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# The Disproof of Asymptotic Freedom and the Breaking of the Landau Pole

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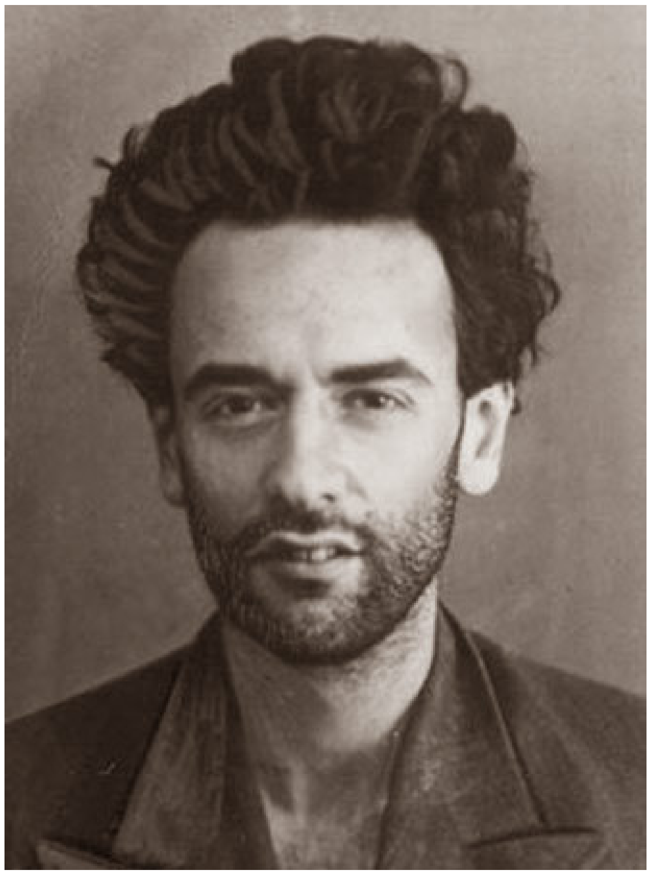

*Lev Landau*
great hair, lousy math

Abstract: Here I will show the mathematical flaws in the Landau equation, proving that the equation is a ghost. Then I will critique David Gross' Nobel Lecture, showing the simple flaw in his derivation of asymptotic freedom. This will bring down two more of the towers of QCD.

Most people (even most physicists) don't know what asymptotic freedom is, but since three men—David Gross, David Politzer and Frank Wilczek—won the Nobel Prize for it in 2004, it is best we give it a look.

Asymptotic freedom is said to have revivified or rehabilitated particle physics, bringing it back from an abyss it faced in 1973. That is the year these men did their work, although they waited 31 years for their prizes. This abyss was an abyss in quantum chromodynamics, or the field in physics that deals mostly with quark interactions inside the nucleus. The problem was with the strong force, in which quarks must play their part. The strong force was proposed to overcome the charge force on the positive protons. Protons exist in the nucleus at very close quarters, despite having a strong repulsion. Therefore it was proposed that an opposite force overwhelmed the charge repulsion. This is the strong force.

The problem was, to make this strong force work, it had to change very rapidly. That is, it turned on only at nuclear distances, but turned off at the distance of the first orbiting electron. The strong force is an attraction, and we couldn't have it affecting electrons. Because the field had to change so rapidly (have such high flux), it had to get extremely strong at even smaller distances. Logically, if it got weaker so fast at greater distances, it had to get stronger very fast at smaller distances. In fact, according to the equations, it would approach infinity at the size of the quark. This didn't work in QCD, since the quarks needed their freedom. They could not be nearly infinitely bound, since this force would not agree with accelerator experiments. Quarks that were infinitely bound could not break up into mesons, for a start.

This problem existed for less than a decade before it was said to be solved. It was solved by proposing asymptotic freedom—which is a short way of saying that the math was pushed. Here is how the math was pushed.

