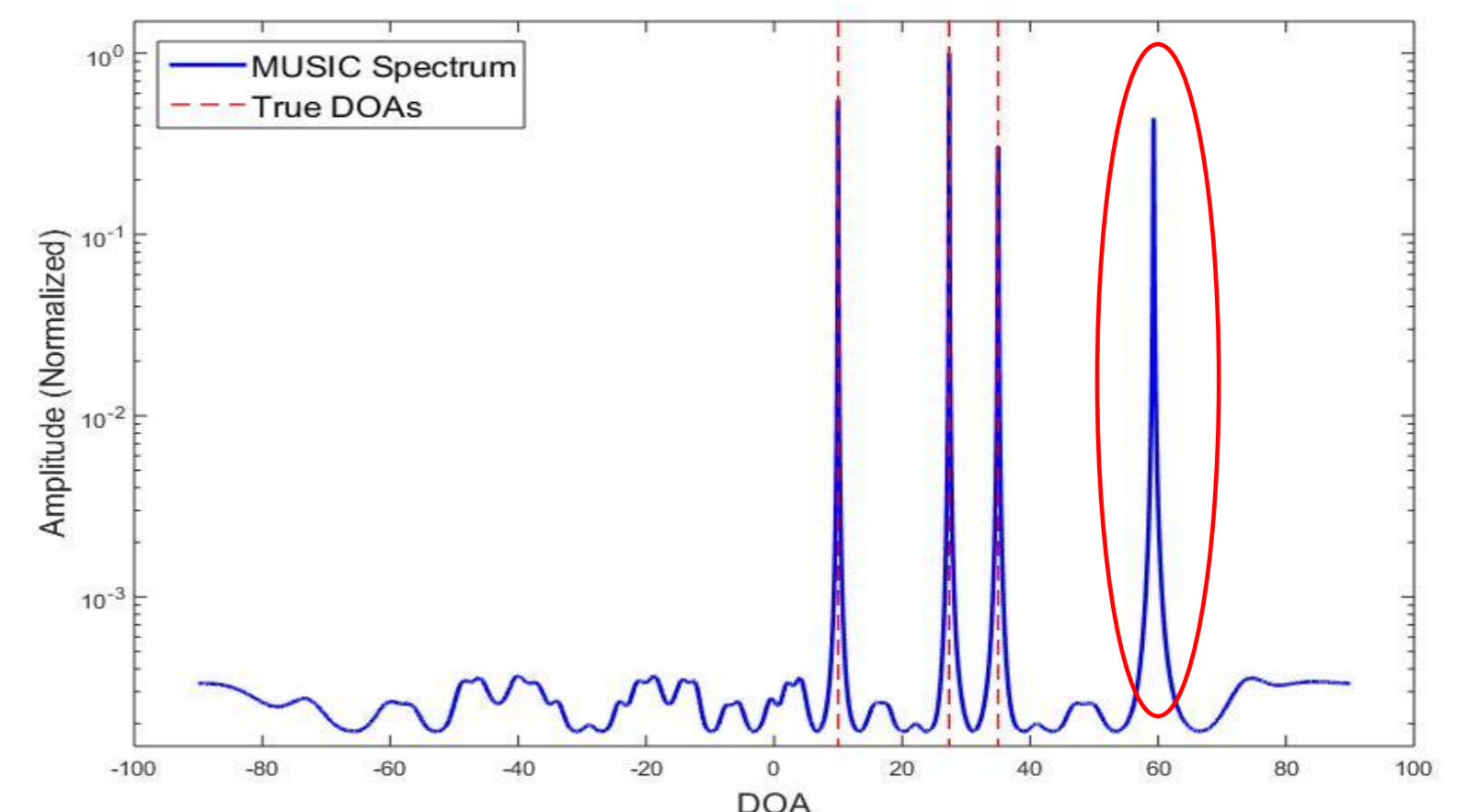
## Ambiguity Problem for Unfolded Co-prime Linear Arrays

Consider there are four signals coming from  $\theta_1, \theta_2, \theta_3$  and  $\theta_4$ , satisfying

$$\begin{cases} \sin\theta_1 = \sin\theta_2 + \frac{2a}{M_1} \\ \sin\theta_1 = \sin\theta_3 + \frac{2b}{M_2} \\ \sin\theta_4 = \sin\theta_2 + \frac{2c}{M_2} \\ \sin\theta_4 = \sin\theta_3 + \frac{2d}{M_1} \end{cases} \Rightarrow \begin{cases} \mathbf{a}_1(\theta_1) = \mathbf{a}_1(\theta_3) \\ \mathbf{a}_2(\theta_1) = \mathbf{a}_2(\theta_2) \\ \mathbf{a}_1(\theta_4) = \mathbf{a}_1(\theta_2) \\ \mathbf{a}_2(\theta_4) = \mathbf{a}_2(\theta_3) \end{cases}$$

$$\mathbf{a}(\theta_1) - \mathbf{a}(\theta_2) - \mathbf{a}(\theta_3) + \mathbf{a}(\theta_4) = \mathbf{0}$$

The directional vector of each one of the four angles can be represented as a linear combination of the directional vectors of the other three, lying in the signal subspace and being orthogonal to the noise subspace, resulting in an ambiguity in the MUSIC spectrum.



## Ambiguity-Solving Method

candidate angles:  $\hat{\theta}_1 \quad \hat{\theta}_2 \quad \hat{\theta}_3 \quad \hat{\theta}_4$

directional vectors:  $\mathbf{a}(\hat{\theta}_1) \quad \mathbf{a}(\hat{\theta}_2) \quad \mathbf{a}(\hat{\theta}_3) \quad \mathbf{a}(\hat{\theta}_4)$

Classical  
Beamforming  
powers:

$$P_{CBF,q} = \frac{\mathbf{a}^H(\hat{\theta}_q) \mathbf{R} \mathbf{a}(\hat{\theta}_q)}{N^2}$$

$\hat{\theta}_q$	$\hat{\theta}_1$	$\hat{\theta}_2$	$\hat{\theta}_3$	$\hat{\theta}_4$
$P_{CBF,q}$	big	big	big	small
True or Ambiguous	true	true	true	ambiguous

