A bit of vibration

Nature Nanotech. **3,** 275–279 (2008)

In 1959, Eiichi Goto proposed that the phase of an excited harmonic oscillator could be used to store and process information, with a phase of 0 or 180° corresponding to a logical '0' or '1' respectively. Although it led to the successful development of computers based on electronic oscillator circuits, Goto's concept was eventually superseded by the advent of faster and more efficient semiconductor-based computers.

Almost 50 years later, Imran Mahboob and Hiroshi Yamaguchi have revisited the idea. However, instead of using an electronically based oscillator they use a mechanical oscillator, consisting of a suspended micrometre-scale GaAs beam. By exploiting the piezoelectric effect to drive, monitor and tune the resonant vibration of this beam (which has a number of gold electrodes patterned on its surface), they show that they can switch the phase of this vibration at will by 180°.

By reducing the size to nanometre scales, the authors suggest that memory cells could be realized that have similar operating speeds at less power compared with conventional silicon electronics.

Constant flow

J. Math. Phys. **49,** 043504 (2008)

Only once, apparently, did Gregorio Ricci-Curbastro publish under the name Ricci. That was in 1900, but the paper — entitled *Méthodes de calcul différentiel absolu et leurs applications*, and co-authored with his former student Tullio Levi-Civita — became the pioneering work on the calculus of tensors, a calculus also used by Albert Einstein in his theory of general relativity.

Ricci-Curbastro's short name stuck, and 'Ricci flow' is the name given to one of the mathematical tools arising from his work. That tool has become known to a wider audience as a central element in Grigori Perelman's proof of the Poincaré conjecture.

Sergiu Vacaru now takes Perelman's work further, going beyond geometrical objects and into the domain of physics with a generalized form of the Ricci-flow theory. In the second paper of a series devoted to these so-called non-holonomic Ricci flows, Vacaru shows how the theory may be applied in tackling physical problems, such as in einsteinian gravity and lagrangian mechanics.

Glue and string

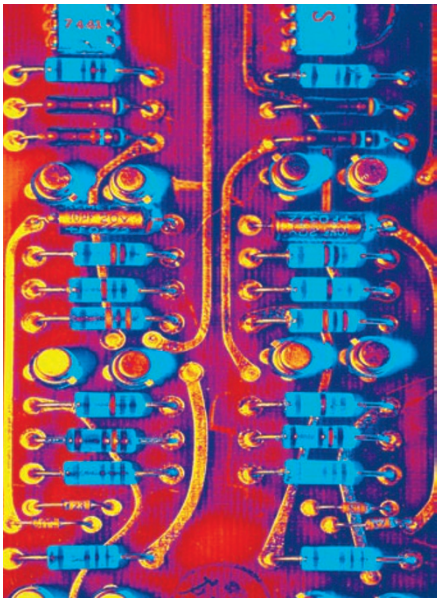
Phys. Rev. D **77,** 086001 (2008)

In quantum chromodynamics, self-coupling between gluons leads to the existence of multi-gluon states, known as glueballs. The lightest glueball should be a scalar state with quantum numbers $J^{PC} = 0^{++}$, and a particle known as the $f_0(1500)$, named for its mass of 1,500 MeV, would seem to fit the bill. Although the $f_0(1500)$ does just about everything a glueball should — such as showing no evidence of coupling to two photons — the proof that it, or any other candidate, is a glueball is not definitive.

Koji Hashimoto and colleagues have tackled the glueball issue using 'holographic QCD' — that is, bringing the AdS/CFT correspondence of string-theory fame into QCD. The correspondence (drawn between gauge and gravity theories) aids the calculations in the tricky mass region occupied by the $f_0(1500)$, to the extent that not only the mass spectrum of glueballs can be worked out, but also the couplings of glueballs to other particles, such as pions.

Hashimoto *et al*. show that, in holographic QCD, the decay of the $f_0(1500)$ to four neutral pions is suppressed, and its coupling to two photons vanishes at first order — all of which ties in with existing experimental data.

The fourth element



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Nature **453,** 76–79 (2008)

Building a resonant electronic circuit? Easy — just connect an inductor, a capacitor and a resistor, and the LCR circuit is ready. But that's not the whole story. In 1971, Leon Chua proposed, based on symmetry arguments, that there should be a fourth fundamental element, one that relates changes in magnetic flux and changes in charge. He named the additional element 'memristor', for 'memory resistor', and demonstrated that it could endow circuits with functionalities that are not achieved using only the other three elements. But, for all the interesting properties memristive systems were predicted to have in theory, a physical realization was missing.

Dimitri Strukov and co-workers have filled that gap. They report a model of a two-terminal electrical device that can behave as a perfect memristor, and show that memristance should appear quite naturally in a range of nanoscale systems. Such insight, they say, explains a number of earlier reported current–voltage anomalies, and could provide the basis for designing improved integrated circuits, for ultradense memories or learning networks, for example.

Quantum transparency

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The fine-structure constant, α, characterizes the strength of the electromagnetic force. Although originally introduced to account for splitting in the spectral lines of hydrogen, it is now considered as fundamental to the behaviour of the Universe as the speed of light or the charge of the electron. One of the most direct ways of measuring the value of the fine-structure constant is using the quantum Hall effect. Rahul Nair and colleagues now describe another, using the optical transmittance of graphene.

The measurement is based on recent predictions that the a.c. conductivity of graphene should be independent of frequency and equal to $e^2/4\hbar$ — a consequence of the relativistic nature of its charge carriers. This implies that the optical transparency of a single layer of graphene should be equal to $1-\pi\alpha$. Visible spectra from a graphene sheet suspended across a perforated metal scaffold confirm this to an accuracy of 0.1%. And, for a multilayer sheet, the authors measure a consistent drop in the transmittance of $\pi\alpha$ (=2.3%) for each additional layer.

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