precious piece of the still very spotty mosaic of deep inelastic phenomena.

Finally the impressive results on the (g—p) measurement of the moon performed at CERN (reported by Feldman) and of the e^+e^- annihilation into $\mu^+\mu^-$ coming from the BCF group at Adone (reported by Palmonari (CERN)) reconfirm that Quantum Electrodynamics is alive and well, still holding up in the face of considerably accurate experiments.

The preceding is a very concise survey of the highlights of experimental physics at the Conference. How about theory? It should be said that most of the participants held the view that if these last years have been a bonanza for experimental physics, for theory they have been far less generous. Several attempts like gauge field theories unifying weak and e.m. interactions have received insufficient experimental confirmation, as reviewed by 'tHooft (U. of Utrecht). However Salam (Trieste) describing the newly proposed supergauge theories, conveyed a very optimistic attitude toward the future of these appealing ideas.

The case for the deep connection between the J-ψ's and the charm quantum number, proposed long ago, was passionately made by Cabibbo (U. of Rome). However some puzzling features of the experimental findings of SPEAR and DORIS seem to present serious difficulties for the otherwise appealing "charm" scheme, as discussed by Yamagouchi (U. of Tokyo) and Mathews (Imperial College) who spoke in favour of the alternative represented by "colour" models. The vast panorama of theoretical interpretation of deep inelastic phenomena was reviewed by Preparata (CERN), who stressed the potentiality of the seemingly chaotic picture, stemming from the various theoretical models, turning itself into an accurate description of hadronic matter as seen in very small space-time regions. The status of theoretical understanding of hadronic interactions at high energy and small transverse momenta was summarized by Schwimmer (Weizmann Inst.). Finally Neven (Ecole Normale) discussed the current ideas on "quark confinement", which constitute a serious attempt on the part of today's theoretical physics to resolve the paradoxical quark behaviour.

At the end of the Conference, after the stimulating summary made by A. Zichichi, people left with the distinct feeling of having spent a very rewarding week.

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2nd International Conference on Phonon Scattering in Solids

Nottingham, England, 27-30 August 1975

The Second International Conference on Phonon Scattering in Solids was held at Nottingham University from 27th - 30th August 1975 and was attended by 192 delegates from 15 European and 9 other countries. The interest in this subject has increased steadily in the last few years as new phenomena and new techniques have been discovered. One major aspect of this work is now known as phonon spectroscopy. It is directly analagous to optical or 'photon spectroscopy' (although is of course limited to frequencies below the Debye cut-off) but the selection rules are sufficiently different that many systems that cannot be seen with photons can be studied readily using phonons. The first clear evidence of resonant phonon scattering resulting from transitions between low lying energy levels was seen in 1961 using microwave phonons generated piezoelectrically — a technique now known as acoustic paramagnetic resonance — and shortly afterwards using thermal phonons in thermal conductivity experiments. It then soon became clear that phonon spectroscopy was going to be a valuable addition to techniques for investigating systems with energy level separations in the frequency range up to a few THz, that is the far infra-red range and below of optical spectroscopy.

The thermal conductivity technique despite its very modest resolution is still in common use because of its ability to observe resonances over a very wide frequency range ($\sim 10^9$ - 10^{12}Hz). In magnetic and electric fields or on application of stress, it can be used to obtain information on the movement of levels with field or lattice coupling constants and if the levels are moved until two levels cross or until two pairs of levels are equally spaced (frequency crossing) spectroscopic information can be achieved with a resolution of better than 1 %. The use of thermal phonons has been further extended by using heat pulses and time of flight techniques to separate different polarizations. A number of other powerful techniques have also been developed. In one of these, the phonons are generated by biasing a superconducting tunnel junction evapored on to the dielectric sample. The electrons injected across the junction lose energy by emitting phonons, and by modulating the bias voltage 'monochromatic' phonons can be selected from the emission spectrum. This technique can be very sensitive and has a resolution of $\gtrsim$ 1 %. Selective quantum detectors have also been developed using magnetic energy levels, stress, dependent levels and tunnel junctions. Also the piezoelectric technique has been extended to above 1 THz using far infra-red lasers. These techniques have been used in spectroscopic studies of magnetic ions, localised electrons and holes in semiconductors, two level systems in amorphous materials, molecular defects and so on. But their application is very much wider than spectroscopy and includes investigations of phonon transmission across interfaces (the Kapitza problem), phonon echoes, cooperative and critical effects, liquid helium, superconductors, anharmonic effects and many others.

