亮点报道：高效消色差液晶衍射光学元件

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增强现实 (AR) 和虚拟现实 (VR) 技术正在迅速变革人机交互，推动医疗、游戏、教育和制造等多个领域的发展。要使 AR 和 VR 设备真正具备可穿戴性，关键在于开发出紧凑、轻便且能效高的光学系统。

由美国中佛罗里达大学吴诗聪 (Shin-Tson Wu) 教授和上海交通大学李燕教授共同领导的团队在液晶光子学领域取得了开创性进展，特别是在 AR/VR 显示技术和成像光学方面的应用。研究团队设计了三种专门针对 RGB 颜色的 Pacharatnam-Berry 透镜 (PBLs)，每种 PBL 都具有相同的焦距；开发了窄带 PBLs，每种 PBL 仅对红、绿或蓝光响应；优化了各层的厚度和扭曲角度，实现了对每种波长的精确相位延迟，有效消除了串扰和色差。通过激光投影仪的实验验证，证明了这一设计的有效性，每个窄带 PBL 仅调制其目标颜色。将三种窄带 PBL 堆叠后，RGB 光束被融合成接近完美的白色图像，色差大大减弱。

本研究提出并验证了一种基于多扭曲结构的窄带 Pacharatnam-Berry 相位光学元件 (PBOEs) 新方法，该方法有效消除了色差并实现了高效率的无串扰的消色差 PBOEs，保持了紧凑的形态，展示了高光学效率、低制造复杂度和广泛的设计自由度，对于各种液晶材料和 RGB 光源的 PBOEs 应用具有巨大的潜力。

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Highlights: High-efficiency achromatic liquid crystal diffractive optical elements

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Augmented reality (AR) and virtual reality (VR) technologies have transformed human-digital interaction, unlocking new opportunities in healthcare, gaming, education, and manufacturing.

The research group led by Prof. Shin-Tson Wu at the University of Central Florida is pioneering advancements in liquid crystal photonics, focusing on applications in AR/VR displays and imaging optics. they introduced a transformative solution using a multi-twist structure to address chromatic aberration in liquid crystal polarization-based optics, achieving achromatic Pacharatnam-Berry phase optical elements (PBOEs). The team designed three specialized polarization-based lenses (PBLs) tailored to RGB colors with identical focal lengths, developed narrowband PBLs, and optimized the thickness and twist angles of individual layers to achieve precise phase retardation for each wavelength, effectively eliminating crosstalk and chromatic aberration. Experimental validation using a laser projector confirmed the efficacy of this design, with each narrowband PBL modulating only its target color. By stacking the three narrowband PBLs, they merged RGB beams into a near-perfect white image with minimal residual aberration.

Overall, this innovative multi-twist structure not only enhances compactness, optical efficiency, and fabrication simplicity but also opens new avenues for high-performance solutions in AR/VR displays, imaging systems, and advanced photonics.

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