Thomas E. Phipps, Jr., in memoriam

These few words are written in honour of Tom Phipps' memory. I have nothing new to add to things I have said or written at earlier times but, nonetheless, such is the singular nature of Tom's lifetime contribution to science and scientific discourse I believe it to be very much well worth the repeating. My following words closely follow the foreword I wrote for Tom's book *Old Physics for New* and, if you, the reader, are unfamiliar with Tom's work, then that book provides a brilliant representation of it ... and I urge you to read it!

The primary philosophy upon which foundation all of Tom's work in physics was rigorously built was that when theorizing about the world around us, we must pay absolute attention to the practicalities of the measurement processes by which the quantities involved in this theorizing are measured.

Let me talk about the Phippsian prose style first: the common experience upon reading a scientific text is to be confronted by a finished article—that is, by a text from which all sense of intellectual journeying has been exorcised, cleansed, deleted. The experience may be necessary but it is rarely exciting and never invigorating—it becomes merely a job that must be done, a dusty dry road along which weary feet must be dragged. But Phipps refuted this puritanical model; he is *renaissance* man—the man who glories in the splendour of the written word and its capacity to illuminate the obscure, and to decorate the plain. And so the experience of reading Phippsian scientific prose is not unlike that of reading a good detective novel—the dim detective, the obvious clues overlooked, the false trail followed, the unsolved crime written up as solved so that the bureaucrat can sleep his dreamless sleep and, finally, Sherlock Holmes with his pipe and Dr. Watson ...

Now let me consider the (for me) perfectly commonsensical view that the practicalities of the measurement process must play an unambiguously prominent role in the theorizing process: As an example of a theory where this was not done (with hugely significant consequences), we need look no further than classical Maxwell electrodynamics. In this case, the formalism absolutely requires that the detectors used by (inertial) observers to measure field quantities be at rest in the observer's frame. Thus, if we have two differently moving observers, each in his own inertial frame, then, since their instruments are physical objects and unable to occupy the same place at the same time, it is absolutely impossible for these two observers to make simultaneous measurements of the same field point. In other words, certain choices made at the theorizing level have rendered impossible a perfectly reasonable thing—that distinct observers can have direct knowledge of conditions occurring at one particular place at a given time. Phipps' answer to this conundrum was simple: there is no reason on Earth why the detector measuring field quantities should be fixed in the (inertial) observer's frame. After all, the source currents which generate the field are not, so why should the test-particles (which comprise the detectors) be? And since the detector need not be fixed in one observer's inertial frame, why should it be fixed in any inertial frame? Following this logic, if we allow the detector to have free motion, then the formalism of electrodynamics which follows must somehow allow for the parameterization of the detector's motion. A natural candidate for this formalism already exists in the equations of Hertz's electromagnetic theory (the known failure of his theory was the fault not of his equations but of his physical interpretation) and these are easily written down: just take Maxwell's equations and replace all appearances of ∂/∂t by *d*/*dt*. This replacement introduces a convective velocity which must be interpreted, and Phipps' solution was to use this convective velocity to describe the motion of the free detector. A simple and elegant idea, don't you think? ...

But now comes the crux: by this simple process, which is driven by the idea that there is no reason on God's Earth why an observer cannot use a freely moving detector, the equations of electromagnetism become Galilean invariant; thus, at a stroke, solving one of the great conundrums of 19th century physics and, in removing the primary *raison d'être* of Special Relativity (SRT), putting a huge question mark over a large chunk of 20th century theoretical physics.

Now Tom Phipps was the supreme realist and as honest & honourable a man as ever walked this Earth, and each of these traits has its consequence on the way his thinking proceeded. Realism first: the story outlined above makes plain that SRT, and all that has flowed from it, is an unfortunate accident of history for some and an incredible stroke of good fortune for others—and it is the 'others' who are in the driving seat here. What was required, Tom realized, was an example of some physical circumstance in which SRT can be shown to have failed ... unambiguously. One does exist, although careful reading of the standard texts (when one is wide awake and on top of one's game) is required to spot it, otherwise the cardsharp cleans you out: stellar aberration is the bone in the fish pie.

Briefly, and as Tom pointed out in entertaining detail in *Old Physics for New*, SRT claims to provide the complete explanation for the Doppler shift and for stellar aberration—both phenomena affecting light that comes from stars. To see the problem immediately, it is sufficient to observe that in order to explain the Doppler shift, the velocity used by SRT is defined as the relative velocity between emitter and detector ($v = v_e - v_d$) which, of course, is perfectly consistent with SRT's own internal logic. However, in order to explain stellar aberration, the velocity used by SRT is defined as the Earth's orbital velocity in the solar frame ($v = v_{orb}$) ... stellar velocities are nowhere to be seen ... and there is no source-sink relativity whatsoever!

So, in order to 'explain' two different aspects of the same starlight, SRT must submit to two different interpretations, one consistent with its own internal logic and one inconsistent with that logic. If you work in a University physics department, try putting that position to any of your colleagues. Honesty second: there are several good reasons for being extremely sceptical about SRT—Phipps was eloquent on them all—but he knew that the clock could not be turned back to 1894 (the year Hertz died). Physics has moved on since then (and I do not mean merely theoretical physics); in particular, although we can with reason reject SRT, the time dilation prediction of SRT has been verified to high accuracy many times over. Indeed, without using the time-dilation formula of SRT to calibrate the relative clock-rates of the Earth-based clocks and orbiting clocks, the GPS system could never work as well as it does. So, Phipps accepted that time dilation is a fact of physics and that the time-dilation formula of SRT is verified and must therefore be properly built into theory.

