degradation via the 4-phosphate is Li^+-insensitive, whereas both steps in degradation via inositol 1-phosphate are equally Li^+-sensitive[24]. The relative rates of $Ins(1,4)P_2$ degradation by these two routes are not known for any intact cells, but it seems probable that variations in this ratio will render signalling more sensitive to Li^+ in some cells than in others.

The point that emerges particularly forcefully from all of these recent findings is that the metabolism of inositol phosphates in stimulated cells is startlingly complex. It is clear that the very simple anion-exchange chromatographic methods that have been widely used for separating various inositol phosphate 'fractions' in recent years are quite unsuitable for analysing the complex mixtures of inositol phosphates present in stimulated cells. At present, the preferred method for more stringent analyses of the inositol metabolites present in stimulated cells is undoubtedly high-pressure liquid chromatography on anion-exchange resins. Three published methods[7,19,25] each have some desirable features, but we can look forward to refinement of such methods and to the development of selective and sensitive assays for individual inositol phosphates. □

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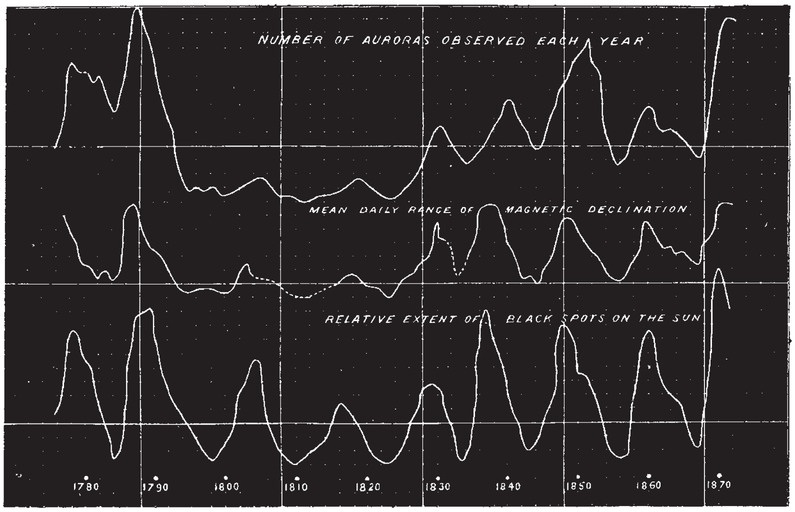
SOLAR SPOTS, MAGNETIC DECLINATION, AND AURORAL DISPLAYS.



Materials science

Limits to Coulomb's law

from Robert W. Cahn

MANY of the scientific laws that the readers of this journal absorbed in their youth are more than a century old and a surprising number go back more than two centuries — but which of them can still claim exact congruence with experimental facts? Some continue in daily use as sound approximations, for example, Boyle's, Hooke's and Ohm's laws, but lose their applicability in specific contexts, such as the behaviour of supercritical steam, 'potty putty' or semiconductor resistivity. Others, such as Newton's laws of motion, remain very close approximations to the behaviour of the real world until extreme conditions (for example, velocities) are attained. On page 203 of this issue, K. Kendall challenges another venerable law — Coulomb's law, formulated in 1773, which describes the frictional behaviour of a bed of power.

According to Coulomb's law, the frictional force between a particle and a smooth plane pressed together by a normal force w is expressed as $f = k + \mu w$, where μ is the friction coefficient and k is a constant representing the intrinsic interaction — the van der Waals' attraction — between the mating surfaces. Coulomb's law has been used for a long time in engineering calculations, particularly in soil mechanics. Kendall now reports on experiments with wet sand confined between two silica plates and finds that the friction coefficient varies substantially, both with normal load and particle size.

The new findings imply that the van der Waals' interaction between, for example, two equal spheres depends on their diameters and on the force pressing them together; this was first established by K.L. Johnson, K. Kendall and A.D. Roberts (*Proc. R. Soc.* A**324**, 301; 1971). If other factors are constant, the friction in a powder bed will rise rapidly as finer particles are used. In view of the widespread use of ultrafine powders in advanced ceramics, this finding has considerable practical importance. As with other named laws, Coulomb's law will presumably remain an adequate approximation under the normal circumstances of coarse powders and soil mechanics, but not under extreme conditions.

Coulomb's law is just one small feature of the varied, untidy but widely useful field of powder mechanics, a term not commonly used, but one that collectively covers dynamics, statics and thermodynamics. Consider some of the ways a powder can behave. When dry and in a still atmosphere, a powder has a 'flowability' that depends on particle mean size, size distribution, mean shape and shape distribution and on intrinsic frictional properties. An assembly of needles may stick obstinately, whereas dry uniformly-sized sand flows easily. The capillary effect of moisture is crucial: common salt needs a hygroscopic additive to keep it free-running; dry powder snow responds to pressure quite differently from wet snow, as any skier knows. If the proportion of water becomes too high, the result may be an avalanche or a quicksand.

A dry powder can be made fluid by blowing air or some other gas through it. Such a 'fluidized' bed has much lower friction than a normal powder bed and resembles a highly mobile liquid. The theory of