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## Quantum gravity corrects QED

Nov 3, 2010 [10 comments](#)

This week's issue of *Nature* includes a paper that's remarkable for two reasons: it is about quantum gravity – a topic usually not covered in the journal – and it is written by just one person. Now, after a little digging, *physicsworld.com* can answer all of the important questions about this paper.

### So, whose citation index ranking is about to go into the stratosphere?

The paper was written by David Toms, a Canadian mathematical physicist and lecturer at Newcastle University in the UK.

### What has Toms done?

He has shown that interactions between quantum gravity and quantum electrodynamics (QED) cause electric charge to vanish at very high energies (above about  $10^{15}$  GeV). He told *physicsworld.com* that his technique can be generalized to apply to the two other "gauge couplings", which define the strong and weak forces.

### Why should electric charge vanish at high energies?

A major problem with QED, which describes the interaction between charged particles and photons, is that electric charge increases at higher interaction energies. This is a result of vacuum polarization, whereby the spontaneous creation of electron–positron pairs tends to screen the electric charge of a particle at low energies. At higher energies, however, the screening is much reduced and the effective charge increases – and this cannot be correct.

### Can you explain?

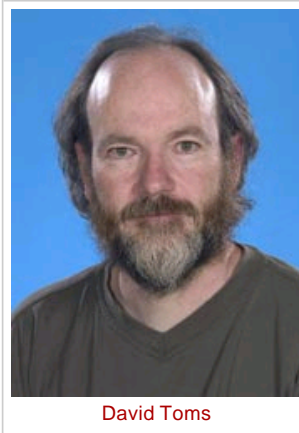
Physicists already know that the strong force – which binds together quarks within hadrons – goes to zero at extremely high energies. This property is called asymptotic freedom and its discovery earned Frank Wilczek, David Gross and David Politzer the 2004 Nobel Prize for Physics. If it can be proved that quantum gravity makes QED asymptotically free then it could stand as a viable theory on its own.

### Can you elaborate slightly?

The main reason why QED was viewed as incomplete, prior to Gross *et al*, was that without asymptotic freedom the electric charge becomes infinitely large at some energy scale and the theory is no longer reliable. For their calculations to be reliable at high energies, physicists expect the strong, weak and electromagnetic forces to become unified and become asymptotically free.

### Hold on, didn't Frank Wilczek and Sean Robinson establish gravity-induced asymptotic freedom of charge in 2006?

Yes, sort of. Robinson and Wilczek came up with the idea of gravity-driven asymptotic freedom and worked out that it applied to all three



David Toms

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gauge couplings (*Phys. Rev. Lett.* **96** 231601). It was later pointed out, however, that there were errors in their calculations. This caused a flurry of activity as other physicists tried and failed to do the calculation using different approaches.

Now, Toms has worked out a way of avoiding these errors by performing a set of careful checks to guarantee that the calculation meets certain mathematical and physical criteria. In doing so, he has shown that Robinson and Wilczek's idea was correct all along.

### So what do they have to say?

"Toms' work is important equally as much because of the way in which he did the calculation as the result itself," said Robinson who is a lecturer at Massachusetts Institute of Technology. He said that an important feature of the technique is that it is "demonstrably flawless". He also pointed out that while Toms' paper was under review at *Nature*, an independent group of physicists at Tsinghua University in China posted a preprint (*arXiv*: 1008.1839) using a similar "flawless" technique but a different set of cross-checks. The Tsinghua team obtained essentially the same result as Toms, illustrating the power of the technique.

### That must be good news for physicists working on unification?

Sort of. Toms has shown that quantum gravity causes asymptotic freedom in all the gauge couplings. This is handy if you want to show that all forces unify in a single (very weak) force at very high energies. However, he treated quantum gravity by simply quantizing Einstein's general theory of relativity. This approach breaks down at the very energies that unification is expected to occur. To take things further, physicists would need to integrate more exotic aspects of quantum gravity such as additional dimensions and supersymmetry.

### Where can I find out more?

- ▶ [Nature paper](#)
- ▶ independent work on [arXiv](#)
- ▶ [Robinson and Wilczek paper](#) (2006)

### About the author

[Hamish Johnston](#) is editor of [physicsworld.com](#)

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### 10 comments

Comments on this article are now closed.

- 
- |   |  |  |
|---|--|--|
| 1 | <b>John Duffield</b><br>Nov 3, 2010 10:28 PM<br>United Kingdom | <a href="#">arXiv paper</a><br><br>▶ <a href="#">Offensive? Unsuitable? Notify Editor</a>  |
| 2 | <b>nick.evanson</b><br>Nov 3, 2010 11:32 PM<br>United Kingdom  | David Toms was my interviewer (and subsequent lecturer) for my physics and maths degree at Newcastle - he hasn't changed a bit! I'm greyer than he is now :(<br><br>▶ <a href="#">Offensive? Unsuitable? Notify Editor</a>   |
| 3 | <b>rloldershaw</b><br>Nov 4, 2010 5:16 AM                      | Are these "asymptotic freedoms" actually observed and measured?<br><br>Or are they purely theoretical constructs that theorists would like to be true, but cannot directly empirically test?<br><br>If charge disappears, what happens to conservation of charge?<br><br>RLO<br><a href="http://www.amherst.edu/~rloldershaw">www.amherst.edu/~rloldershaw</a><br><br>▶ <a href="#">Offensive? Unsuitable? Notify Editor</a> |
| 4 | <b>nick.evanson</b><br>Nov 4, 2010 5:52 PM<br>United Kingdom   | It would be nice if people chose to abide by the rules when it comes to posting comments and refrained from using the site as a sounding board for their own published or non-published work. Of late this site just seems to be a referral service for online papers...<br><br>▶ <a href="#">Offensive? Unsuitable? Notify Editor</a>   |
-

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BGK

Nov 5, 2010 12:24 AM  
 Canberra, Australia

moderation of comments needed.

