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Comment on the paper

"Introductory Gauge Invariance

by F. Barlow, [Eur.J.Phys. 11(1990)45-46]

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Kraków, March 1992

Recently, R. Barlow [1] reported an interesting dialog between God and the Devil. His nasty Devil argued that God's creation was not perfect but finally God won by inventing the gauge fields. We regret, although happy that the Devil did not notice, the necessity of pointing out that Barlow's God argued erroneously.

1) Barlow's God introduced the gauge fields as objects absolutely necessary for saving the gauge invariance of the Schrödinger (or any other matter field) equation. However his God could have used the gauge covariant derivatives

$$D_\mu = \frac{\partial}{\partial x^\mu} - [1-\alpha)]A_\mu - \alpha B_\mu \tag{1}$$

where α is an arbitrary number between 0 and 1 and

$$B_\mu = -i \; \frac{\psi^* \dfrac{\partial \psi}{\partial x^\mu} - \dfrac{\partial \psi^*}{\partial x^\mu} \psi}{2\psi^* \psi} \tag{2}$$

It is easy to see that under gauge transformations the nonlinear expressions (2) transform exactly in the same way as the gauge fields A_μ. Clearly, expressions (1) for $\alpha = 1$ lead to nonlinear field equation of the Heisenberg type [2].

2) Barlow's God also stated that "... the A particle must be massless; there is no way that a mass term can be included if the invariance property is to be satisfied ". But there is a way! To see it let us write the field equation for the A-field in the following form

$$\left(\frac{\partial^2}{\partial t^2} - \Delta\right) A_\mu - \partial_\mu \left(\partial_\nu A^\nu\right) + m^2 A_\mu = m^2 B_\mu + e j_\mu \tag{3}$$

where j_μ is the usual gauge invariant current, e is the electric charge and m is an arbitrary mass parameter.

We recall the Commandment that one should not use God's name in vain.

References:

1. R. Barlow; Eur.J.Phys.**11**(1990)45-46.
2. W. Heisenberg; *Introduction to the Unified Field Theory of Elementary Particles*, Interscience Publishers, London, New York, Sydney 1966.