to process quantum information, particularly because of the ease with which these circuits are expected to be scaled up. However, the first observation of coherent oscillations in a Cooper-pair box[7] — a superconducting island connected to a superconducting electrode via a Josephson junction — showed, amongst other things, that these artificial atoms can be quite sensitive to different sources of decoherence, most of which are not fully understood. Alternatives have arisen, however, with new types of Josephson-junction-based artificial atoms with significantly improved coherence times. One such approach is to encode information into photon states, and use superconducting circuits to store and process this information. The field of circuit QED (an analogue of cavity QED in which an artificial atom interacts with a light field confined in an on-chip microwave resonator) is moving in this direction, driven by the possibility of achieving strong field–matter interactions[8]. In this context, 'strong' implies that the coupling strength between the atom and the field can be engineered to be larger than the decay rate of the photon. Exploration of this regime enabled the deterministic creation, manipulation and characterization of arbitrary photon states[4,6,9].

There are numerous possible implications of this experiment for manipulating multiphoton states in circuit-QED architectures. An example is the practical realization of a beam-splitter operation for microwave photons. This is an essential element for linear optical quantum computation protocols (LOQC)[10] and continuous-variable quantum information processing. One of the motivations for implementing LOQC experiments with Josephson circuits is the possibility of achieving strong field–matter interactions: indeed, two-photon interactions require strong nonlinearities at the single-photon level, which are not easily achievable in optical systems. Knill, Laflamme and Milburn[10] provided an alternative based on using measurement and post-selection. The potential to design strong nonlinearities based on Josephson-junction devices may provide a valuable way of creating deterministic two-photon gates. It is also worth emphasizing that a natural extension of the work by Zakka-Bajjani *et al.* would be to generate two-mode squeezing based on parametrically induced interactions, a 'cups and balls' trick where two balls can appear or disappear at the same time in two different cups: this would provide another key element for continuous-variable quantum information processing. ❐

P.–M. Billangeon and Y. Nakamura are in the Macroscopic Quantum Coherence Team, Advanced Science Institute, RIKEN and at the Green Innovation Research Laboratories, NEC Corporation, 34 Miyukigaoka, Tsukuba, 305-8501 Ibaraki, Japan.
e-mail: pierre.billangeon@gmail.com; yasunobu@ce.jp.nec.com

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AERODYNAMICS

Bird's eye view

The majestic flight of birds of prey, wings spread wide and eyes fixed on a potential meal, is indeed a thing of awe. Smaller birds impress with their manoeuvring capabilities: hummingbirds, famously, manage to fly backwards and sideways. But there are other birds that have also mastered hovering flight, with their bodies seemingly suspended in mid air as they rapidly flap their wings.

Jian-Yuan Su and colleagues have now uncovered a phenomenon that makes the feat seem even more remarkable, at least from a mechanics point of view: the most stable point of the bird's motion while hovering is not at its centre of gravity, as might be expected, but at eye level (*Phys. Rev. E* in the press). This does, on second thoughts, make sense, as a bird on the look out for food would benefit from a blur-free view of its environment.

To work out how hovering birds might manage to stabilize their position such that their eyes are at the centre of motion, Su *et al.* studied a passerine known as the Japanese White-eye (*Zosterops japonicus*, pictured). They trained eight


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birds to perform their hovering flight inside a chamber monitored by two high-speed cameras, each recording 1,000 frames per second — fast enough to finely resolve the flapping motion at some 24 Hz.

The recordings reveal that the bird's body swings up and down quite substantially during hovering. During downstroke, the extended wings generate a downward air jet that pushes the bird up, whereas the upstroke, during which the wings are retracted, is aerodynamically inactive; therefore the bird drops under gravity to its original position. (Hummingbirds, by contrast, produce a continuous lift throughout the wingbeat cycle.)

The point of action of the lifting force does not, however, coincide with the centre of mass of the passerine; instead, its position is slightly dorsal. This means that the wing motion causes simultaneously a translational uplift and a rotation of the bird's body. And these two motions turn out to be so finely balanced that the eyes remain nearly stationary — their displacement is less than a tenth of that experienced by the tip of the tail.

As well as using the aerodynamic mechanisms proposed by Su *et al.*, the bird can further stabilize its head and eyes by muscular and skeletal motion. This should enable it not only to keep a level head, but also to maintain its gaze — and keep its eyes on the prize.

ANDREAS TRABESINGER