of advanced mass spectrometry imaging to spatially resolve metabolite signatures in tumours can uncover previously unknown nutrient dependencies in cancer.

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Photonics

Twisted system makes nanolasers shine together

Liqin Tang & Zhigang Chen

Ultrathin semiconductor materials that mimic twisted layers of atoms have been used to build synchronized arrays of nanometre-scale lasers. The systems can be configured — and easily reconfigured — to form intricate patterns. **See p.282**

It might seem straightforward to make a bright light source by combining multiple lasers but, in reality, it is tremendously complex. This is because ordinary lasers emit light with several modes — the standing waves that form inside a laser and determine the beam's frequency. These modes can interfere with each other, causing the light to lose the 'coherence' associated with laser emission and making the light's intensity fluctuate. Forcing one laser to operate in a single mode is not easy, and it is even harder for a whole array of lasers. On page 282, Luan *et al.*[1] demonstrate a way of overcoming this challenge by using the remarkable properties of systems known as moiré lattices. The authors' innovative approach enables laser nanoarrays to be synchronized in any pattern, which can be reconfigured on demand.

Moiré lattices are typically formed by stacking two or more layers of materials of single-atom thickness, and then twisting the layers relative to each other. The way in which electrons interact between the layers in this twisted configuration can fundamentally alter the materials' properties and give rise to intriguing new phenomena[2]. Consequently, these materials have opened an arena for exploring quantum phenomena, and for engineering the interactions between light and matter for applications in optoelectronics and photonics[3].

Central to the strong interactions between electrons in moiré materials are their 'flat bands', a name that conveys the fact that the energy of the electrons is constant — or flat — with respect to their momentum[4]. This in turn means that the electrons can be well localized at specific positions in the lattice, which allows them to interact more strongly than they would otherwise. Condensed-matter physicists have long been intrigued by moiré flat bands, because the strong interactions can be used to investigate exotic states of matter. However, these concepts have also had an impact on photonics[5].

The photonic analogue of a moiré material is made up of optical nanostructures that are designed to manipulate light in a way that is reminiscent of an atomic lattice's effect on its electrons. Photonic moiré flat bands give rise to localized states that can help the laser to maintain coherence, a synchronization of the electromagnetic waves' phase (the fraction of the waveform completed at a given point in time).

Luan *et al.* built a photonic moiré system consisting of one thin layer of the semiconductor material indium gallium arsenide phosphide (InGaAsP), which the authors engineered to mimic the pattern of a widely used moiré material called twisted bilayer graphene (Fig. 1). Members of the same research group had previously shown that such a structure could function as a nanolaser when pumped (excited) optically with an external laser[6,7]. Luan *et al.* have now shown that it is possible to build synchronized arrays of such nanolasers to shine together, and that these high-performance arrays can be easily reconfigured and scaled up in size.

The nature of the flat bands in Luan and colleagues' photonic moiré system is such that any combination of flat-band modes is also a localized mode of the superlattice that

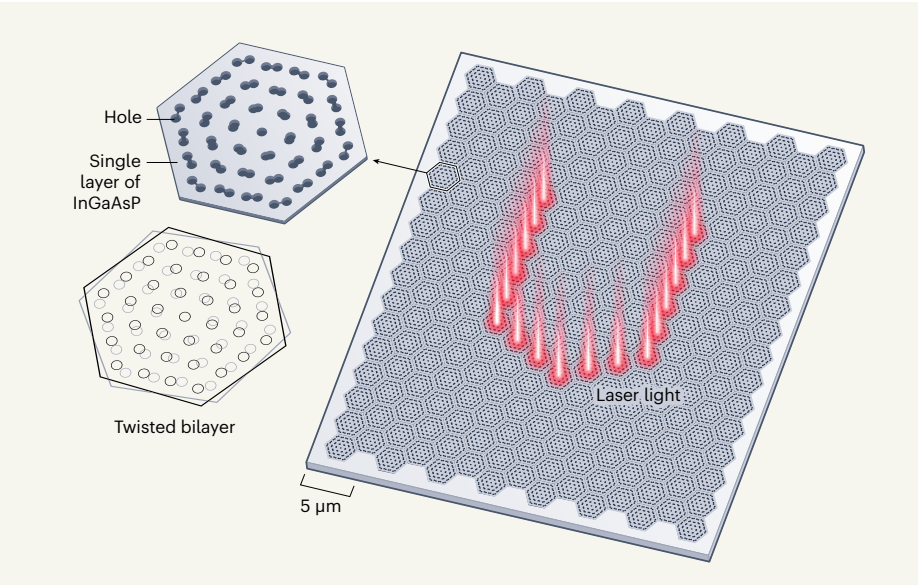

Figure 1 | A reconfigurable nanolaser array. Photonic moiré systems are optical nanostructures that are designed to control light. Luan *et al.*[1] built such a system, which they intended to mimic the structure of an atomic moiré material known as twisted bilayer graphene (shown schematically here as twisted hexagonal lattices). The authors' system comprises a single layer of indium gallium arsenide phosphide (InGaAsP), patterned with holes, and can function as a nanolaser. The authors showed that they could fabricate synchronized arrays of such nanolasers, and that the nanolasers could be configured to form intricate patterns, such as letters of the Roman and Chinese (not shown) alphabets. (Adapted from Fig. S10 of ref. 1.)

makes up the whole nanolaser array. This is the basis for the authors' ability to synchronize the phases of the nanolasers. As they increased the number of nanolasers emitting light with a synchronized phase, the authors found that the directionality of the light emitted was enhanced. The intensity pattern of the pump laser was carefully engineered to enable the nanoarrays to shine in particular patterns, and to ensure that light from individual nanolasers combined constructively.

