Optical and Electronic Fourier Surfaces

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Gratings and holograms are patterned surfaces that tailor optical signals by diffraction. Despite the long history of such structures, variants with remarkable functionalities continue to be discovered. Further advances could exploit Fourier optics, which specifies the surface pattern that generates a desired diffracted output through its Fourier transform. The required surface profile should contain a precise sum of sinusoidal waves, each with a well-defined amplitude, spatial frequency, and phase, to shape the optical wavefront. However, because fabrication techniques typically yield profiles with at most a few depth levels, complex "wavy" surfaces cannot be obtained, limiting the straightforward mathematical design and implementation of sophisticated diffractive optics. In this presentation, we will discuss a simple yet powerful approach to eliminate this design–fabrication mismatch by demonstrating optical surfaces that contain an arbitrary number of specified sinusoids [1]. Multicomponent linear gratings allow precise manipulation of the dispersion, stopbands, and coupling of electromagnetic signals. More broadly, we analytically design and accurately replicate intricate two-dimensional Moiré patterns, quasicrystals, and holograms, demonstrating a variety of previously impossible diffractive surfaces. Finally, we show that such patterns can be reduced to nanometer length scales, creating wavy Fourier surfaces for 2D electronics [2]. Therefore, this approach provides benefit for optical devices and emerging topics in photonics and 2D optoelectronics.

[1] N. Lassaline, R. Brechbühler, S. J. W. Vonk, K. Ridderbeek, M. Spieser, S. Bisig, B. le Feber, F. T. Rabouw, D. J. Norris, *Nature* **582**, 506 (2020).
[2] N. Lassaline, D. Thureja, T. Chervy, D. Petter, P. A. Murthy, A. W. Knoll, D. J. Norris, *Nano Lett.* **21**, 8175 (2021).