How did Phipps respond to this state of affairs? Well, close analysis is hardly required ... for the Emperor is clearly naked to the innocent eye ... SRT makes two independent statements, of which we are all aware: firstly, there is the statement about time dilation (with a formula which works in well-defined situations) and, secondly, there is a statement about length contraction ... which, as Phipps correctly pointed out, is a prediction of an effect which (a) has never been observed and (b) creates all kinds of difficulties, not least of which is making it impossible to consider SRT as a generalization (or covering theory in Phippsian lingo) of Newtonian Mechanics. It is the length contraction prediction, for example, that makes the science of rigid body mechanics impossible for the "relativist." For Phipps, and for any right-thinking person in my view, the notion of length-contraction was a metaphysical fantasy that can have no place in a theory of physics. And because length contraction and time dilation are independent statements then—as Phipps pointed out—we can cherry-pick. We can have a theory which assumes the reality of time dilation whilst denying that of length contraction. The way forward is formally trivial—just replace ordinary clock time, t, in the Hertz formalism by the proper time parameter, τ, defined in the usual SRT way where the velocity parameter, v_d, is the velocity of the detector in the (inertial) observer's frame.

The result is the Neo-Hertzian formalism, the ramifications of which Phipps worked through in great detail—but I shall stick with the big canvas: in denying the existence of length contraction but accepting the existence of time dilation Phipps was, in fact, denying spacetime symmetry; but, in doing so, is regaining the possibility of rigid-body mechanics and, through the neo-Hertzian formalism, is finding mutually consistent treatments for the Doppler shift and stellar aberration. This is already a huge bonus.

This Phippsian saga as it unfolds in *Old Physics for New* closes with a couple of chapters devoted to discourse on the nature of timekeeping (rather than on the nature of time). As I see it, this section is driven by three circumstances: firstly, there is no identifiable causal mechanism within SRT for the "predicted" physical effect of clock retardation. If there were, the twinparadox would never have arisen in the first place. Secondly, there is the (almost) self-evident fact that any man (or, in this politically correct world, person) engaged in theorizing about the world armed with a sensibly constructed clock which furnishes a time t, can either choose to use t directly as his measure of time or choose to use an arbitrarily defined strictly monotonically increasing function $T = g(t)$ as his measure of time. The only consequence is that there will be some choice of g which provides maximal simplicity to his theorizing—but all choices are equally valid. Thirdly, there is the empirical fact of the engineers' experience about how to make the GPS system work in practice—the fact of an Earth-bound Master Clock against which all the to-be-launched satellite clocks are calibrated so that once they are in orbit they keep synchronous time with the Earth-bound Master Clock. This calibration process amounts to the choice of a set of g-functions –$g_1, g_2, \ldots$ say—each one tailored separately to account for the distinct operating conditions of its associated clock.

In effect, Phipps argued that there are no reasons whatsoever—beyond vain prejudice and ideology—for believing that there exists for any system an inherently fundamental measure of time (or "proper time" in the sense intended within SRT and GR). And, upon reflection, I find myself agreeing with him. In which case, he argues, the most simple system of time-keeping is the one pioneered by the GPS engineers—that of an agreed (almost inertial) Master Clock against which all other clocks placed wheresoever are synchronized by a g-transformation chosen according to the operating conditions of the clock concerned (gravitational potential, relative velocity, *etc*., accounted for).

Thus, the vision spawned by SRT & GR according to which there are as many different "proper" clocks as there are particles in the universe is replaced by one in which there is a single (arbitrarily chosen) inertial Master Clock against which all other clocks are synchronized. As always, Phipps, in his last book, provided an exhaustive analysis of the ramifications of this timekeeping methodology—but two can be mentioned in a single breath: the absoluteness of the here and now is restored to the discourse of physics—with the corresponding consignment of the relativity of simultaneity to the proverbial dustbin; and the resurrection of the distinct possibility of a realistic theory of many-particle physics.

I shall finish my few words in praise of Tom's scientific life by remarking briefly on that aspect of the neo-Hertzian formalism which I find to be most remarkable. As a student (forty years ago) I struggled with Maxwellian electrodynamics, and part of my problem was that I always found two things rather odd: firstly, was the fact that here we had a theory in which the (supposedly) most important parts were the fields, E and B, which were unashamedly defined in terms of Newtonian forces—and yet this very same theory was proclaimed the fountain-head of all that was non-Newtonian in the whole world; secondly, was the fact that, although ideas of force were hard-wired into the definitions of the field quantities, the theory still required an additional postulate (the Lorentz force law) to make it into a useful theory of electrodynamics. One can accept such things in an entirely mechanical way, of course. But they left me feeling perpetually slightly disconnected from any claim to a real understanding of the Maxwellian picture. At a stroke, Phipps had removed all such impedimenta to clear sight: no longer is electrodynamics claimed as the portal to a shining new world, quite different from the old; instead, it sits firmly and squarely as an integral part of that old world. And, almost by magic—yet not really—Phipps showed us that, in its neo-Hertzian reincarnation, electromagnetism is already electrodynamics; there is no need to postulate force laws additional to those inherent in the basic definitions of the field quantities ... I could go on.

But I shall close on a much more personal note: when my youngest son was born, my wife, Priscilla, & I could think of no one more fitting as a God-Father for the newly born than Tom; he picked up that weighty mantle with a diligence beyond all expectations and in due course introduced the boy concerned to the glories of the hand-written word: so let us raise a glass to the memory of Tom Phipps, *Primus inter pares ... Salute*!!

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