CONSERVATION

Parrot patrol

Understanding the movements of animals can help to focus conservation efforts on key regions of habitat. A standard approach to tracking small animals is to tag them with a tiny radio transmitter and monitor the emitted signals using a hand-held device. But this can prove challenging when following highly mobile animals across difficult terrain.

Writing in *Science Robotics*, Cliff *et al.* report their analysis of the use of autonomous aerial vehicles to track tagged birds (O. M. Cliff *et al. Sci. Robot.* **3**, eaat8409; 2018). They monitored wild swift parrots (*Lathamus discolor*, pictured), an endangered Australian species. The authors report that these drones can estimate birds' positions as rapidly as can humans experienced at using the standard manual-tracking method. **Mary Abraham**

SIMON BENNETT/BIA/MINDEN/GETTY

OPTICAL PHYSICS

Precise control of infrared polarization

A natural material has been discovered that exhibits an extreme optical property known as in-plane hyperbolicity. The finding could lead to infrared optical components that are much smaller than those now available. SEE LETTER P.557

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Hyperbolic materials are highly reflective to light along a certain axis and reflective to light along a perpendicular axis. Typically, one of these axes is in the plane of the material and the other is out of the plane. A material in which both of these axes are in the plane would enable, for example, the manufacture of ultrathin waveplates — optical components that alter the polarization of incident light. Moreover, the reflective behaviour of this material would allow light to be confined and manipulated at extremely small scales (less than one-hundredth the wavelength of the light). On page 557, Ma *et al.*[1] report the existence of such in-plane hyperbolicity in the natural material molybdenum trioxide.

Many crystals exhibit birefringence, in which their refractive index — a measure of the speed of light in a material — is different along different axes. This property can be used to manipulate the polarization of incident light. The crystal size that is required to achieve sufficient polarization control for practical applications is directly proportional to the wavelength of the incident light and to the strength of the birefringence. Consequently, for light in the mid- to far-infrared regions of the electromagnetic spectrum (with wavelengths of 3–300 micrometres), the crystals typically need to be a few millimetres thick[2]. To overcome this requirement, a potential solution is to consider materials that exhibit hyperbolicity, which is an extreme form of birefringence.

Hyperbolicity was originally thought to exist only in artificial materials consisting of integrated reflective and transparent domains[3]. But in 2014, it was observed in the natural material hexagonal boron nitride[4,5]. The reflective behaviour of both this material and molybdenum trioxide is derived from crystal-lattice vibrations, known as optical phonons, that oscillate in a highly anisotropic (direction-dependent) way. These phonons have relatively long lifetimes (in excess of a picosecond; 1 ps is 10^{-12} s), which strongly suppresses the absorption of light by the material[6]. Since the discovery of hyperbolicity in hexagonal boron nitride, a broad array of natural hyperbolic materials has been identified[7].

Preliminary investigations of molybdenum trioxide were reported earlier this year[8] and showed the existence of hyperbolicity for long-wave infrared light (with wavelengths of 8–14 μm). Ma and colleagues have now demonstrated and characterized in-plane hyperbolicity for the same spectral range. They used this property to confine light to dimensions substantially smaller than its wavelength, through the formation of hybrid light–matter excitations called hyperbolic phonon polaritons. The authors report lifetimes for such polaritons of up to 20 ps, which is about ten times longer than the best values reported for hexagonal boron nitride[9].

Because the crystal structure of molybdenum trioxide is highly anisotropic, all three crystal axes, which define the edges of the crystal's unit cell, have different lengths. Consequently, there is a large difference in the phonon energies associated with these axes and therefore in the corresponding refractive indices — resulting in a birefringence of about 0.31. It should be noted that, earlier this year, a similarly large in-plane birefringence of 0.76 was reported in the natural material barium titanium sulfide for mid-infrared to long-wave infrared light[10]. However, hyperbolicity was not observed for this material.

The in-plane hyperbolicity of molybdenum trioxide offers opportunities to replace conventional optical components with ones that are much smaller. In particular, using the large in-plane birefringence of this material (or of barium titanium sulfide), infrared waveplates could be constructed from thin slabs that have