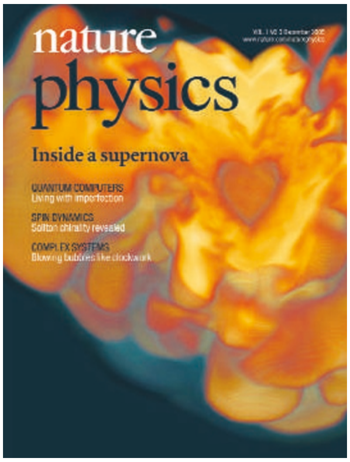


COVER STORY

Vol.1 No.3 December 2005

Supernovae are the most powerful events known in the Universe. Most frequently a supernova results from the core-collapse of a dying star, and the wealth of physics involved in the process presents a huge computational challenge to those who try to model it. In this issue, Stan Woosley and Thomas Janka guide us through gravitational collapse, convective instability, neutrino emission and energy deposition, gamma-ray bursts and rapid neutron capture. Two complicating factors — the rate of rotation of the star and the presence of magnetic fields — are likely to be key factors in determining its death throes as a supernova. **[Review article page 147]**

SOLITON CHIRALITY

Quantum solitons are fundamental excitations that arise in the one-dimensional chains of coupled magnetic ions in a quantum antiferromagnet. The nature of these excitations is believed to have important implications for the behaviour of a wide range of strongly correlated electron systems, including high-temperature superconductors. It has long been suspected that quantum solitons possess a distinct handedness, or chirality — the property of an object that means it cannot be superimposed on its mirror image — but direct evidence for this has proved elusive owing to the complex nature of the systems in which they arise. Using polarized neutron scattering, Hans-Benjamin Braun and colleagues have now unambiguously demonstrated the chiral nature of quantum solitons in the model antiferromagnet $CsCoBr_3$.
[**Letter page 159; News and Views page 143**]

FAULT-TOLERANT QUANTUM COMPUTATION

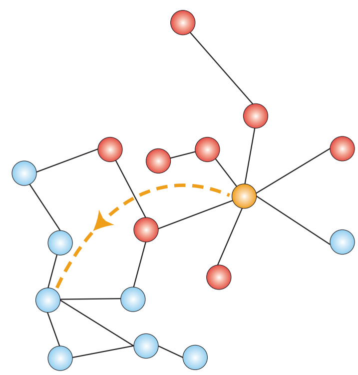
Quantum computers, once built, will have to cope with imperfect components and interfering noise. In principle, however, arbitrarily accurate quantum computation is still possible, as long as the initial errors are below a certain threshold. Jacob Taylor and colleagues present a detailed analysis of the prospects for accurate computation using a specific solid-state system, which is based on electrically controlled electron spins in a semiconducting material. They show that a suitable combination of protection measures should enable the suppression of errors below the critical limit. The strategy involves a careful choice of qubit states and gating operations that are tolerant of errors. The parameters are consistent with the current state-of-the-art, so it seems that practical fault-tolerant quantum computing in this scalable architecture is feasible.
[**Article page 177; News and Views page 145**]

REPETITIVE COMPLEXITY

From weather patterns to stock markets, the study of complex dynamics is one of the most fascinating and important fields of research today. But, owing to the sensitivity of most complex systems to small changes in any of their parameters, obtaining a complete picture of the mechanisms that govern complexity in the real world is close to impossible. So it is perhaps surprising that Piotr Garstecki and colleagues describe the intricate and complex patterns of bubbles that emerge from a microfluidic bubble-generator. More surprising, however, is that in certain regimes of operation, these patterns repeat over and over again, with remarkable fidelity — like clockwork. As well as demonstrating a striking example of rich spatiotemporal behaviour, the authors' microfluidic system provides an ideal model for studying self-organized complexity.
[**Letter page 168; News and Views page 139**]

CHASING COMPUTER VIRUSES

Future strategies against the spread of computer viruses might involve a different scheme of immunization from that of centralized, static distribution of the vaccine. For example, if specific computers in the network could autonomously identify viruses and develop immunizing agents, the antivirus could spread in the same epidemic fashion as the virus itself. However, the vaccine would only be in the slipstream of the virus. Jacob Goldenberg and colleagues propose giving the immunizing agent an advantage by endowing it with a handful of extra network connections that are not available to the virus. They have optimized the required connectivity patterns and simulations indicate that, using this strategy, the vaccine could efficiently immunize computers before they are infected, resulting in the successful containment of cyber-plagues.
[**Article page 184; News and Views page 135**]



A vaccine created in a 'honey-pot' node leap-frogs into uninfected areas to protect the network from a virus.
p184

VIRTUAL STATES MULTIPLY EXCITONS

The discovery that nanocrystals can generate many exciton pairs from each photon they absorb — known as carrier multiplication — could improve the performance of a range of optoelectronic devices, from solar cells to low-threshold lasers. The mechanism has been difficult to pin down, but Richard Schaller and colleagues now propose an explanation. By analysing the temporal dynamics of carrier multiplication in CdSe and PbSe nanocrystals, they found that the process takes place in less than 200 femtoseconds. This indicates that carrier multiplication is instantaneous and direct, and the authors suggest that it involves virtual single-exciton states. Such a mechanism is not expected in bulk semiconductors, but is made possible in nanocrystals by the Coulomb coupling of single- and multi-exciton states, which is enhanced by confinement effects. [**Article page 189**]