of soliton-like bubbles of a new phase, whose lifetime is much longer than the characteristic time in which the heavy ions interact strongly (2×10^{-21} s). Indeed, a width of 2 keV corresponds to a period of 2×10^{-19} s, long enough for the ions to separate by 10^3 fm. Third, if the heavy-ion collisions were to trigger the formation of solitonic regions of a new phase of matter, there should be several such excitations, explaining the multiple peaks seen.

Possible phase diagram for QED in the presence of a strong external electromagnetic field. (O), an order parameter for depending on the external field; α , the electromagnetic coupling constant.

The proponents of a new phase of QED use these arguments, and the Z-independence of the observed signals, to justify their hypothesis on phenomenological grounds¹⁻³. They also adduce the mounting theoretical evidence from comprehensive studies of the Schwinger-Dyson equations¹³ and recent lattice calculations¹⁴, that there is a strong-coupling phase of QED. The latter study, in particular, gives clear indications that QED has a strong-coupling phase, in which chiral symmetry is spontaneously broken by the presence of electron-positron condensates. It seems to me, however, that this is something of a red herring, for in the heavy-ion collisions, the coupling constant α (proportional to the strength of interaction) has the usual QED value $1/137$, whereas close coupling occurs when $\alpha \approx 1$. For the new interpretation of the data to be sensible, there must be an order parameter (O) that depends on the external electromagnetic field, such that a phase transition is also possible at weak coupling, as shown in the figure.

Unfortunately, there are some theoretical indications contrary to this picture. Dagotto and Wyld (preprint) recently studied a compact version of QED in a strong Coulomb field on the lattice and found that the phase transition point, rather than moving towards weaker coupling, moves towards stronger coupling. The strong electric field, apparently, tries to dissociate the electron-positron pairs created, impeding the formation of the condensates responsible for the breaking of chiral symmetry, observed at strong coupling. Solà, Wetterich and I reach

similar conclusions (DESY preprint), in the much simpler case of QED in the presence of a space-time constant electromagnetic field. In this case also, even for very strong fields, no breakdown of QED is apparent. The essential point is that nonlinearities, whose growth could drive a transition to a new phase, occur only through the coupling of the external fields to the photons, via an electron loop. Thus, irrespective of the strength of the fields, one must always pay at least a factor of α . These counterexamples notwithstanding, it seems worthwhile to continue exploring whether other external field configurations can drive QED to a new phase. But the phase diagram shown in the figure is clearly an oversimplification.

Theoretical proof that the heavy-ion phenomena are or are not connected with a new phase of QED is unlikely for some time. But phenomenological observations could clarify the matter sooner. The masses and widths of the observed signals should be an intrinsic property of the soliton bubbles of the new phase and therefore should be independent of detailed characteristics of the collision. The rate of production of the bubbles, however, being connected to the strength of an order parameter, should depend on the charge, velocity and scattering angles of the ions. Furthermore, in general, variations in the signal caused by changing some parameter, like Z, should be correlated with those produced by changing some other parameter.

It is important to obtain clear experimental information on these issues. For instance, using the electromagnetic interaction energy as an order parameter gives a production rate for solitons, multiplied by the heavy-ion collision rate, roughly independent of the ions' charge, scattering angle and velocity. Unfortunately, the data from EPOS and ORANGE are contradictory, the EPOS data being particularly sensitive to velocity but not to the charge and the ORANGE data showing just the opposite. Only when these points are settled, and the Z-independence of all peaks is firmly confirmed, are we likely to know more about the possible existence of a new phase of QED. □

1. Celenza, L.S., Mishra, V.K., Shakin, C.M. & Liu, K.F. *Phys. Rev. Lett.* **57**, 55-57 (1986).
2. Caldi, D.G. & Chodos, A. *Phys. Rev. D* **36**, 2876 (1987).
3. Ng, Y.J. & Kikuchi, Y. *Phys. Rev. D* **36**, 2880 (1987).
4. Schweppe, J. *et al. Phys. Rev. Lett.* **51**, 2261 (1983).
5. Cowan, T. *et al. Phys. Rev. Lett.* **54**, 1761 (1985).
6. Clemente, M. *et al. Phys. Lett.* **B137**, 41 (1984).
7. Tseros, H. *et al. Phys. Lett.* **B162**, 273 (1985).
8. Cowan, T. *et al. Phys. Rev. Lett.* **56**, 444 (1986).
9. Bokemeyer, H., Cowan, T. & Greenberg, J.S. in *Physics of Strong Fields* (ed. Greiner, W.) (Plenum, New York, in the press).
10. Koenig, W. *et al. Z. Phys.* **A328**, 129 (1987).
11. Danzmann, K. *et al. Phys. Rev. Lett.* **59**, 1885 (1987).
12. Riordan, E. *et al. Phys. Rev. Lett.* **59**, 755-758 (1987).
13. Fomin, P., Gusynin, V., Miransky, V. & Sitenko, Yu. *Riv. Nuovo Cim.* **6**, 1 (1983).
14. Kogut, J., Dagotto, E. & Kocic, A. *Phys. Rev. Lett.* **60**, 772 (1988).

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Daedalus

Salt of the earth

LAST week Daedalus outlined his scheme to develop timber-trees that tolerated heavy metals like copper and nickel in their soil, and accumulated them in their wood. This toxic metal-bearing timber would resist attack by insects and fungi, making it an ideal and long-lasting structural material. Daedalus is now contemplating the same sort of approach to the most deadly phyto-toxic metal of them all — sodium.

Salty soil will not support normal plants. Accordingly, every artificial irrigation scheme is threatened by the inevitable traces of salt in its water. The salt slowly accumulates in the soil and destroys its fertility. This sad fate overtook the irrigated land of the earliest Western civilization in Mesopotamia, and lies in wait for many modern farming regions today.

However, some specialized plants, halophytes, flourish in salty conditions. They do not actually concentrate sodium, but can tolerate high concentrations of it in their tissues. The other noteworthy biological relation to sodium is shown by the mould *Streptomyces*, many varieties of which elaborate ionophore antibiotics. These natural polyethers, reminiscent of the synthetic crown ethers, bind firmly to alkali-metal ions (they kill bacteria by stealing their potassium). So Daedalus plans to combine these separate achievements of biochemistry. By transferring genes from *Streptomyces* to suitable halophyte plants, he hopes to develop a range of plants that can extract sodium even from low concentrations in the soil, and accumulate it in the plant's tissues.

Thus the creeping salinity which sabotages all irrigated land will be held at bay. By growing Daedalus's salt-extracting plants on his land, either at intervals in a crop-rotation scheme, or as a permanent component of his usual crop, a farmer will be able to remove the sodium from his soil as fast as it accumulates.

The extractor-plants will have to be harvested and removed from the land with their saline burden, so Daedalus must make them useful. His first idea was to develop salty varieties of edible crops; salted potatoes for potato-crisps, for example. But his neatest and most ambitious idea is to develop a sodium-fixing plant of the oilseed family. On grinding up and cooking such a plant, its sodium should go to sodium carbonate, its oil should hydrolyse to free fatty acids, and the two should combine to give soap! A soap-plant would be a splendid cash-crop, especially for peasant farmers. And its sodium would be soundly disposed of. It would ultimately go down the sewage system into the sea where it belongs.

David Jones