Luan *et al*. showcased the reconfigurability of their technique by using their nanolaser arrays to form the distinct shapes of letters in the Roman alphabet, such as P, K and U (the abbreviation of Peking University in Beijing, with which the authors are affiliated). They also configured more intricate patterns resembling the Chinese characters for 'China'. The authors demonstrated the scalability of the method by achieving single-mode lasing in a large pattern comprising more than 160 synchronized nanolasers with high-spatial and spectral coherence. All the lasers emitted light with the same frequency and polarization, while maintaining a constant relative phase that maximized directionality and brightness.

The key innovations of Luan and colleagues' work lie in the reconfigurability and scalability of the nanolaser arrays, but the method offers other practical advantages. Existing lasers based on photonic crystal cavities localize light only under stringent conditions, and the flat-band mechanism underlying the authors' approach dispenses with these requirements, offering increased flexibility for both design and fabrication.

It would be preferable to excite the moiré system electrically, instead of using an external pump laser, but this would require carefully designed electrical interfaces and further chemical engineering. Another unresolved issue involves how to make the lasers as robust to defects and perturbations as those that are based on topological principles in photonics[8–12].

Looking forwards, various photonic devices have already profited from the integration of discoveries made by physicists, and by technologies devised in photonics and materials science research. We imagine that Luan and co-workers' ingenious application of moiré flat bands will open an avenue for exploring smaller, smarter and more powerful laser sources, lighting our way towards a brighter future.

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Cancer

Harmful tumour–kidney interactions identified

Pierre Leopold

Fatal renal dysfunction is often associated with tumour development. Fly and mouse data reveal evolutionarily conserved mechanisms that link tumours to renal failure and offer potential for future therapeutic approaches. **See p.425**

Kidney dysfunction or injury is commonly found in people who have cancer, contributing to illness and mortality[1]. Kidney disease can be the consequence of chemotherapy treatments, which in many cases induce toxicity during the elimination of these drugs in the kidney. Alternatively, the tumour can obstruct or compress the urinary tract (tissues including the prostate or bladder), which in turn can drive alterations in kidney function. An intriguing further scenario is now coming to light, with the discovery of tumour-produced molecules that modify host metabolism and organ physiology. On page 425, Xu *et al*.[2] report a study in flies and mice that provides key advances in our understanding of tumour-associated renal dysfunction.

"This finding raises the prospects of new therapeutic opportunities."

A cancer-induced wasting syndrome called cachexia occurs at advanced stages of the disease. It is characterized by a substantial loss of weight, muscle and fat mass — often associated with conditions such as the eating disorder anorexia nervosa — by a lack of energy (asthenia) and by renal failure. No effective treatment is available for cachexia, which is responsible for up to 20% of deaths associated with cancer[3,4]. The reasons for the drastic metabolic switch observed in host tissues are not understood. However, over the years, a direct role for tumours in producing and secreting 'cachectic factors' involved in tumour–host interactions has emerged[5]. Knowledge of the molecular mechanisms of renal dysfunction in cachexia is limited, so progress is needed from studies of animal models.

Lately, fruit flies (*Drosophila melanogaster*) have emerged as a valid biological model for studying tumour-induced metabolic changes[6]. Fly tumours can be induced genetically, both in juveniles (larvae) and in adults. In both cases, metabolic modifications across the body are observed that mimic cancer-induced cachectic syndromes. The powerful genetic tools developed for this model system have enabled the identification of cachectic factors produced by tumours that are responsible for metabolic transformations. Many of these molecules are evolutionarily conserved between flies, mice and humans, raising hope for the development of innovative therapeutic approaches.

Xu and colleagues studied tumours of the adult fly gut (Fig. 1) obtained after expressing an activated form of the evolutionarily conserved transcription factor protein Yorkie–Yap/Taz (the activated form is termed Yki^{3SA}) in intestinal stem cells (ISCs). These tumours induce severe cachectic syndromes associated with an accumulation of abdominal fluid, called bloating, which is a sign of impaired fluid excretion. By blocking expression of genes encoding ligands (proteins that can bind to receptors) in ISC-derived tumours, the authors identified an antidiuretic hormone (one that reduces urine output) called ITP as a potent inducer of tumour-associated bloating. They found that the hormone affects neither tumour growth nor other wasting syndromes.

ITP was previously described as a fly hormone produced by specialized neurons with functions similar to those of the human hormonal systems (vasopressin and