evolving, and the meeting itself was the first of its kind in the field of NNM. The meeting did agree that four experts, drawn from among the participants of the meeting, would work out the required draft outline of the national programme on NNM and submit it to DST.

In the background of major developments in the area of parallel computing, the neural network approach has much to offer as it is an inherently parallel approach to problem solving. Neural network-based algorithms could contribute significantly to application areas like picture processing, VLSI design and constrained optimization. In fact, realizing the importance of this work, the European Economic Community (EEC) has launched a programme called BRAIN (Basic Research in Adaptive Intelligence and Neuro Computing) to promote cooperation among researchers in mathematics, computer science, biology and condensed matter physics interested in neural networks.

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Esoteric physics and delicate experiments

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Quantum mechanics is now more than sixty years old. It is a strange theory. Despite tremendous empirical success covering a wide range of areas from nuclear reactors to liquid helium, worrying doubts continue to persist about its intriguing interpretational aspects. For the last sixty years physicists have been busy examining if this weird theory can interpret all the facts emerging from a comprehensive probing of the atomic and subatomic world. Now that the working rules have been vindicated to a great extent, physicists have become more concerned with the conceptual problems. The proliferation of literature and conferences on this topic reflect this new mood.

In recent years there has been a resurgence of interest in this subject owing to the emerging interface between experimental studies and foundational problems. Thanks to technological advances it is now possible to perform some incredibly delicate experiments seeking to probe recondite conceptual issues. An impressive testimony to this is that the Central Research Laboratory of Hitachi, Japan, in collaboration with the Physical Society of Japan, organize, once in three years, an International Symposium on Foundations of Quantum Mechanics*.

In the words of Y. Takeda, director of the Central Research Laboratory, Hitachi: 'Like the Renaissance, going back to basics must be the driving force towards the next significant step. This is why it is inevitably valuable for physicists, mathematicians and industrial researchers to get together and discuss their dreams and problems. . . . It is now time for industry to return a great favour to quantum mechanics, hoping for its further advancement.' In fact, this series of ISQM were motivated by Akira Tonomura's fascinating experiment performed at the Hitachi Laboratory to unambiguously prove a striking quantum-mechanical effect (known as the Aharonov–Bohm effect) that produces a physically observable quantum effect (due to vector potential) on charged particles in a magnetic field-free region. Tonomura used electron holography and a toroidal magnet of micron dimension.

The interplay between quantum mechanics and technology is a two-way process. From the perspective of technology, the microfabrication technique has reached the stage where one really needs quantum mechanics to design, for example, integrated circuits on a scale approaching microscopic dimensions, or superconducting transistors using the overlap of Cooper-pair wave functions penetrating into a semiconductor substrate. Similarly, reduction of noise, for instance, in the case of superconducting quantum interference devices (SQUIDs) has reached the level where one needs to be concerned with quantum-mechanical zero-point fluctuations instead of ordinary thermal noise.

From the perspective of quantum mechanics developments in fields like electron holography, neutron interferometry and quantum optics have enabled realization of many 'thought experiments' conceived to discover new facets of quantum theory. For instance, H. Rauch (Wien, Austria) reported results of some fascinating experiments performed with neutron interferometry. To quote Rauch himself, 'Particle and wave properties appear simultaneously if a partially absorbing neutron detector is inserted to obtain a certain degree of beam path detection, although the interference pattern remains visible up to a surprisingly high degree.' This raises thought-provoking issues related to the uncertainty relations for unsharp particle-wave behaviour and their interpretation in terms of quantum-mechanical measurement theory.

