Another possibility is that strong or weak forces—the type that are operative when a pion or muon respectively interact with a proton or neutron—could be the source of the problem. Strong interactions are in fact unlikely to be the culprits, as the theoretical value for the magnetic moment used by the CERN term incorporated a contribution from these forces, and the associated error is less than a half of the experimental one. Weak interactions due to the coupling of a muon to an intermediate boson field could cause either an increase or a reduction in the discrepancy, and this is certainly an avenue for further investigation. On the face of it such contributions are nevertheless likely to be rather small.

What the experiment does achieve is the setting of new limits on the success of quantum electrodynamics, measured in terms of momentum and distance cut-offs. The CERN team, in a communication on the experiment in the December 9 issue of *Physics Letters*, points out that a conventional high momentum cut-off of 5 GeV/c would lead to an absurd situation in the light of the experimental results.

LASERS

Chemical Laser in Action

PUMPING a laser with the energy generated in a chemical reaction is in principle an elegant technique, but in practice suitable reactions have so far been initiated only at the expense of vast amounts of energy for relatively low light output. Such chemical lasers are, however, being developed partly in the hope that an energetically more efficient system will be discovered but also because they furnish unique chemical information about the reaction itself and the properties of the higher energy states of the excited molecules involved.

Chemical laser action was first observed (Kasper and Pimentel, *Phys. Rev. Lett.*, **14**, 352; 1965) from molecules of hydrogen chloride excited by flash photolysis in a mixture of hydrogen and chlorine. Chlorine absorbs the flash radiation and dissociates into chlorine atoms which then react exothermically with hydrogen. The energy released in this process goes into raising the HCl molecules to an excited vibrational state which becomes the upper laser level. Since then, hydrogen halide laser emission has been obtained from a number of systems in which chemical reactions fix the population inversions. The transitions involved are either vibration–rotation or pure rotation transitions and generally fall in the infrared. Output powers are at most tens of watts emitted in short microsecond or so bursts. So far, no continuous wave chemical laser has been made to work because of the difficulties of finding a self-sustaining chemical reaction and of removing reaction products and introducing fresh reactants fast enough for the laser action to continue.

One of the simplest chemical laser systems to interpret is the high gain UF_6–H_2–hydrogen fluoride laser, and in a recent paper (Kompa *et al.*, *J. Chem. Phys.*, **49**, 4257; 1968) scientists at the University of California report their measurement of the rates at which HF molecules are pumped into the first, second and third excited vibrational states and their conclusions about the specific reactions responsible for populating these states. For both this laser and the equivalent deuterium fluoride laser, the emission consists of a series of pulses as consecutive transitions are stimulated and then rapidly quenched. The HF emission is in the *P*-branch from vibrational levels 2 to 1, the *J* values rising during the emission from 3 to 9. Two consecutive DF transition series occur simultaneously, from the third and from the second vibrational levels. By identifying the first transition to each laser threshold and making some assumptions about the operative relaxation mechanisms, the rate constants for the two systems could be estimated. These ratios also indicated that the important exothermic reaction is $F + H_2 \rightarrow HF + H$.

SOLUTIONS

Forces between Uncharged Plates

AN intriguing calculation of the electrical forces to be expected between two uncharged parallel plates immersed in an ionic solution has been carried out by G. M. Bell and S. Levine, of the Imperial College of Science and Technology and the University of Manchester respectively (*J. Chem. Phys.*, **49**, 4584; 1968). The problem itself has evidently much in common with that of calculating the forces between neighbouring colloidal particles in an ionic liquid, but there are also close analogies with problems of liquid crystals and the stability of lamellar crystals containing large proportions of free ionic material.

For convenience, the parallel plates are assumed to be infinitely thick, with low dielectric constant. They are supposed to be immersed in an aqueous solution of a symmetrical binary electrolyte. The forces between the plates arise because of the way in which ions in the solution cause image potentials in the dielectric plates, and because of the way in which the physical distribution of the ions is then rearranged. Because of the symmetrical nature of the electrolyte, there is no mean charge density within the liquid, but the concentration of ions in boundary layers near the two plates will differ from that in the bulk of the liquid, as will the electrostatic potential. Indeed, because the dielectric constant is supposed to be small, the concentration of ions in the interfaces will be less than that in the bulk liquid. This in turn implies that the osmotic pressure near the two plates is less than that in the bulk, which means that there is an attractive force between the plates, at least when their separation is small.

The complete calculation, however, involves a calculation of the free energy of the electrolyte as a whole. The novel contribution of Bell and Levine to this problem is to demonstrate that there is what they call a "cross-effect" represented by a repulsive force between the plates which arises from the effect on the free energy of the system as a whole of the disturbance of each interface layer of electrolyte by the image charges in the other plate. Although this repulsion decays as the cube of the separation between the plates, it is large enough to be the dominating component of force at large distances, which means that the attractive force at small separations is replaced by a repulsion as the distance between the plates is increased. Except for the sign this repulsion at wide separations takes the same form as the Hamaker attraction, with an equivalent Hamaker constant. In an appendix, Bell and Levine gratifyingly prove that the local free energy density and local pressure formalisms they used yield surface tension relations deduced by Buff and Stillinger from a different starting point.