on the masses of the two stars. The 'best fit' for the masses seems, according to the authors, to be $(1.39 \pm 0.15)M_\odot$ and $(1.44 \pm 0.15)M_\odot$. The observed periastron shift $\dot{\omega} = 4.226 \pm 0.002$ deg/yr can then be explained entirely as the general relativistic effect. Since the stars are compact (most probably neutron) stars, the tidal effects are not going to be important. It may be remarked that since some of the orbital parameters had not been known before, Hulse and Taylor (op cit) could not argue whether the observed $\dot{\omega}$ was explained by general relativity.

Another interesting aspect of these observations is the rate of decrease of orbital period: $\dot{P}_b = -(8.64 \pm 0.02) \times 10^{-12}$. Why should the period decrease? The reason provided by general relativity is that a binary star system has changing quadrupole moment and hence radiates energy. Because of this, the orbit changes and the period decreases. The authors point out that the observed result is consistent with this interpretation. They also mention that theories of gravity which predict dipole gravitational radiation are in disagreement with the observations. They also rule out Rosen's suggestion that gravitational waves are time-symmetric and do not transport energy.

Finally, the authors point out another test of general relativity, namely, the spin orbit coupling, which should cause the pulsar spin axis to precess at a rate of ~ 1 deg/yr. The pulsar shows a double-peaked pulse shape, which is probably caused by the rotation through our line of sight of a hollow cone of beamed emission. As the spin axis precesses, we should expect to see different sections through the radiation beam, probably accompanied by changes in pulse width and/or shape. Such an effect has been seen, although a quantitative estimate of the result cannot yet be made.

It is remarkable that a single object should combine so many different tests of general selativity. Whether 'no other' interpretation of these observations is viable still remains to be carefully investigated. Nevertheless, the ease with which general 'relativity can account for the data will go a long way towards boosting confidence in the theory. These observations also indicate that thanks to radical improvements in technology the 'weakness" of gravity need no longer pose a major obstacle towards testing theories of this type.

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REPORT ON EINSTEIN CENTENARY SYMPOSIUM AT AHMEDABAD

Einstein Centenary Symposium which was held in Ahmedabad from 29th January—3rd February, 1979, sponsored by Physical Research Laboratory, Space Applications Centre, Gujarat University, Ahmedabad, Tata Institute of Fundamental Research, Bombay, Raman Research Institute and the Indian Institute of Science, Bangalore along with the Indian Association for General Relativity and Gravitation, was a great success with over two hundred participants amongst whom fifteen were from abroad. The Symposium in a way reflected the true spirit of Einstein's own concept of unity of nature by bringing in scholars in different aspects of Physics like Relativity, Astrophysics, field theory and foundations of Quantum Mechanics and Statistical Mechanics, fields in which Einstein's contributions have been fundamental.

Prof. J. V. Narlikar in his inaugural lecture spoke on the philosophical foundations of Einstein's theories particularly of Relativity. He emphasized on the creative genius of Einstein and on his process of thinking. After briefly indicating the ideas of special relativity he talked about the transition to general relativity and eventually considered the solution of two body problem in general relativity. Prof. Ted Newman, from Pittsburg gave an overview of research in Relativity, since Einstein (a biased view in fact as he called it) broadly outlining the new developments in understanding solutions of Einstein's equations using the modern differential geometry on the one hand and the study of gravitational radiation, asymptotics and black hole physics on the other. As he pointed out, in spite of many developments there has been no breakthrough in attempts to quantise gravity. However, Hawking's attempts of Eucliedean quantum gravity with gravitational instantons and Penrose's theory of twistors seem to be more promising lines in this direction. Speaking on his personal work during recent years, Prof. Newman elaborated on the theory of H-spaces (solutions of Einstein's vacuum equations on complex manifolds) highlighting their structure and some plausible arguments for studying them.

Prof. A. Papapetrou of Institut Henri Poincare, Paris, speaking on problems of gravitational radiation gave an appraisal of recent trends in theoretical research in this field particularly in connection with radiation in a two body system. Prof. J. Pachner described his new method of numerical integration for a spherically symmetric collapse which he found to be accurate and stable as compared with some analytical results of the similar problem. His conclusion was that for any non-uniform spherically symmetric distribution with monotonically decreasing density the collapse is highly non-uniform.

One of the most outstanding problems of general relativity had been the famous positive mass conjecture. As is well known, the singularity theorems require for their validity the positivity of energy. Dr. D. Brill of University of Maryland reviewed this problem and he described his proof of the conjecture in the case of asymptotically flat spacetime as one can define a unique total energy only for such a system.

