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A well-known challenge for fabricating metamaterials is to make unit cells significantly smaller than the operating wavelength of light, so one can be sure that effective-medium theories apply. But do they apply? Here we show that nonlocal response in the metal constituents of the metamaterial leads to modified effective parameters for strongly subwavelength unit cells. For infinite hyperbolic metamaterials, nonlocal response gives a very large finite upper bound to the optical density of states that otherwise would diverge. Moreover, for finite hyperbolic metamaterials we show that nonlocal response affects their operation as superlenses, and interestingly that sometimes nonlocal theory predicts the better imaging. Finally, we discuss how to describe metamaterials effectively in quantum optics. Media with loss or gain have associated quantum noise, and the question is whether the effective index is enough to describe this quantum noise effectively. We show that this is true for passive metamaterials, but not for metamaterials where loss is compensated by linear gain. For such loss-compensated metamaterials we present a quantum optical effective medium theory with an effective noise photon distribution as an additional parameter. Interestingly, we find that at the operating frequency, metamaterials with the same effective index but with different amounts of loss compensation can be told apart in quantum optics.

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