First, we take the strong force and its flux as given. We have no direct proof of this field—it is only a postulate—but we assume that our assumptions are correct. In order to calculate the flux, we must calculate how the energy of the field approaches the upper limit. This upper limit then becomes an *asymptote*. You may remember from high school math that an asymptote is normally a line on a graph that represents the limit of a curve. Calculating the approach to this limit can be done in any number of ways, but Gross, et. al., did it by mirroring the math of quantum **electro**dynamics. QED had met this same problem, on a lesser scale (as I will show below). Lev Landau developed a famous equation to find what is now called a Landau Pole, which is the energy at which the force (the coupling constant) becomes infinite. Landau found this pole or limit or asymptote by subtracting the bare electric charge *e* from the renormalized or effective electric charge $e_R$:

$$1/e_R^2 - 1/e^2 = (N/6\pi^2)\ln(\Lambda/m_R)$$

I won't bother you with the right side of this equation yet, since the largest problem is on the left side. What we have here is a value for *e* obtained by one sort of math, and then another value for *e* that has been pushed by another sort of math to match the experimental value. We subtract one from the other to find a momentum over a mass (which is of course a velocity). [Take note that although momentum is normally represented by $\rho$, we are told that $\Lambda$ is a momentum in this equation.] Now, if we hold the renormalized variable $e_R$ steady, we can discover where the bare charge becomes singular. Landau interpreted this to mean that the coupling constant had gone to infinity at that value, and called that energy the Landau pole.

I could begin my critique of all this by reminding my reader that renormalization is heuristics. Even Richard Feynman, the master of renormalization and inventor of much of it, admitted that, calling it hocus-pocus. The renormalized charge here is just a charge that has been pushed to match experiment. But even if we accept that renormalized math is genuine, one of our charge values here must be wrong. In any given experiment, the electron has one and only one charge, so that either $e$ or $e_R$ must be *incorrect*. Either the original math or the renormalized math must be wrong. If two maths give us two different values, both cannot be correct. But Landau is telling us we can subtract an incorrect value from a correct value, to achieve real physical information!

Some will say that I have misunderstood the terms. They will say the bare charge $e$ is not just an outcome of a variant math. They will say that the effective charge and the bare charge are *both* experimental values, of a sort, the effective charge being charge as seen from some distance and the bare charge being the charge on the point particle. In a way, the bare charge comes from $19^{th}$ century experiments and the effective charge comes from $20^{th}$ century experiments. The difference must then tell us something about the field. I realize this is the current interpretation, but it is factually incorrect, as those who interpret it this way must know. The bare charge on the electron contains a negative infinite term, just as the bare mass of the electron has (is) an infinite term. To get a usable figure, *both* have to be renormalized. Feynman got his Nobel Prize for renormalizing the *bare* mass, and for the bare charge to be used in an equation, it too has to be renormalized, at least to some extent. Landau is not planning to plug infinities into his equation, at least not as initial values. So the fact is, both the bare charge and the effective charge are renormalized. Otherwise the bare charge would be infinite or undefined to start with. This means that neither charge is "an outcome of experiment." Both are an outcome of math, math that is not defined itself. Therefore it is absurd to claim that you can subtract one renormalized number from another, and achieve a meaningful velocity or a meaningful limit. Renormalization is a trick, Landau's math is a trick, and Gross' math is a trick. So we have a triple-decker fudge here, nothing less.

In reality, math like this cannot tell us anything about a limit or a pole or a maximum energy. If you subtract an incorrect value for a charge from a correct value for that same charge, the only information you can get is information about your margin of error. You can tell how wrong one of your maths is. But you can't tell anything about the flux of any field. Landau's math is complete and utter bollocks, nothing less.

As more proof of this, look at the *form* of the equation: the left side has potential values between 0 and 1. We can see this by multiplying both sides by the smaller charge.

$$1 - e_R^2/e^2 = e_R^2\,(N/6\pi^2)\ln(\Lambda/m_R)$$

If $e_R^2$ is the smaller charge, then $e_R^2/e^2$ cannot be greater than 1 or less than zero. If N = 4, and we set the value of $e_R^2$ at 1, then the natural log of the velocity must have values between 0 and 14.8. With a natural log of 14.8, the velocity would have to have a numerical value of 2.68 million. Lower values for $e_R^2$ will raise the value of the natural log, and therefore the velocity.

For instance, if we measure velocity in meters per second, the charge on the electron must be very much smaller than 1. It must be around $10^{-19}$. This increases the natural log to around $10^{20}$, making the velocity $e^{100000000000000000000}$.

Let us say the bare charge and effective charge diverge so that one is double the other. This makes the left side ½, which lowers the natural log to $10^{19}$, which lowers the velocity to $e^{10000000000000000000}$. At the speed of light, the natural log is 19.5, which means the charge values must have converged to within $10^{-19}$(which, remember, *is* the charge on the electron). To get any appreciable divergence would require the electron to travel billions of times over the speed of light. For this reason, the Landau pole is meaningless. Even if the equation were in the correct form, the limit on the speed of a particle means that the charge values cannot approach these limits. The Landau pole is way beyond the velocity limit of the electron.

