100 YEARS AGO

Prof. John Perry has asked me to write something in criticism of the views he has lately expressed about the teaching of mathematics… It is shocking that young people should be addling their brains over mere logical subtleties, trying to understand the proof of one obvious fact in terms of something equally, or, it may be, not quite so obvious, and conceiving a profound dislike for mathematics, when they might be learning geometry, a most important fundamental subject. I hold the view that it is essentially an experimental science, like any other, and should be taught observationally, descriptively and experimentally in the first place… The value of π should be measured; it may be done to a high degree of accuracy. So with the area of the circle, ellipse and all sorts of other things… The boy who really measures and finds it true will have grasped the fact far better than by a logical demonstration without adequate experimental knowledge; for it happens that boys, who are generally very stupid in abstract ideas, learn a demonstration without knowing what it is all about in an intelligent manner.

From *Nature* 4 October 1900.

50 YEARS AGO

As a result of examination of the hands of decomposed cadavers over a long period, it has been noticed that as a rule the muscles and skin of the left hand exhibit signs of greater decomposition than the right. This may be explained by the fact that the muscles, tendons, aponeuroses, etc., are less developed in the left hand than in the right, and would, therefore, less effectively withstand the ravages of the elements. There may be other causes for the more rapid decomposition of the left hand; but it would need confirmation by the examination of the decomposed hands of left-handed persons and of the ambidextrous. Unfortunately, it is difficult to obtain reliable data for this purpose. Since the left hand appears to be more susceptible to change under post-mortem conditions than the right, it was thought that the left hand of a living person might show certain signs indicative of disease, or even the approach of disease. A study of finger prints of persons suffering from certain pathological conditions lends some support to this contention.

From *Nature* 7 October 1950.

co-workers[3,4] found that computer simulations resulted in unexpectedly aggressive transfer of materials from resonances. First, most asteroids and meteorites fell into the Sun, requiring an even larger supply from the asteroid belt to explain the smaller fraction that reaches Earth. Second, transfer timescales were unexpectedly short — just a few million years, incompatible with the tens of millions of years since the meteorites were first exposed to cosmic rays, known as their cosmic-ray exposure age. The amount of cosmic-ray exposure indicates the time that has lapsed since the meteorites were blasted off their parent asteroids. Mysteriously, most of the exposure must have occurred while the meteorite was in transit to the resonance.

Farinella and colleagues[5] then turned to a long-dormant idea involving the effect of asymmetric emission of thermal radiation on the movement of small objects. Essentially, the 'afternoon' side of a rotating body is warmer than the 'morning' side, so the re-radiation of the Sun's heat produces a small net force across its path, causing the asteroid to drift from its original orbit. In addition to this diurnal effect, there is an analogous seasonal asymmetry. This effect was discovered in the mid-1960s by a graduate student, Charles Peterson, who applied it to the control of small spacecraft. Later, Peterson published a paper in *Icarus*[6], which considered a two-step mechanism involving both resonances and asymmetric thermal forces to explain the meteorites' cosmic-ray exposure ages.

Peterson's paper was reviewed by the elderly astronomer Ernst Öpik, who had never forgotten a largely ignored explanation of such thermal forces published by a Russian engineer, I. O. Yarkovsky, in about 1900. Peterson's work on the relevance of the Yarkovsky effect to meteorites also remained unappreciated until its recent resurrection by Farinella. Rather than being ejected directly into resonances, metre-sized fragments from asteroids a long way from the gap can be gradually moved towards resonances, while being exposed to cosmic rays, over tens of millions of years. Such slowly acting Yarkovsky forces, followed by the chaotic ejections from resonances, might together account for cosmic-ray exposure ages and deliver copious meteorites to Earth. But the idea needed quantitative proof. That is what Vokrouhlický and Farinella now provide[1]. Their computer simulations of the Yarkovsky-influenced orbits of tens of millions of asteroidal fragments simultaneously track their collisions — by which the asteroids are fragmented into smaller pieces — while delivering the fragments to the two major resonances for rapid transfer to the Earth. The authors ran simulations for Hebe as well as for two asteroids far from the resonances: the inner-belt asteroid Flora, and Vesta, the putative parent body of the so-called achondritic meteorites.

The combination of Yarkovsky and collisional processes results in a surprisingly high efficiency of about 0.5% for delivery of asteroidal material to Earth, although most still falls into the Sun or ends up elsewhere. The simulated cosmic-ray exposure ages agree with meteoritic measurements. So we finally know that our collected meteorites represent asteroids from throughout the inner half of the main asteroid belt, rather than just a few, specially located bodies. Indeed, there must be many ordinary chondritic asteroids, as meteoriticists always assumed; the spectroscopic mismatch was a red herring, now

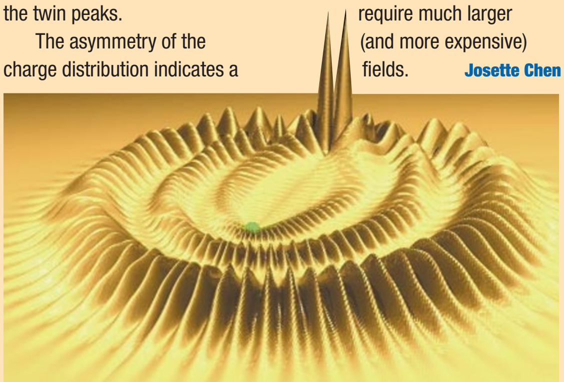
Bose–Einstein condensates

The next big thing

Simple diatomic molecules, such as oxygen (O_2), have a uniform charge distribution and an interatomic distance of a few ångströms (1 Å = 10^{-10} m). In a report in *Physical Review Letters* (**85,** 2458–2461; 2000), Chris Greene and colleagues predict that a vastly different diatomic molecule, Rb_2, could exist in a quantum gas of rubidium atoms — a Bose–Einstein condensate (BEC).

If a rubidium atom with a loosely attached electron forms in a BEC, it could bind with a normal Rb ground state atom, forming an extremely large molecule with an interatomic distance of 500–50,000 Å. The molecule also has a unique charge distribution, shown here, reminiscent of a trilobite fossil. The Rb ion is the green sphere; the other atom is below the twin peaks.

The asymmetry of the charge distribution indicates a large electric dipole. If this unusual molecule can be formed, its dipole will be easily manipulated by small electric fields, unlike normal molecular dipoles, which require much larger (and more expensive) fields. **Josette Chen**



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