

system. An hour can further be divided into one hundred minutes. The new minute will be 0.72 times shorter than the present unit. This ratio is reasonable, as it is comparable to that between a kilometer and a mile.

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Grammatical error

It has shocked me to find in the February issue (page 33) the following sentence: "He who neglects the connection between paper recycling and private investments in the Southern pine forests is spiritual brother to he who neglects the plasma potential in his ion source."

The message is good, but the grammatical error is inexcusable.

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Permanent part-time

I propose that university and college physics departments help to solve the problem of the overabundance of physicists with advanced degrees by providing for part-time, permanent faculty positions. These part-time positions would be completely equivalent to the present full-time positions in responsibilities and privileges. Course loads, research responsibilities, committee assignments, and so on, would be scaled down in accordance with salary. The professional regard and prestige associated with such positions should be the same as for full-time positions.

I have two reasons for suggesting such a scheme. First, it would result in more jobs for physicists. If two faculty members in a department switched to two-thirds-time positions, they would be creating a new two-thirds-time position. If, in each large physics department (15 or more full-time faculty members) in the nation, two faculty members out of every 15 or 20 switched to two-thirds-time positions, more than 225 new positions would be created. Additional positions could be created in some smaller departments in this manner.

My second reason concerns the lack of flexibility in our system. A physics faculty member usually has the choice of a full-time position or no position. He should have more alternatives; there are many reasons why a faculty member might want to hold a part-time position, and our system should be flexible enough to allow for individual choice in this matter.

What kinds of physics faculty members might be interested in switching to

a part-time permanent position? A consultant—he needs the faculty position, but he might not need or want it full time. Someone who is nearing retirement and wants to ease into it gradually. The person whose health is endangered by the pressures of his job—a lightened work load could prevent a heart attack or ulcers. The parent of small children, who would like to take a more active part in rearing them. The person who is devoted to research and doesn't need the money from teaching but still would like to teach a little. The physicist who, for a reason either personal or professional, wishes to devote a great amount of time over a period of years to study in a discipline outside his field of specialization or outside of physics entirely. Surely there are other categories also.

What about economic considerations? Certainly many physics faculty have to earn a full-time salary to live comfortably. But others could support their families comfortably on, say a two-thirds-time or three-fourths-time salary. Still others have wives who contribute to the family income. Many more have wives who could work and would work if appropriate jobs were available, and if they and/or their husbands were persuaded that it is socially acceptable and morally right for husband and wife to share in the breadwinning responsibility. (In this regard, permanent part-time jobs should be promoted throughout the educational system and in as many other walks of life as possible.) Finally, perhaps many of us should lower our standard of living purposely, to reduce our contribution to the pollution of our environment.

What would be the benefits to the physics profession? New blood would be brought into departments to enliven them and prevent their stagnation. The quality of teaching would improve, as a result of the additional time available for reflection and personal and professional development. Speculative, creative research, often neglected because of the pressure to engage in research for which grants can be obtained and publications produced, could flourish under these more relaxed conditions. For a researcher could satisfy the lessened demands of his profession for grants and publications, and have spare time to speculate to his heart's content.

Innovations are needed quickly if we are to ease the current crisis in which highly trained people in many academic fields find themselves unable to secure rewarding jobs. I suggest that our own discipline set an example to others. I urge that every college and university physics department give immediate and serious consideration to methods for alleviating the academic unemployment crisis, and I suggest that one of the

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methods considered should be the establishment and promotion of permanent part-time faculty positions. I urge also that the AIP and the most prestigious departments of physics formulate a program that will unify and strengthen the efforts of individual physics departments, and which will encourage, in as strong terms as possible, that everyone in the physics academic community address himself to solving this problem.

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Scale symmetry

In his recent article on scale symmetry (January, page 23) Roman Jackiw suggested that dilatation symmetry must be inexact for massive particles. His proof of this assertion applies, however, only in the framework of the Lorentz group, $O(3, 1)$. If one goes to the larger group $O(4, 2)$ (the conformal group), which contains $O(3, 1)$ as a subgroup, it is quite possible to construct an explicit acceptable scale-invariant wave equation for massive spin-1/2 composite particle system, and we shall do this specifically for the quark triplet (ϕ, χ, λ) system.

We begin with the most general minimal linear parity-conserving currents in the $O(4, 2)$ algebra of Dirac matrices¹

$$J_\mu =$$

$$\bar{q}\gamma_\mu q - i\left\{\bar{q}M^{-1}(\partial_\mu q) - (\partial_\mu \bar{q})M^{-1}q\right\} \quad (1)$$

where

$$M = \begin{bmatrix} m_\phi & 0 & 0 \\ 0 & m_\chi & 0 \\ 0 & 0 & m_\lambda \end{bmatrix} \quad (2)$$

defines the quark masses $(m_\phi, m_\chi, m_\lambda)$ assumed to be nonzero. (We adopt the natural units $\hbar = c = 1$). The simplest wave equation that conserves this current is the $O(4, 2)$ wave equation

$$i\gamma^\mu \partial_\mu q + M^{-1}\partial^\mu \partial_\mu q = 0 \quad (3)$$

The Lagrangian density may be written $L = \theta_{\mu\nu}$, where $\theta_{\mu\nu}$ is the energy-momentum tensor

$$\begin{aligned} \theta_{\mu\nu} = & i\frac{1}{4}\left\{\bar{q}\gamma_\mu(\partial_\nu q) - (\partial_\nu \bar{q})\gamma_\mu q\right\} \\ & + [\mu \leftrightarrow \nu] - \frac{1}{2}\left\{(\partial_\mu \bar{q})M^{-1}(\partial_\nu q)\right. \\ & \left. + [\mu \leftrightarrow \nu]\right\} \quad (4) \end{aligned}$$

(Where $[\mu \leftrightarrow \nu]$ means that the term is repeated with μ and ν interchanged.)