

Date: Tue, 25 Sep 2007 14:19:06 +0200

From: [Richard Davis <rdavis@bipm.org>](mailto:rdavis@bipm.org)

To: rf17@mail.gatech.edu

Subject: RE: Better definition of kilogram

Dear Prof. Fox,

I was already aware of your work in this field, including your article, with Prof. Hill, in American Scientist.

The recent literature on this subject is large and growing. The most recent article to hit the electronic street is by Milton et al.:

<http://stacks.iop.org/0026-1394/44/356>

You may find it interesting, if only for the references. Your own view of these matters is in many ways consistent with this article, although you dwell mostly on problems with the mole and the kilogram. If I have a criticism of your approach, it would only be that the SI is intended to serve the needs of a vast community. The choice of a redefined kilogram has an enormous ripple effect in the fields of electrical metrology and fundamental constants, and these people must be heard from as well. I think there is no serious argument about whether it is a good idea to replace a 19th century artifact with a better definition of the kilogram! The only questions are how and when to do it.

I know that for so-called "quantum metrology", which now includes routine, precise measurements of voltage and resistance, the "obvious" choice is to fix the values of the Planck constant (h) and the elementary charge (e). Since the speed of light, c , is already fixed, this proposal requires that the permeability of vacuum, μ_0 (at the moment fixed to be $4\pi \cdot 10^{-7} \text{ N/A}^2$), become a measured constant. Otherwise the fine-structure constant would be [f]ixed, but of course this is not allowed by our present knowledge of physics. Viewed this way, the fixed value of h determines the value of the kilogram.

As for elegance, these people would argue that nothing is more elegant than combining

$E=mc^2$ and $E = hf$ to produce a kilogram definition based on $m = hf/c^2$.

You and I might not find that particularly satisfying, but the debate must (in my opinion) be focused on: what are the real problems we are facing in our unit system; what practical solutions are available now or in the very near future; how can all this be accomplished in the cleverest, least disruptive way.

What about the mole? As you are well aware, at present the mole is defined as the number of atoms in 12 g of carbon-12. According to the proposal that I outlined above, one would not be allowed to fix this number of atoms because a fixed number would also define the kg. A suggestion is on the table (see Milton et al.) to divorce the definition of the mole from the kilogram, defining the mole as a fixed number of entities, with no reference to mass. As always, this has some important implications, some of which are discussed by Milton et al.

Ultimately, however, neither you nor I nor Milton et al. will make the decision on a future SI. These decisions are made in a deliberate way, passing up through the Consultative Committee for Units (CCU):

http://www.bipm.org/en/committees/cc/ccu/members_cc.html

whose membership includes the major international scientific unions. I suggest that one way to promote your own ideas would be to send them directly to the President or Executive Secretary of the CCU. Another would be through the NIST representative to the CCU. A third, of course, is to do exactly as you and Prof. Hill have done: put your ideas before the scientific community.

After the CCU has made a recommendation, the actual adoption of new units must be done at a diplomatic level.

Instead of rambling on, I will simply conclude by pointing out that the opinions expressed above are strictly my own and not those of the BIPM; and, as I have said, individual opinions do not count for much in this collaborative endeavor.

Kind regards,

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-----Original Message-----

From: rf17@mail.gatech.edu [mailto:rf17@mail.gatech.edu]

Sent: Monday, 24 September, 2007 6:02 PM

To: rdavis@bipm.org

Subject: Better definition of kilogram

Dear Dr Davis

I hope you find <http://arxiv.org/ftp/arxiv/papers/0709/0709.2576.pdf> of interest. Defining Avogadro's number exactly seems to us the most simple solution. Your comments are welcome.

Ron Fox
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