Dr. M. Walker of the Max Planck Institut, Munich, gave a detailed account of the asymptotic structure of spacetime particularly with reference to the definition of isolated systems in the presence of radiation. He further gave a description of the recent exciting discovery of Taylor and his colleagues concerning the changes in the binary periodicity of the binary pulsar PSR 1913+16. This in fact is an outstanding discovery as this indirectly confirms the existence of gravitational radiation which is a prediction of general relativity. It is heartening that this discovery and the associated confirmation came in at the birth centenary of Albert Einstein.

It is a curious situation in Relativity that after Schwarzschild's first solution of Einstein's equation in 1916 the only other exact solutions were that of Weyl for cylindrical symmetry and of Kerr in 1963 for axi-symmetry. The game of finding exact solutions for Einstein's equations got its momentum only after 1963 and since then there have been many solutions though not all of them are physically interesting. Dr. D. M. Chitre of the R.R.I. reviewed the status of exact solutions for asymptotically flat stationary axisymmetric space-times indicating a classification scheme based on a simple algebraic relationship among the potentials. He further pointed out that these potentials which form a representation of the infinite parameter symmetry group of Einstein's equations can be used to obtain new solutions.

After all these mathematical aspects of Relativity the programme of the symposium moved towards cosmology and astrophysics. Prof. J. V. Narlikar of T.I.F.R. gave a lucid survey of cosmological theories starting with the works of Einstein and deSitter. He described the various theoretical models and compared their individual status with the present observational evidence particularly the m-z relation and the 3°K background radiation. As a propounder of Steady State Cosmology, he confessed that his review was naturally a biased view and he concluded with the note that no one should take it for granted that Cosmology is a 'closed book' in the sense that all the problems have been solved. With ever increasing new evidences pouring in, it is as much of an open field and new interpretations for even existing observations should be looked into. Dr. Judith Perry of the M.P.I., Munich, talking on Quasars as probes in understanding the cosmos presented a new model to account the anomaly of absorption red shifts of Quasars. This model assumes existence of shell of matter at about a kpc away from the central object (whatever it is) produced by sweeping relativistic plasma, which is supposed to be the source of absorption lines in the spectrum. Dr R. Cowsik of T.I.F.R. gave a nice survey of all proposed tests of Relativity by using space platforms and satellites. As most of the participants were theoreticians, this survey was very welcome as it showed how developments in space-technology paved way for very accurate measurements of Relativistic corrections.

The fourth day of the symposium began with a lucid survey of black hole physics by Dr. C. V. Vishveshwara of R.R.I. This survey though presented in a lighter vein was highly informative and explained some of the very important results of black hole physics and pointed out some of the difficulties in its present understanding. Following this survey, Dr. Haridas, also of R.R.I., discussed the study of quantised fields in external gravitational fields, particularly with reference to Hawking radiation of black holes. Being originally a particle physicist, he used Schwinger formalism which was developed to demonstrate the instability of static external electric field against spontaneous pair-production, and discussed the quantised scalar field. He concluded with the note that Hawking's attempts to reconcile thermodynamic concepts with black hole phenomena inevitably led to the inclusion of quantum behaviour in general relativity which is indeed a great tribute to Einstein himself. Plasma disks around black holes and neutron stars constitutes one of the most important models for high energy sources like Quasars and X-ray sources. Dr. Prasanna of P.R.L. presented a case for studying the structure and stability of such disks in general relativistic framework by discussing possible stable orbits of charged particles very close to the event horizon and presented some preliminary results concerning such a study.

The trend of discussion slowly shifted towards quantum physics from classical physics with a review by Dr. M. Sohnius of M.P.I., Munich, on Supergravity. In fact it is known that with the large influx of elementary particle physicists into study of gravitation in recent years, the study of quantum gravity is increasing by quantity though no qualitative breakthrough has been achieved. Supergravity has been the new arena for testing computational skill with wider group than Poincare group. The main idea in Supergravity is to construct a gauge theory by considering the invariance of the combined Einstein-Cartan Lagrangian and the Rarita-Schwinger Lagrangian under supersymmetry transformation. As he pointed out, the characteristic new feature of super-symmetric theories is the occurence of anticommutators leading beyond the usual Lie groups for particle symmetries.

As is well known Einstein himself never agreed with the Copenhagen interpretation of Quantum mechanics. As he characteristically described "He does not play dice", Einstein was of the opinion that Nature cannot be indeter-ministic. Although this view of Einstein did not gain any momentum during his life, Schools have come up after Einstein which discuss the so-called Hidden Variable theories of quantum mechanics. Prof. Virendra Singh of T.I.F.R. reviewed the status of aspects of Quantum Mechanics as of today. He dealt with the measurement problem, the completeness proof of Von Neumann and possible hidden variable theories. He showed how the Bel's inequality would arise and how it offers an experimental tool to distinguish between quantum mechanics and the local hidden variable theories.- He pointed out that the presently overwhelming experi. mental evidence is on the side of the quantum mechanics Prof. R. K. Varma of P.R.L. continuing the discussion in the same trend proposed a deterministic basis for non relativistic quantum mechanics and presented the equations of motion which describe distribution over the deterministic trajectories. In his formalism, the generalised description seems to admit an infinte number of wave functions following coupled set of Schrodinger-like equations while the total probability is given by the sum of the modulus squared of all these wave functions, one of them being identified as Schrodinger function. He concluded with the note that classical probability not only embraces probability in quantum mechanics but allows other new modes for its propagation.