Magnetic flux quanta (fluxons) are important in both fundamental and applied superconductivity. Until recently, a fluxon was too small to be observed. Akira Tonomura reported the first observation of magnetic lines of force of a single fluxon using electron interference. He also indicated some tantalizing future prospects of the electron holography technique. A. Garuccio (Bari, Italy) emphasized that the experiments related to the Einstein–Podolsky–Rosen (EPR) paradox using correlated photons have not yet provided an unambiguous verdict on the much-debated question of quantum mechanics versus local realism, owing to low efficiency of the photomultiplier detectors for visible photons, which is at most about 20%. He discussed the plan for a new type of experiment on the EPR paradox where one can vary the correlation between two photons in an EPR state by varying the magnetic field at the

*The Third International Symposium on Foundations of Quantum Mechanics (ISQM—Tokyo '89) was held in Tokyo, 28–31 August 1989.

source emitting those photons. This experiment, when completed, would be a valuable complement to other experiments critically testing the non-local aspects of quantum theory manifested in the apparently bizarre correlation between two non-interacting and spatially separated particles in the EPR-type examples. There was thorough discussion of how to circumvent the difficulties in providing clear-cut tests on this issue. Developments were reported concerning avalanche photodiodes (solid-state detectors for photons), which have achieved efficiency as high as 50%. This effort looks promising. The efficiency needed is of the order of 70–80%. A new twist to the EPR paradox in the presence of CP violation was discussed by D. Home (Bose Institute, Calcutta, India). This was an elaboration of earlier work by A. Datta, D. Home and A. Raychaudhuri pointing out the possibility of quantum non-local effect at the statistical level. An attempt was made to clarify some of the controversial elements in that work, and subtleties involved in the use of 'non-orthodox' measurements involving physically observable non-orthogonal states in the EPR context were analysed. Animated discussion following this talk revealed that the issue of compatibility of such quantum non-local effects with the basic principles of special theory of relativity merits more careful scrutiny. The possibility of carrying out experiments along the lines suggested by Datta *et al.* was also discussed.

M. Peshkin (Argonne National Laboratory, USA) outlined new ideas for measuring the neutron electric dipole moment by using neutron interferometry techniques. A non-zero value for the neutron electric dipole moment, if experimentally proved, would signify a sensitive measure of time-reversal asymmetry. Aharonov and Casher had recently predicted an interesting quantum-mechanical effect in which neutral particles having magnetic dipole moment diffract around a line of electric charge and pick up an additional phase shift in the quantum-mechanical wave function. Experimental verification of this prediction was reported by A. Cimmino and his group at the School of Physics, University of Melbourne, Australia. The significance of this effect in terms of gauge symmetry was expounded by J. Anandan (University of South Carolina, USA). There were also several review talks on the topological aspects of quantum theory (including one from E. C. G. Sudarshan), the quantum measurement problem, Bell's theorem, and quantum effects in single-photon and single-atom experiments. The present status of experimental studies purporting to demonstrate macroscopic quantum coherence effects (related to the 'Schrödinger's cat paradox') was reviewed. Van Wees (Delft University of Technology, The Netherlands) discussed the implications of the recent discovery of the quantized conductance of point contacts in the absence of a magnetic field. There were also reports on interesting new effects in random networks of very small Josephson junctions and their quantum-mechanical explanation.

In a session on quantum cosmology J. B. Hartle (University of California, Santa Barbara, USA) advocated the point of view that resolutions of the problems of interpretations presented by quantum mechanics are not to be accomplished by further scrutiny of the subject as it applies to reproducible laboratory situations, but rather through an examination of the origin of the universe and its subsequent history. S. Wada (University of Tokyo) analysed the conceptual ramifications, albeit controversial, of certain interesting characteristics of the wave function of the universe in the inflationary cosmological scenario. A special session included stimulating talks by the celebrated physicist John Wheeler and Nobel laureates W. E. Lamb, L. Esaki and C. N. Yang. Yang traced with historical detail the genesis of Maxwell's equations and the key role played by the concept of vector potential. In a separate presentation Yang outlined his own ideas on the theory of high-temperature superconductivity. Lamb presented his analysis of the theoretical understanding of the hotly debated, so-called 'cold fusion' experiments.

The proceedings of this conference should be of interest to anyone for whom physics is more than just a set of calculational recipes. It would contain brain food for a wide spectrum, ranging from the formal theorist, through hardcore experimenter, all the way to the artistically minded one searching for new concepts in our understanding of the mysteries of physical phenomena. After attending the conference one feels uneasy, and wonders how such a conceptually problematic theory as quantum mechanics can achieve such spectacular success. That is a puzzle whose answer lies hidden somewhere in the future.

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