光学量子计算机实现新突破

近日，中国科学技术大学潘建伟教授的团队公布了其在光学量子计算机方面取得的重大突破。除了实现十光子纠缠，该团队还构建了用于玻色采样的量子模拟机，实现了高效多光子玻色采样。

玻色采样被认为是展示量子优势的一个有效手段，研究人员开发了具有 99%传输率的强大的 9×9 模式多光子干涉仪和基于量子点-微柱的高效率、高纯度和不可区分性的主动解复用单光子源，通过超低损耗的光子电路，实验和验证了三光子、四光子和五光子玻色采样，并分别实现了 4.96 kHz，151 Hz 和 4 Hz 的采样率，速度较此前类似试验快了至少 2.4 万倍。

这是第一台超越早期经典计算机的基于单光子的量子模拟机，为最终实现 “量子霸权”这一目标奠定了坚实的基础。该研究成果于 2017 年 5 月在线发布于《Nature Photonics》上。

Nature Photonics, 2017, **11**: 361–365.
DOI: 10.1038/nphoton.2017.63

基于可拉伸衬底的动态结构色彩显示

传统的彩色显示技术主要基于色彩吸收材料，如染料、色素等，不能满足高分辨显示和成像的要求。随着纳米技术和纳光子学的发展，通过调控人工纳米结构(如超材料和超表面)的结构尺寸可以改变结构所呈现出的色彩，成为显色领域的一种新技术。与传统技术相比，通过结构产生的色彩具有亮度更高、不会褪色的特性，因而在彩色显示、成像技术、防伪技术上具有很大的潜在优势。

近日，《Advanced Optical Materials》中报道了一种色彩动态调控的显示技术。在文章中，聚二甲基环氧烷(PDMS)作为可拉伸衬底被引入到传统的等离子体结构中，以构建动态结构色。通过干涉曝光技术制备出了该结构色样品，并且这种铝-PDMS 复合结构中共振机制所产生的结构色在宏观光学测试中，通过拉伸 PDMS 衬底可获得从绿色到紫红色的变化。此外，结构中的物理机制在文中也得到了近一步分析。这种基于可拉伸衬底的结构色在防伪、生物传感、力学测量方面具有潜在优势。

Advanced Optical Materials, 2017, **5**(9): 1600829.
DOI: 10.1002/adom.201600829.

超透镜实现色散定制

超构表面为衍射光学元件的设计提供了一种新思路。2016 年，哈佛大学的 Capasso 团队成功研究出了基于超表面的可见光波段的平透镜，该成果被列入 Science 杂志的十大突破之一。但是该透镜在同一时刻只能聚焦一种颜色的光波。

2017 年 1 月《Nano Letters》在线报道了该团队进一步的研究成果，展示了一种可在可见光波长范围内使用的消色差超透镜(AML)，它制作简单，只需要一步光刻工艺，*NA*=0.2，并且在 490 nm~550 nm 的连续波段内有恒定焦距。该平透镜由铺在金属镜面上的具有正方形横截面的二氧化钛纳米柱构成，纳米柱和金属镜面之间夹有二氧化硅薄层。为了证明该方法的有效性和可定制性，研究者还设计了一种具有反向色散的超透镜，透镜焦距随波长的增加而增加。

该方法能够用于开发对色散有特定要求的器件，从而在 LED 照明、荧光和光致发光光谱成像等应用中发挥前所未有的作用。

Nano Lett, 2017, **17**(3): 1819–1824.
DOI: 10.1021/acs.nanolett.6b05137.

采用自卷微管的新型光分插复用器

光分插复用器(OADM)是在光域实现支路信号的分插和复用的一种器件，是全光通信网的核心设备。

伊朗设拉子大学的科研人员设计了一种新型的双通道光分插复用器，它由硅直波导和一个 180° 弯曲波导，以及一个沿着管轴向呈抛物线形波纹图案的自卷微管(SRM)组成。SRM 作为双通道 OADM 的关键组件，包括三个部分：一个独立部分和两条腿。中央部分较薄，不与基板接触，而较厚的支脚保持接触。沿着轴向方向靠近 SRM 的直波导作为输入通行端口和分插端口，而 SRM 的独立部分作为谐振器件。

通过耦合模式理论分析 SRM 和波导的垂直配置，当 SRM 和硅波导之间的间隙选择 60 nm 时，性能最佳，信道间隔为 1.6 nm，最小插入损耗为 1.94 dB。

该器件体积小，插入损耗低，适合集成电路，可用于光通信网络的芯级互连技术。相关文章发表在 2017 年 2 月的《Chinese Optics Letters》上。

Chinese Optics Letters, 2017, **15**(2): 022501.
DOI: 10.3788/COL201715.022501.

