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Source Coherence Modeling Methods for slits imaging

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ABSTRACT We present two source coherence modeling techniques. The first technique is the random screens method which adds random phases to the source complex field and calculates the irradiance. The second method is the plane waves technique. It considers the source as the superposition of plane waves which are propagating in different angles. We compare the irradiance patterns of the double-slits for different amounts of coherences. In addition, the both two methods have the same irradiance pattern for a certain amount of coherence.

1. Geometry Definition

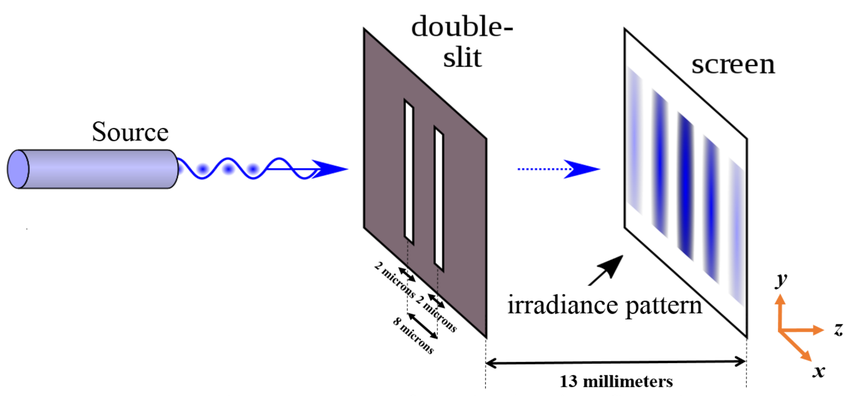

Fig. 1. Geometry of the simulated configuration

Fig1 shows the 3-D view of our simulated configuration (Center to center distance between the slits, slits width and the image plane distance from the double-slit). The source illuminates the Double-slits and the irradiance is calculated on the screen/image plane. The Source wavelength is 405 nm .

2. Complex field and irradiance in the image plane

- The complex field in the image-plane is the fourier transform of complex field in source plane for every single frequency.
- The waves with two different wavelengths do not interfere (in-coherent waves).
- The non-coherent irradiance pattern (it is more clarified in Fig. 2.).

$$I_{image-plane} = \sum_{i=1}^{n} \sum_{j=1}^{m} I(P_i, \lambda_j)$$

m: number of wavelengths corresponding to a point
n: number of points in source plane

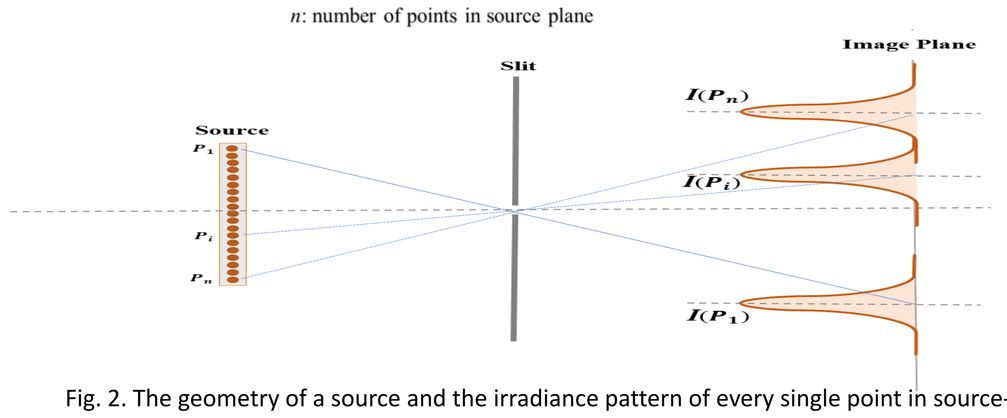

Fig. 2. The geometry of a source and the irradiance pattern of every single point in source-plane

