

## The Hafele-Keating Experiment

Praises be on high to the airborne cesium clocks! For in those days when the Land of Paradox was barren, so as not to produce a living thing, relativistic physics has given birth to an experiment. The ass has dropped a foal.

But before we go on our way rejoicing, let us pause briefly to retrace our steps, and with considerable care. As an old woodsman of many years' experience, in which getting lost in the wilderness is no new thing, I am naturally reminded of those two great principles which long guided the historic *coureurs de bois* when lost - - either retrace your steps to where it all began, or sit down and shut up so it won't get any worse. Since a good physicist abides by an action principle, we shall then find upon retracing our steps that, in the first place, the Hafele-Keating experiment does *not* follow Einstein's instructions, and in the second place that Einstein was wrong in the first place.

For all of this derives from that original publication of his in 1905, and precisely on that particular page where he suddenly found himself intrigued by the observation that "...*hieraus ergibt sich folgende eigentümliche Konsequenz*". Einstein then proceeds to say, in translation:

If we assume that the result proved for a polygonal line is also valid for a continuously curved line, we arrive at this result ... If one of two synchronous clocks at A is moved in a closed curve with constant velocity until it returns to A, the journey lasting t seconds, then by the clock on its arrival at A will be  $\frac{1}{2}t (v^2/c^2)$  second slow. Thence we conclude that a clock at the equator must go more slowly, by a very small amount, than a precisely similar clock situated at one of the poles under otherwise identical conditions.

Granting that Einstein begins with a situation which might be interpreted as giving real motion to a clock along a closed curve, hence in the nature of the Hafele-Keating experiment, we nevertheless see that his own conclusions confine themselves specifically to clocks *at rest on the Earth's surface*, directly comparable to the situation of the Michelson-Morley interferometer. At this stage Einstein is in no way in disagreement with experiment-

al physics, since he predicates his conclusion upon the experimentally demonstrated principle that an interferometer *at rest on the Earth's surface*, whether pole or equator, would still register a null datum. No experiment was on record in his time, nor has any come on record since, in which instruments of experimental physics were in actual motion relative to Earth coordinates and still registered a null datum. Therefore a true test of Einstein's original *Gedankenexperiment* would require comparing a cesium clock at some high latitude, with another closer to the equator, and *both stationary relative to the lithosphere*.

When Einstein next assumed that it made no difference whether the interferometer was in physical motion or not relative to terrestrial coordinates, he ventured beyond lines drawn by experimental physics. We have descanted sufficiently upon this before, and have described that act as a gross error, responsible for every one of the annoying paradoxes in the history of relativistic physics. To have Hafele and Keating use moving "clocks" in an alleged reconstitution of a quite different original situation is to compound Einstein's error; and then to use "clocks" which have no relationship whatever to the to-fro optical signalling and studies of the simultaneous problem in early relativistic physics is to compound it once again.

For this physical transport by Hafele and Keating of a special type of timing mechanism based upon subtle subatomic dynamics not only departs from all these previous studies, but does so categorically. Even the electromagnetic forces are possibly transcended in the hyperfine resonance phenomena, delving instead into the weak and even the strong interactions; and from this view it seems not so strange that relationships should develop similar to those encountered with elementary-particle decay.

What Hafele and Keating have done, therefore, is to provide some detailed and presumably accurate data on the alteration of subatomic frequencies under conditions of displacement and motion relative to the axes of the embedding Maxwellian field, namely the terrestrial magnetosphere. Until these possibly subtle interactions between field and particle are more thoroughly clarified, it is worse than sheer hypothesizing to define the phenomenon in terms of velocity-dependent time dilation under conditions of an absolute motion, when the concept of time dilation arose out of a categorically different type of test, and with instruments at rest relative to Earth coordinates rather than in physical motion.