improve the sensitivity of sensors. Consider diamond spin sensors. Rather than using optical resonances, diamond spin sensing relies on the precision measurement of transitions between resonance states that are associated with a quantum property of electrons: spin. Such sensors can be responsive to various quantities, including magnetic[10] and electric fields[11], temperature[12], pressure[13] and strain[14]. But the sensitivity of these devices — particularly for temperature and strain — is limited by the nature of the ground-state spin wave function of the electrons used in the sensing mechanism[13].

It has been proposed[15] that this problem could be overcome by constructing a hybrid sensor using the same magnetostrictive material as that used by Forstner and colleagues. However, the material would function in exactly the opposite way to that reported by these authors: a strain (or an electric field) would generate a magnetic field, which is sensitively detected by the electron spins, which in turn are read out optically. The resulting diamond hybrid sensor is predicted to be about 1,000 times more sensitive for pressure, force or electric field than diamond spins alone, and would retain excellent spatial resolution.

Hybrid sensors thus seem to be an upcoming theme in sensor technology. An important further step will be to use advances in quantum technology to achieve the limits of accuracy. The resulting quantum hybrid sensors could potentially revolutionize sensor technology in various disciplines, enabling unprecedented opportunities in technology and basic science. ■

Jörg Wrachtrup *and* **Amit Finkler** *are at the Third Institute of Physics, University of Stuttgart, Stuttgart 70569, Germany.*
e-mail: wrachtrup@physik.uni-stuttgart.de

1. Forstner, S. *et al. Adv. Mater.* http://dx.doi.org/10.1002/adma.201401144 (2014).
2. Budker, D. & Romalis, M. *Nature Phys.* **3,** 227–234 (2007).
3. Kotler, S. Akerman, N., Navon, N. Glickman, Y. & Ozeri, R. *Nature* **510,** 376–380 (2014).
4. Kominis, I. K., Kornack, T. W., Allred, J. C. & Romalis, M. V. *Nature* **422,** 596–599 (2003).
5. Lee, S.-K., Sauer, K. L., Seltzer, S. J., Alem, O. & Romalis, V. *Appl. Phys. Lett.* **89,** 214106 (2006).
6. Forstner, S. *et al. Phys. Rev. Lett.* **108,** 120801 (2012).
7. Gavartin, E., Verlot, P. & Kippenberg, T. J. *Nature Nanotechnol.* **7,** 509–514 (2012).
8. Krause, A. G., Winger, M., Blasius, T. D., Lin, Q. & Painter, O. *Nature Photon.* **6,** 768–772 (2012).
9. Bagci, T. *et al. Nature* **507,** 81–85 (2014).
10. Taylor, J. M. *et al. Nature Phys.* **4,** 810–816 (2008).
11. Dolde, F. *et al. Nature Phys.* **7,** 459–463 (2011).
12. Neumann, P. *et al. Nano Lett.* **13,** 2738–2742 (2013).
13. Doherty, M. W. *et al. Phys. Rev. Lett.* **112,** 047601 (2014).
14. Ovartchaiyapong, P., Lee, K. W., Myers, B. A. & Bleszynski Jayich, A. C. *Nature Commun.* **5,** 4429 (2014).
15. Cai, J., Jelezko, F. & Plenio, M. B. *Nature Commun.* **5,** 4065 (2014).

BEHAVIOURAL ECOLOGY

Love thy neighbour

A theoretical model suggests that the cause of female-driven extra-pair mating lies in the spreading of male interests among neighbouring families, creating powerful incentives for male cooperation and concomitant benefits for females.

BEN C. SHELDON & MARC MANGEL

Birds have long served as paragons of contented coupledom, and with apparent justification, given that more than 90% of bird species breed in socially monogamous pairs, with the male and female seemingly cooperating to rear offspring. But appearances can be deceptive. In fact, in the majority of bird species tested — data are available for more than 200 species — a substantial proportion (sometimes exceeding 50%) of offspring are sired by a male other than that providing parental care. A huge, but rather fruitless[1], effort to explain the evolution of female extra-pair mating behaviour in birds has focused on potential genetic benefits to females. Now, writing in *PLoS ONE*, Eliassen and Jørgensen[2] offer an alternative explanation: that extra-pair mating by females creates an incentive for males to cooperate with their neighbours, generating a form of collective good that may be a powerful evolutionary force.

The development in the 1980s of genetic markers to assign parentage revolutionized our understanding of mating patterns in many organisms, but nowhere was the effect greater than in birds[3]. Before this, most birds seemed rather uninteresting from the perspective of sexual selection, because it was expected that social monogamy, reinforced by the need for rapidly growing offspring to receive extensive care from both parents, would limit the extent to which sexual selection could influence fitness (in evolutionary terms, the likelihood of survival and reproductive success). The realization that extra-pair paternity could, in principle, greatly increase the fitness variation among males relative to females, hence creating the potential for strong sexual selection, led to a vigorous interest in testing the causes and consequences of extra-pair copulation

50 Years Ago

'Obituary: Prof. James Franck' — I remember his famous lecture … which gave strong support to Bohr's new theory of the atom. Einstein said to me: "It's so lovely, it makes you cry!" … In 1920 Franck was called to a chair in Göttingen … many honours … have come his way, among them the Nobel Prize in Physics in 1926 jointly with Hertz … Göttingen saw Franck's happiest and most fruitful period … Those happy days ended when Hitler came to power. When the racial laws were announced, Franck published a courageous open letter in which he resigned his chair … He was the most lovable of men because he loved people; kindness shone from his eyes. There must be many beside myself who now feel they have lost one of their best friends.
Lise Meitner
From *Nature* 29 August 1964

100 Years Ago

The Trail of the Sandhill Stag by E. T. Seton; *Wild Game in Zambezia* by R. C. F. Maugham — The first of the books before us aims rather at being a work of art than of natural history … Never since the days of melancholy Jacques was such an outpour of sentiment upon a stricken deer. To those who like this mood the book may be recommended, for it is curiously wrought and daintily embellished … The second book on the list strikes quite another strain … But the list of stores required by two persons for a trip of two months is startling. It almost shakes one's confidence in the author to learn that he cannot go into camp with a friend for two months without a dozen tins each of lobster and salmon, two dozen tins of sausages, and three dozen tins of fruit in syrup.
From *Nature* 27 August 1914