Again, my critics will say that I have pulled this velocity out of my hat. Landau's equation has no velocity in it. He never assigns the maximum momentum Λ to the electron itself, therefore I cannot assign the velocity to the electron. But again, Landau and current theory are wrong. Landau has the electron represented on both sides of the equation, as charges on the left side and as mass on the right side. This means the momentum variable will automatically assign itself to the electron. Landau may mean to assign it to the field or to another entity, but his intentions mean nothing to the numbers. The way the equation is written, that momentum must attach to the electron, giving us a velocity by the equation $\rho$ = mv, so that $\rho$/m must equal v. Since that velocity has a limit, the charges must have limits that Landau and the standard model have never seen.

Even some mathematical physicists, using the same tricks as Landau and Gross, have come to the conclusion that something is wrong with the Landau pole. In the late '90's, there was a well-known "Landau pole problem" that made the pages of several journals. In one of them, the physicists claimed that, "A detailed study of the relation between bare and renormalized quantities reveals that the Landau pole lies in a region of parameter space which is made inaccessible by spontaneous chiral symmetry breaking."[1] Yes, as I have shown with very simple math, the Landau pole *does* lie in a region of space which makes it inaccessible to its own variables, and this region of space is inaccessible to them due to the limit on c. These physicists, with their complex math of spontaneous chiral symmetry breaking, were not able to tease out the real problem here, but with many pages of dense equations they were able to tell something was not right. There are many things not right with Landau's equation, but it has nothing to do with parameter spaces or difficult math. It has to do with assignment of kinematic and dynamic variables. It has to do with logic. Physicists have gotten in over their heads with these maths, and they cannot spot the flaws in even the simplest equations. They cannot, since they no longer study basic math and motions. They are buried under fancy operators and renormalized fields.

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Gaps between renormalized values cannot yield energy limits, but Gross took this math of Feynman and Landau as bedrock. He accepted the Landau pole as legitimate, and using this math he calculated a Landau pole for QCD. This pole was way too high, so he needed a fix. He needed to lower that pole by a large margin. How did he do that? Well, with a lot more fudgy equations, of course. But under the equations lay the idea of **anti-screening**, which is the faux-mechanical explanation of asymptotic freedom. In short, Gross used the Dirac sea of virtual particle pairs to explain the drop in energy at very close quarters in the nucleus. First, Gross inserted the vacuum in between quarks. This is legitimate (even to me) since no distance is infinitely small. You can always insert the vacuum. Then he proposed that the vacuum is made up of virtual particles. In the narrow confines of QCD, only the gluons can exist in this squashed vacuum, and they exist as another sort of virtual particle pair. In this case, the gluon is a color, anti-color pair. If the quark approaches too close to this color-anti-color boundary, the gluon faces it with a similar color, driving it away. This "screens" part of the strong force, explaining why it doesn't continue to increase at the smallest distances.

The idea of color confuses this analysis somewhat, and it is easier to understand screening by looking at the screening in QED. In QED the vacuum is composed of positron-electron virtual pairs. As a real electron interacts with the vacuum, the virtual pair shows its positive face, attracting the electron even more. So in QED, this mechanism is used to explain the opposite phenomenon. In QED, we have screening, and in QCD we have anti-screening. In QED, the electron is attracted to the vacuum itself. This is said to solve other problems I don't have time to address here.[2], http://milesmathis.com/screen.html

What is wrong with this explanation? Many things. We start with the fact that neither gluons nor quarks have ever been seen, or tracked singly in accelerators. Neither have virtual particles. Nor has color. Color has never even been *defined* mechanically. Is it charge, is it spin, is it emission? No one knows. We don't even get the beginning of a mechanics. Just pages full of paragraphs like those above, proposing fields and particles and colors from nothing.

We also have a bald contradiction and *reductio* in this postulate that the vacuum is a sea of particles. It is a contradiction in that the word vacuum has always been used to mean "that thing that is not material or particulate." The vacuum is supposed to be nothing, by definition, but here it becomes something. That is a contradiction. It is a *reductio* because it begs the paradox of Parmenides. If the vacuum is composed of virtual particle pairs, then it is no longer the vacuum: it is matter. If everything is matter, then you have a plenum in which motion is impossible. Calling this matter "virtual" is just a dodge. The vacuum then becomes nothing when you need it to be transparent and something when you need it to have physical characteristics (like polarity). Defining something as both x and non-x is not physics, it is magic, sophistry, or pettifogging. No matter how many high-profile sophists or magicians we have (Dirac, Higgs, Yang-Mills, etc.), we cannot outrun illogic. You cannot turn a contradiction into a postulate, no matter how many authorities say you can.