Quantum computers achieve new breakthroughs

The latest progresses about optical quantum computer were announced by Prof. Pan Jianwei team at University of Science and Technology of China. They have achieved ten photon entanglement, and built a quantum simulator for high-efficiency multiphoton boson sampling.

Bose sampling can be used for demonstrating quantum supremacy. The researchers have developed 9×9 mode multiphoton interferometers with 99% transmission rate and actively demultiplexed single-photon sources based on a quantum dot–micropillar with simultaneously high efficiency, purity and indistinguishability. The three-photon, four-photon and five-photon Bose samples were tested and verified. The sampling rates were 4.96 kHz, 151 Hz and 4 Hz, respectively, which are over 24000 times faster than previous experiments.

This is the first single photon-based quantum photonic machines which are provably faster for the boson-sampling task than the early classical computer, laying a foundation for the "quantum supremacy ".

Nature Photonics, 2017, **11**: 361–365.
DOI: 10.1038/nphoton.2017.63.

Actively tunable structural color rendering with tensile substrate

Traditional strategies for coloration based on selectively absorbing materials like pigment and dye cannot meet the high-resolution display and imaging requirements. With the recent advances in nanotechnology and nanooptics, tailoring the structure parameters of artificially fabricated nanostructures (such as metamaterials and metasurfaces), renders significant benefits for achieving tunable colorations. Compared with other color generation mechanisms, those structural colors are bright and immune to bleach.

Recently, an actively tunable structural color rendering with tensile substrate has been reported in *Advanced Optical Materials*. In this work, the tensile substrate (e.g., polydimethylsiloxane, PDMS) has been introduced into the conventional plasmonic structures to demonstrate the dynamic tunable structural colors. The proposed structure fabricated via interference on PDMS has been experimentally realized, and it shows that resonance-induced colors in the Al-PDMS composite structures can be dynamically tuned from green to fuchsia by stretching the tensile substrate in the macroscopic measurements. Moreover, the further theoretical analysis of the physical mechanism in the proposed structure has been investigated. This devised method has potential applications in anticounterfeiting, biometric sensors and mechanics measurement.

Advanced Optical Materials, 2017, **5**(9): 1600829.
DOI: 10.1002/adom.201600829.

Metalenses with tailored chromatic dispersion

Matesurface has added another dimension to diffractive optics. In 2016, the Capasso team at Harvard University successfully developed a flat lens worked in visible spectrum based on metasurface, which was named among *Science Magazine*'s top discoveries of 2016. But the matelens could only focus one color at a time.

The team reported an achromatic metalens (AML) operating over a continuous bandwidth in the visible in January 2017. The AML requires only a one-step lithography process with $NA = 0.2$ and a constant focal length over a continuous range of wavelengths 490 nm~550 nm.

The building block of the AML consists of a titanium dioxide nanopillar with a square cross-section tiled on a silicon dioxide thin layer above a metallic mirror. With this approach, the researchers also designed a metalens with reverse chromatic dispersion, where the focal length increases as the wavelength increases.

This method can effectively develop new components with desired dispersion in these applications such as imaging under LED illumination, fluorescence.

Nano Lett, 2017, **17**(3): 1819–1824.
DOI: 10.1021/acs.nanolett.6b05137.

Optical add-drop multiplexer with self-rolled-up microtube

Optical add-drop multiplexer (OADM) is a device to add and drop the branch signals in the optical domain , as the core equipment of all optical network.

Researchers at the University of Shiraz, Iran, designed a new a two-channel OADM consisting of an self-rolled-up microtube (SRM) that has a parabolic lobe-like pattern along the tube's axial direction, as well as straight silicon waveguides and a 180° waveguide bend. The SRM includes one free-standing part and two legs. The straight waveguides, which are placed close to the SRM along the axial direction, are introduced as the input-through and add-drop ports, and the free-standing part of SRM acts as a resonator. The vertical configuration of the SRM and waveguides was analyzed for an optimum gap. The OADM has the best performance with the channel spacing of 1.6 nm and the minimum insertion loss value of 1.94 dB.

The new OADM is small in size, low in insertion loss, and suitable for integrated circuits, which can be used for chip-level interconnect technologies for optical networks.

Chinese Optics Letters, 2017, **15**(2): 022501.
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