The quantum ideas were later on taken into Cosmology with Dr. Gunzig from Brussels speaking about spontaneous symmetry breaking and the origin of the universe, which he called quantum cosmological history. In his formalism the particle production mechanism is interpreted as a phase transition in which the edge of the universe is considered as boundary between two phases, and the transition itself occuring through a general symmetry breaking mechanism in which the gravitational field itself arises at the same time as the beginning of the universe. The novel feature of this theory seems to be the avoidance of initial sigularity (big bang) and a possible combination of both pictures viz. steady state and evolution. But still the problem of initial nucleation has not been satisfactorily explained.

The problem which occupied Einstein's mind most towards the later part of his life was the unification of physical theories. There have been several attempts to unify electromagnetism and gravitation but none of them is satisfactory. But the attempts of elementary particle physicists in unifying the fundamental interactions mainly electromagnetic and weak seem to be more successful and there have been attempts to include strong and gravitational interactions into this scheme. Dr. G. Rajasekharan of Madras University gave a bird's eye view of this unification scheme in his review of gauge theories. He briefly touched upon the many-way classification of elementary particles and the various group theoretical basis of describing them. He presented in particular the Salam-Weinberg model of unifying electromagnetic and weak interactions and its recent success as seen from experiments at SLAC. He further expressed a hope that super-symmetry might show a new direction in the grand unification of all interactions.

Though Einstein's name is commonly known for his theory of Relativity, one cannot forget his equally fundamental contribution to foundation of statistical mechanics through his explanation of Brownian motion and his introduction of light quanta (photon) through the discovery of photoelectric effect. In fact Einstein got his Nobel prize for this discovery. The last day of the symposium was devoted to discuss these two aspects of Einstein's contributions. Prof. E. S. Rajagopal of the I.I.Sc. spoke on Fluctuations, Critical Opalascence and Critical point phenomena the basis of which are the works of Einstein and Smoluchowski. After briefly reviewing the earlier work, he described some of the current experiments on the behaviour of electrical resistivity which probe aspects of correlations among fluctuations. He pointed out some anamolies in the temperature derivative of resistance in ferromagnetic and binary liquids as well as in the theory of dielectrics, where experimental studies are lacking. He concluded with the remark that the phenomena near the critical phase transitions offer a situation where the observations of fluctuations yield dramatic results and some of these observations are yet to be properly understood, and as such yields good scope for continued work. Dr. M. P. Das of Sambalpur University talking on photoemission from solids, presented the current state of understanding of the phenomenon of photoemission and discussed how much the electron structure of solids may be understood via this phenomenon. Having described in detail the conceptual foundation and recent theoretical developments in photoelectron spectroscopy he pointed out that with the availability of sources like synchroton radiation one can get reliable data for theoretical analysis. He further indicated that the detailed calculation of 'work function' with the help of many electron theory particularly for simple metals has provided an important check of the photo-threshold.

Apart from all these invited lectures covering various aspects of the developments in Relativity, Astro-physics and foundations of quantum mechanics and field theory, there were eight parallel sessions of contributed papers covering the same fields. These papers were largely from research scientists working in Universities. An interesting feature of the symposium was the two public lectures, one by Prof. D. S. Kothari on " Einstein, Physics and Beyond " and the other by Prof. Philip Morrison of M.I.T. on " The great and the small—Einsteinian scale". Prof. Kothari spoke largely about metaphysics and in particular the philosophical implications of Einstein's work. Prof. Morrison touched upon the unity in nature from the microcosom to the macrocosom and presented very lucidly Einestein's role in making this realisation possible. He emphasised on the humanitarian aspect of Einstein's personality and recalled his personal encounter with Einstein.

The symposium provided quite a lot of time for scientific discussions among participants after and in between lectures. It was pleasing to note that young student participants were very active in asking good questions and they made the discussions very lively. In fact, student participation was a novel feature of this symposium.

To quote one of the foreign participants " Einstein as a modest man would have least wanted all the attention paid to him in his centennial year. But surely he would be happy to see physicists paying attention to his thoughts and ideas, and I think, he would be pleased that, besides all the commemorative gatherings there was also a *Scientific* Symposium such as we have had here at Ahmedabad."

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