3. Plane waves Method

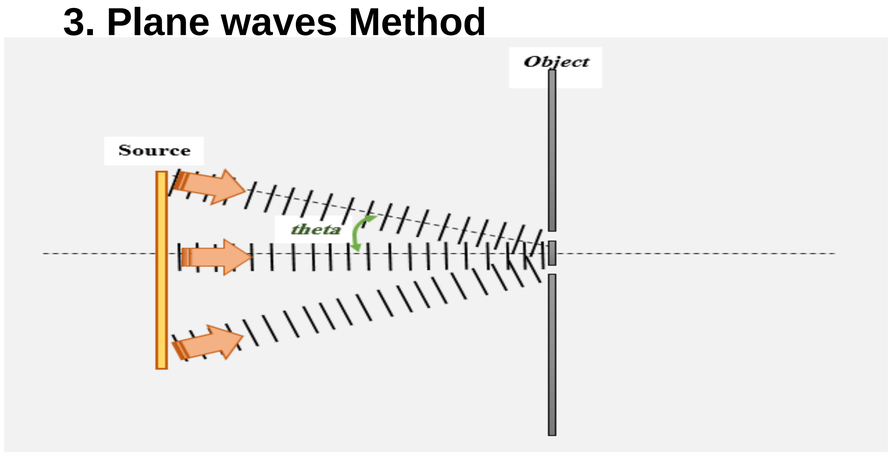

Fig. 3. The geometry of plane waves method

Fig. 3. shows how the plane waves method works. The source is considered as the superposition of plane waves in different angles. The biggest angle is defined as *theta* in Fig 4. This parameter shows the amount of coherency. For bigger angles, the coherency is lower. For near zero angles, the source is much more coherent.

4. Random Screens Method

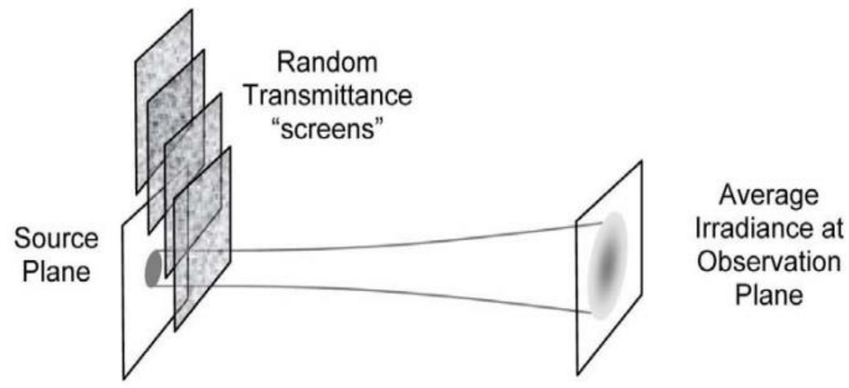

Fig. 4. The geometry of random screens method

Fig. 4. explains the mechanism of random screens method. Random screen phases are multiplied by the complex source field and the irradiance is calculated incoherently. This process is done for a certain number of random screens and the average irradiance is the output.

5. Results

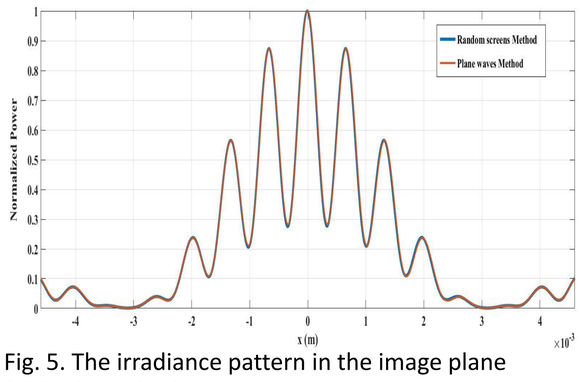

Fig. 5. The irradiance pattern in the image plane for both methods

Fig 5 shows the irradiance pattern in the image plane for both methods. Both simulations were done for the same contrast of 0.78. As the both two methods have the same irradiance patterns for a certain contrast.

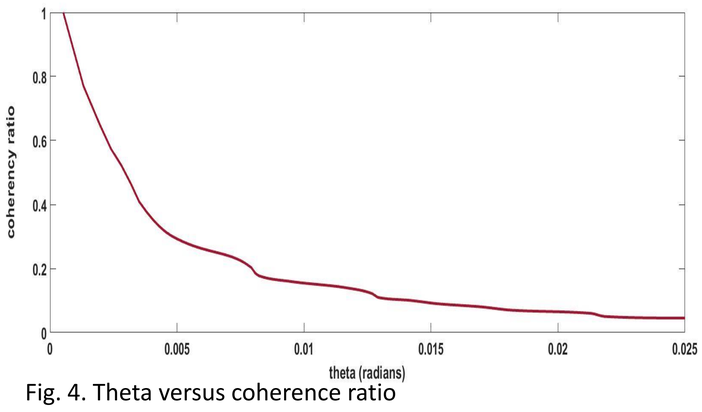

Fig. 4. Theta versus coherence ratio

Fig. 6. demonstrates a relation between the two parameters of these methods. Every 'theta' corresponds to a 'coherency ratio' which both result in the same contrast.

Conclusion

- Two different methods are used to model the source coherency.
- The both method demonstrate the same irradiance pattern for a certain contrast
- Both methods are doing the same job with different procedures

References

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