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By the end of the 19th century scientists thought they had it all worked out, says **S.Ananthanarayanan**.

Newton had elegantly formulated the laws of motion, the gas laws had been found and Maxwell had unified the laws of electromagnetism. Planetary motion had been exactly understood, the steam engine and the petrol engine had been discovered and even the electric bulb, telephone and wireless had become realities.

New mysteries come to light

And then, came disturbing discoveries, like radioactivity by Madame Curie and the virtual overturning the apple cart by Einstein. The Curies had discovered a new kind of radiation that emerged from some metals and defied explanation. Einstein reworked the bases of our concepts of time and measurement in reconciling a seeming contradiction of Maxwell's equations by experiment. Thompson and Rutherford had discovered the structure of the atom. The way the radiation from a hot body was distributed over wavelengths had not been explained by classical physics. This problem led Max Plank to discover that energy did not transfer in a continuous flow, but in 'packets', or 'quanta'.

In the beginning of the 20th century it looked like all physics was being discovered afresh!

Relativity and Quantum Mechanics

The Special Theory of Relativity showed that measurement of both lengths and time intervals shrink when carried out in a moving frame of reference (the difference is noticeable only when moving at speeds near that of light) and also that mass and energy are equivalent. The celebrated $E=mc^2$ equation has changed the world, with nuclear power and the atom bomb. The General Theory considered the nature of gravity itself and showed that all masses caused a curving of space, whose nature had been redefined in the theory, as measured not only by the coordinates of place but also that of time.

The theory made most unimaginable predictions, at the astronomical scale, at any rate, and these have all, consistently, been verified to the last detail. One of the most startling was that the path of light is bent by gravity, and this has been seen to be a fact by sighting a star when it was covered by the disk of the sun, thanks to light curving around sun due to gravity!

At the level of very small things, the quantum theory, consistent with the equivalence of mass and energy of the special Theory of Relativity, has been unprecedented in the accuracy of its predictions. The accuracy of the predicted frequency of the emission from an atom, for instance, is of the order of measuring the distance from Mumbai to New Delhi correct to a millimeter!

Lasers, nuclear physics, transistors, modern chemistry, understanding the processes in suns and stars, how the elements came into being, are areas of modern science built on quantum mechanics.

But e'er the twain shall meet?

But the crisis in Physics at the moment is that quantum mechanics ignores the force of gravity, while quantum effects are no part of the General Theory of Relativity. At a fundamental level the nature of things is still far from understood and scientists are perturbed by these two theories, gloriously successful in explaining portions of reality, not being part of a unified 'theory of everything'!

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