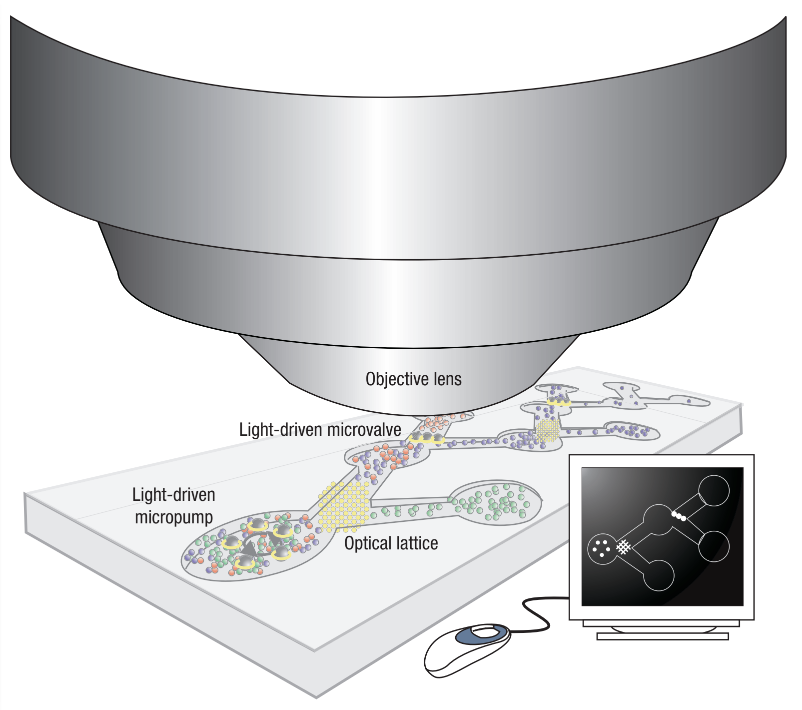

Figure 2 The 'lab-on-a-microscope' concept. Using spatially sculpted light, a user can assemble structures, perform optical fractionation, and control the functionality of light-driven pumps, valves and mixers inside microfluidic channels. These multiple and dynamic functionalities can be controlled simultaneously through a computer interface.

inherent to optical fractionation are the capabilities of cascading multiple lattices, or re-circulating the particle flows for even greater sorting efficiency.

This is not the first attempt at sorting particles optically. Korda and co-workers[5] suggested the use of an array of highly focused optical trap sites to obtain very much the same mechanisms as MacDonald *et al.* Their studies of monodisperse colloidal solutions indicated that particles interacting strongly with multiple optical traps would be pushed to one side by an appropriately tuned array. Particles that interact less strongly should pass through the same trap-array undeflected. However, this approach of so-called kinetically locked-in colloidal transport seems to imply small angles of deflection on dilute flows. A major concern is that particle dwell-time in highly focused trap-arrays will slow particles with respect to the flow, and thereby become an obstacle to true sorting and fractionation. In contrast, MacDonald's fine-tuned and interlinked three-dimensional optical lattice elegantly avoids particle congestion by effectively creating 'surfing ramps' at strong angular deflections to maintain a high throughput in addition to a high sorting efficiency.

Although the present work provides an impressive demonstration of the potential of spatially sculpted light fields for achieving optical fractionation, it is merely one part of a much larger story. By integrating a range of optically assembled, driven, and controlled components onto a single microfluidic chip, all-optical 'lab-on-a-microscope' systems could soon be realized (see Fig. 2). Indeed, most of the individual building blocks required for such a system, including switches, pumps, valves, mixers, sifters, grids and more, have already been demonstrated[6]. Such flexibility can span out to entirely new and emerging scientific and technological fields. Advanced light patterns and properties can be used for the efficient assembling of complex micromachinery[7], and dynamically sculpted light can subsequently be applied for powering and controlling these devices in a fully parallel manner. A key technology in this endeavour is the development of advanced spatial light modulators that can dynamically modify the key properties of light, such as the wavefront phase and polarization, without losses or undesired distortions. Ultimately, interactive and real-time user-configured light patterns[8] in combination with advanced microscopic observation will allow us to spatially align, orient, rotate, switch and control forces simultaneously, acting on many microparticles at once.

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A spectacularly reactive cathode

JOSH THOMAS

Nature Materials **2**, 705–706 (2003).

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