The Nottingham conference followed conferences in Paris and St Maxime in 1972 organized by Albany and by Zylberstejn respectively. It was clear that the subject had advanced considerably in these three years. The Kapitza conductance problem was one area discussed with great enthusiasm. It now seems very likely that the transmission of phonons across interfaces between any two materials can be accounted for by classical acoustic theory at frequencies below $\sim$ 1 GHz. But at higher frequencies, $\sim$ 10 GHz and above, although the theory still works well for most interfaces, for some, in which one of the materials is gaseous, liquid or solid helium or solid hydrogen, it very badly underestimates the transmission observed. In one paper measurements using monochromatic phonons, and so providing much better resolution than earlier work using thermal phonons, showed the presence of a rapid decrease in phonon reflectivity between 20 and 50 GHz as the frequency was increased. In another paper it was shown that some phonons ($\sim$ 10 % at 1 K) do propagate through the interface with conservation of the parallel component of wave vector but the major fraction of the phonons are scattered at the interface. This now seems a rather general result as it has been found for several solids. Attention is now being focussed on the interface states which cause this scattering. From reflection measurements off surfaces covered with a few atomic layers of helium it seems that these states are localised within $\sim$ 3 atomic layers of the solid surface. Several suggestions were tentatively put forward. These included tunnelling states, surface waves, surfons, low energy rotons and desorbed atoms. It is also becoming clear that in metals the conduction electrons play a role in the Kapitza processes.

There has also been considerable activity and real progress in the study of amorphous systems. Work using both thermal phonons and ultrasonics was described. A large part of the strong phonon attenuation in glass is believed to be due to the presence of 'impurities' with two energy levels — two because the attenuation can be saturated at high intensities. One of the papers described a double pulse technique to determine the lifetime of the excited state and also the strong broadening of this level which, it is suggested, arises from interactions between the 'impurities'. The possible nature of this interaction and of the cooperative state that it might lead to at low temperatures were discussed in a theoretical paper.

The largest section of the conference was concerned with phonon spectroscopy of magnetic ions. The magnetic ions detected most readily are of particular interest both because they are very likely to be Jahn-Teller ions — and the theories of these ions are still undergoing improvements — and secondly because they are very sensitive to static strain. Because of these two complications a detailed picture of some of the ions is still far from complete. For example much has still to be learned about the chromous ion despite the fact that it has been studied for more than a decade now and there were five papers on this ion at the conference. Other ions such as Ni^{3+} and V^{3+} seem more tractable although even here some problems remain. Localised electrons and holes in semiconductors also received much attention. Localised electrons seem to be moderately well understood but a number of papers on localised holes indicated that there are still interesting problems here. In principle the ground state is simple — Γ_8 quartet — but there is considerable debate as to whether the data from a variety of techniques are consistent with this. At higher dopings the papers included one showing intriguing changes in the velocity of propagation of heat pulses in p-Insb and others in which X-ray techniques have been used to observe the spectral distribution of phonons produced by piezoelectric amplification. These experiments reveal the high frequency cut off in the acousto-electric coupling when the phonon wave vector is greater than twice the reflection wave vector. The work on metals and semimetals included a report of the first observation of quantum oscillations using heat pulses.

Phonon scattering studies were also reported of phase transitions in co-operative systems in which the interaction between localised oscillators is carried by phonons. One example of such a system is the Jahn-Teller material $TmVO_4$ in which ultrasonic attenuation has been used to study the phase transition and also to observe the effect of random strains on the wave functions of the thulium ions. Another type of cooperative system in which the phonons carry the interaction is the hydrogen bonded ferroelectric KDP. An investigation of this system was reported using the phonon-echo technique which allowed measurements to be made using a powdered sample and in the frequency range 50 - 100MHz.

Among the technical advances reported were the generation of phonons above 1 THz using relaxation phonons from aluminium tunnel junctions and even higher (2.5 THz) frequencies were obtained by shining an infra-red laser on to a quartz crystal. The storage of phonon holograms by spatially varying trapped charge distributions was reported. The hologram is imprinted using the non-linearity of the ionisation of trapped electrons. Two, time separated, phonon pulses are injected into the crystal to produce the hologram and it can be read out by applying a third pulse. Applications of this technique to phonon studies, such as signal averaging, and attenuation measurements at very high frequencies were discussed.

The conference had an atmosphere of keen interest and this field seems likely to be an exciting one for several years to come. The Proceedings are to be published shortly by Plenum Press.

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