Reply

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Universal self-similar asymptotic behavior of optical bump spreading in random medium atop incoherent background: reply

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In his comment [Opt. Lett. 45, 3510 (2020)], Charnotskii claims that the cross-spectral densities recently studied in Opt. Lett. 45, 698 (2020) of partially coherent beams atop a statistical background do not satisfy the non-negative definiteness requirement. We argue that Charnotskii's claim stems from his misunderstanding of the non-negative definiteness concept as applied to the model of Opt. Lett. 45, 698 (2020).

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In a recent comment [1], Charnotskii claims that the cross-spectral densities of partially coherent "irradiance bumps" discussed in Ref. [2] fail to satisfy the non-negative definiteness criterion, which is a fundamental requirement of any genuine cross-spectral density [3]. The cross-spectral density of any statistical bump on a partially coherent background reads

$$W(\mathbf{r}_1, \mathbf{r}_2) = \Phi(\mathbf{r}_-) + \Psi(\mathbf{r}_+), \tag{1}$$

where we introduced the difference and center-of-mass coordinates by the equations

$$\mathbf{r}_- = \mathbf{r}_1 - \mathbf{r}_2, \qquad \mathbf{r}_+ = (\mathbf{r}_1 + \mathbf{r}_2)/2. \tag{2}$$

Charnotski claims that the second term on the right-hand side of Eq. (1) is not necessarily non-negative definite.

This is a moot point, though, because it is the non-negative definiteness of the **total** cross-spectral density of the "bump+background" source, i.e., the sum of **both** the "background" **and** "bump" terms on the right-hand side of Eq. (1), that must be non-negative definite for any physical source. Thus, it makes no sense whatsoever to discuss non-negative definiteness of the "irradiance bump" **alone**. In other words, negative values of $\Psi(\mathbf{r}_+)$ can be compensated by high enough positive values of the background $\Phi(\mathbf{r}_-)$. In fact, in our previous work [4], we **explicitly** constructed the cross-spectral density of a source involving either a "bump" or a "dip" on a background that satisfies the non-negative definiteness requirement. Moreover, the beams generated by such sources were experimentally realized in the laboratory [5].

In summary, starting from a misguided premise, the author of Ref. [1] arrives at erroneous conclusions. Therefore, the claim advanced in Ref. [1] is baseless, and all conclusions are irrelevant.

Disclosures. The authors declare no conflicts of interest.

REFERENCES

1. M. Charnotskii, Opt. Lett. **45**, 3510 (2020).
2. X. Li, S. A. Ponomarenko, Z. Xu, F. Wang, Y. Cai, and C. Liang, Opt. Lett. **45**, 698 (2020).
3. L. Mandel and E. Wolf, *Optical Coherence and Quantum Optics* (Cambridge University, 1995).
4. S. A. Ponomarenko, W. Huang, and M. Cada, Opt. Lett. **32**, 2508 (2007).
5. X. Zhu, F. Wang, C. Zhao, Y. Cai, and S. A. Ponomarenko, Opt. Lett. **44**, 2260 (2019).