Optics à la mode – a new way of making, using and understanding optics

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Modern micro and nano fabrication now let us make complex and highly functional optics. Examples include sophisticated metasurfaces and highly programmable and even self-configuring silicon photonic interferometer meshes, with many potential applications in areas such as imaging, sensing and communications. Such systems are, however, quite unlike the previous optics of lenses, mirrors and prisms, so we also need new ways to think about them, physically and mathematically. Fortunately, there is a very powerful new "modal" approach for these and other complex wave systems, one that is both mathematically straightforward and physically directly meaningful. It leads to new fundamental physical laws and limits, gives new understanding of old optics, such as why your mobile phone camera needs thickness and where diffraction limits really come from, correctly counts channels for communication and sensing, and opens new design approaches and classes of optical systems and applications. Programmable circuits based on such ideas can also exploit convenient new architectures, topologies and algorithms that allow simple control and even direct optical solution of difficult problems in real time. The talk will introduce these ideas, showing how these lead to new systems, applications, understanding, and limits in optics and waves generally.