Quote:

*Originally posted by **nick.evanson***

It would be nice if people chose to abide by the rules when it comes to posting comments and refrained from using the site as a sounding board for their own published or non-published work. Of late this site just seems to be a referral service for online papers...

I agree with Nick completely. Certain people simply clutter up the comments section with nonsense. They appear not to have read the material in the report.

This is not the place to advertise silly ideas which these people are unable to get published in reputable journals.

I suggest some degree of moderation, especially of repeat offenders.

Nor is it a place where people should expect answers to questions like "what is asymptotic freedom". Clues to the answer to this are in the article. There are many sources on the web which can provide answers to such questions if readers are interested. Why not use them ?

Brian

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reader01

Nov 5, 2010 12:08 PM

**Need QLED additional dimensions ?**

I think that QED explain behavior of quarks and gluon at dimensions of compound particles and also this is the subject of QLED. But at longer dimensions we maybe can use just QLED with additional dimensions.

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nick.evanson

Nov 5, 2010 12:17 PM  
 United Kingdom

Quote:

*Originally posted by **andwor***

There is a fine line between guidelines and censorship, which I think is excersised very well in this forum.

Certainly any peer reviewed and published material should be allowed. After all, such material appears regularly in encyclopaedia britannica.

Indeed some of the less mainstream stuff could well be important. Where else better than a physics forum.

This is **not** a forum though: it's a section to permit people to pass comments on news and blog items. Directly underneath the field I'm typing this in to states:

Quote:

Comments should be relevant to the article and not be used to promote your own work, products or services.

Repeatedly using one's own published work as a response to another's comment is arguably a *promotion* of one's work: I agree that *peer-reviewed* articles should be used with references but too many regular users of the comments section are highly questionable with regards to their 'intepretation' of the guidelines. There's nothing worse than seeing the same people linking the same files in the same topic areas over and over again: it cheapens this site to my mind. It's certainly not conducive to showing students how to discuss a topic in a professional and scientific manner. Does one turn up at symposiums and repeatedly counter every point in a conversation with "I've published a paper: here it is"?

Quote:

*Originally posted by **andwor***

QED, QCD and quark confinement

Could someone explain to me again why quarks are confined.

The above such comments are as equally unnecessary: you're no longer commenting on the news item and without wishing to cause offence, it's not hard to see that your 'query' is your foil to commence a new and tangential discussion. I care nothing for the reasons why but the history of the comments section strongly hints at this being done to generate the opportunity to insert a promotion of one's research and/or published/non-published papers.

Personally I think the loPP should look to creating a proper discussion board (physicworld.com is, after all, promoted as being a *community website*) and work on instructing people to take lengthy discussions away from the comments section. I also think they need to using IP address blocks to remove some of the spambots and/or a moderation system to check the first couple of comments from new users: it's not a particularly tiresome task given the number of comments that are posted each day.

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**nick.evanson**Nov 5, 2010 1:51 PM  
United Kingdom

Comments don't need to be scrutinised, considered and carefully judged at all. Once again: this isn't an open forum, it's a comments section of the news section in a website privately owned and funded by the IoPP. It's *their* guidelines that state people should not be using this section to promote their own work and if they wish to edit or remove anything that's entirely *their* choice. I fully expect Hamish et al to remove my remarks because they're not relevant to the news item at all - this is why I suggested they make a discussion board so you can respond to news articles at length and have the room to go off topic, use peer-reviewed papers, etc, all without breaking the guidelines.

Quote:

...those trying to dictate to people...

What? No irony? Gosh! But hey, I'm interfering with the progress of science, so what do I know? There was a good reason why I felt that the IoP no longer deserved my £120 annual membership fee but I've long since forgotten it.

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**luizfcpe**Nov 5, 2010 2:12 PM  
athens, United States

I agree with nick.evanson on this issue. Why does the IoP allow all sorts of crackpots to come here and try to promote their revolutionary new theories of everything? It does make one wonder if the membership fees are indeed being put to good use.

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**Hamish Johnston**Nov 5, 2010 4:56 PM  
Bristol, United Kingdom**Comment on commenting**

Thanks to everyone who has contributed to this discussion on commenting. I'd like to address a few of the points that people have brought up.

1) *physicsworld.com* is aimed at readers with a background in physics and we assume that most of our readers have studied -- or are studying -- physics to degree level. It is not our intention to educate non-physicists about physics -- there are other sites such as [physics.org](#) that fulfil that role.

2) The comment section of an article is not meant to be a free discussion. It is intended to allow readers to comment specifically on issues discussed in the article.

3) Unfortunately some comments quickly lower the level of discussion and discourage others from taking part. Such comments will be removed and, if necessary, commenting will be suspended on certain articles

As such, I'm going to suspend comments on this article -- which is a shame because I think Toms's paper is worthy of further discussion.

*Edited by Hamish Johnston on Nov 14, 2010 3:32 PM.*

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