detailed account of this work has been submitted for publication in the *Astrophysical Journal*.

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PHYSICS

Bearing of Recent Experiments on the Special and General Theories of Relativity

It has been shown[1-3] that the frequency of an atomic absorber at the end of a rotating arm is less than that of a similar atomic emitter at the centre of the rotor by the amount $\Delta\nu = \nu v^2/2c^2$, that there is no frequency shift[4] between an emitter and absorber at opposite ends of a rotating arm, and that there is a shift[5] when the emitter and absorber are at different gravitational potentials. All these results are generally assumed to be in accord with both the special and general theories of relativity, but a critical examination of the question leads to a different conclusion.

Champeney and Moon express surprise that the naïve use of the transverse Doppler effect formula without any account being taken of the acceleration gives the correct answer. The reason is simply that Einstein[6] assumes this result in the general theory with an argument which can be summarized as follows: (1) A clock at the circumference of a rotating disk is in motion relative to one at the centre and therefore appears to go more slowly when viewed from the centre, in accordance with the special theory. (2) For a steady state of rotation all the waves emitted by the clock at the circumference are received at the centre. (3) The clock at the circumference therefore actually goes more slowly than that at the centre.

The foregoing argument is unsound because it is first assumed that the accelerated clock undergoes the same time dilatation as one in uniform motion, and then that this dilatation is entirely due to the acceleration. However, it has been pointed out[7] that the time dilatation result is actually contained in the postulates of the special theory, so that in effect Einstein is using these same postulates in the general theory rather than using a result of the special theory. The weakness of the argument is of no consequence to the general theory, but it removes the dependence which it is thought to have on the special theory. It is more accurate to regard the two theories as alternative ways of explaining the postulates.

In the special theory it is also postulated that two observers in relative uniform motion obtain identical experimental results. The time dilatation must in consequence be an apparent effect arising in some way from the transmission of signals between the observers. Mathematically the result can be obtained only by making the units of measurement depend on the relative velocity[8], and Einstein makes his hypothetical observers adjust their units to keep the value of c constant. In an actual experiment such adjustments are not made and if the theory is to have any physical significance they must follow automatically from the transmission process.

In the general theory, on the other hand, there is no symmetry between the two observers, and the time dilatation can be a real effect. This idea was indeed introduced by Einstein in the special theory, but in the context of this theory it led to the well-known clock-paradox. Einstein[9] later agreed that the prediction based on the assumption that one clock actually goes slower than the other contradicts the special theory.

Experimental results now vindicate the view that the time dilatation is due to acceleration and also to a difference in gravitational field, thus supporting the principle of equivalence.

The null result of the experiment of Champeney and Moon with the absorber and emitter in relative motion but having the same acceleration indicates that the time dilatation is not due to relative motion or to the process of wave transmission and that the special theory is wrong. It may be that this theory should not be applied since it relates to uniform motion, but in this case it is not applicable to any experiment carried out on the Earth's surface[10].

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Generation of Giant Optical Maser Pulses using a Semi-conductor Mirror

This communication reports the observation of high-intensity pulses of light when one mirror of a laser Fabry–Perot resonator is a semiconductor.

The reflectance at a semiconductor–air interface may be regarded as due partly to the dielectric nature of the material, arising in particular from bound electrons and partly to the metallic properties attributable to free electrons and holes associated with quantum states in the conduction and valence bands, respectively.

In the case of germanium, the dielectric properties usually predominate but intense light incident on the germanium surface may generate sufficient electron-hole pairs locally to make the plasma contribution to reflectance appreciable. This generation process competes against diffusion and recombination processes, but initial calculations have indicated that the light pulses from a ruby laser operated in the ordinary free running condition can generate at the surface a plasma density greater than 10^{18} charges per cm^3. According to Sosnowski[1] this should yield an increase of more than 1 per cent in the reflectance of the surface.

The effect has been used to provide 'Q-switching' in a ruby laser by replacing one of the usual metallic or dielectric mirrors of the Fabry–Perot resonator with an optically flat germanium surface.

The dielectric reflectance of germanium is high enough (0·36) to allow initiation of laser action when the input energy to the pumping flash tube is about 25 per cent above the threshold observed with a silver mirror (reflectance about 0·9).

Oscillograms show that the light output of such a system consists of many typical laser pulses of low intensity together with one or more 'giant pulses' the peak intensity of which is at least 40 times greater than