But the basic problem is that we have an equally clear *reductio* here in the regression of fields. First, in order to explain a force, physics created a field called E/M. It never explained mechanically how that field worked, it just created field lines. To this day, we have no mechanical explanation of charge. Is it emission, is it spin, is it motion? If so, how does emission or spin or motion create both attraction and repulsion? No answer, either at the macro-level or the quantum level. Then, we look closely at this field and discover it doesn't work in the nucleus. Our opposite charges should create a repulsion. So we create another field that only works at this level, to counter E/M. But we don't define this field in terms of spin or motion or emission either. We only define it mathematically, and with cutesy names. Then we look closer, and we see that this field also doesn't work, in and around baryons. So we create another field. That is what the gluon field is. This anti-screening gluon field reverses the strong force just like the strong force reversed the E/M field.

But to be consistent, we must then look at the flux of the anti-screening gluon field. The standard model is sick of this stuff, so it just decides to go virtual at this point, dodging all further questions. But if the flux of the strong force was a problem, the flux of the anti-screening gluon field must be a similar problem. Gluons switch from attractive to repulsive over an even smaller area, so they must have greater flux. Gluons are called gluons because they are the "glue" of the hadrons, and glue is an attraction. But in anti-screening, they switch to repulsive. Therefore, we have a repulsive field underneath the strong force, and this force must have greater flux than the attractive strong force. In which case we need a fix for that also, so that *it* does not have a Landau pole creating an infinite coupling constant.

QCD answers this by throwing up its hands and saying, "We are beneath the Planck length now, and we refuse to answer any more questions!" But the problem is not one of size, it is one of logic. QED and QCD keep fixing problems in existing fields and particles by proposing sub-fields and sub-particles. But they try to do this by dodging mechanics. Instead of fixing the mechanical hole in the E/M field, they drive around that hole and build another sub-field. That is, instead of showing how charge is created mechanically, they propose the strong force, to counteract charge. Instead of showing how the strong force is created mechanically, they propose anti-screening, to counteract it.

But I have shown that if you build the E/M field with the right mechanics http://milesmathis.com/g.html, you don't need the strong force http://milesmathis.com/strong.html. And if you have no strong force, you don't need asymptotic freedom to fix it. If you get your first field right, you don't need an infinite regression of sub-fields to fix your errors. We don't need all this illogical math and theory, since we can fix the E/M field with simple and logical postulates. We don't need to renormalize our equations: we need a theory that gives us normal equations to start with. With these normal equations and postulates, we don't need an infinite regression of repairs.

To be specific, many have interpreted asymptotic freedom as giving us a field like a rubber band,[3] which is slack at near distances and taut at greater distances. It is a sort of inverted field. But this begs the opposite question: "If the field is greater at greater distances, what causes the asymptote or limit at the *other* end? That is, why doesn't the strong force get stronger as you pass the nuclear shell? Why doesn't the strong force pull on electrons? Physicists have solved the problem by inverting it and then ignoring the inverted problem.

The answer to this question is that the strong force needed to be inverted in order to make it change like the E/M field is changing. The physicists think they are measuring strong forces between quarks, but they are actually measuring stacked spins on the baryon, and gravitational-E/M forces percolating through the spins. They therefore have to invert the flux to make the strong field change like the E/M field. They have to make their theoretical field change like the real field, even though an attractive field cannot possibly increase with distance. There is no strong force, so it has to be reversed. Reversed, it magically has the same flux as the E/M field it inhabits, while having the opposite sign! This gives them a force field that acts nonmechanically and illogically, but it at least allows them to keep their strong force. But, as I hope you can see, it is much simpler to assign the reversed flux to a repulsive E/M field, which it fits. Then you can explain attractions as weaker E/M fields, instead of more powerful strong fields. You don't need finessed math to explain the inversion of the field, you just need a theoretical clean-up. An asymptotically free strong field mirrors the E/M field because it IS the E/M field. The strong force is just a subset of the Unified Field, and does not exist as a separate or separable field.

For instance, in 1964 Vanyashin and Teren'tev calculated the charge renormalization of vector mesons, getting the opposite sign they expected. The field flux was reversed, according to their math. They thought there was something wrong with the math. Quantum physicists now explain the sign with asymptotic freedom. But the real answer is that the vector mesons were not traveling in a field of "strong" vectors or potentials: they were traveling in a field of potentials created by gravity-E/M—a field of real *B*-photons that was mainly repulsive, but that was a compound of E/M and gravity. The field, though having the flux of E/M, appeared attractive because most of its strength had been turned off. It was *relatively* attractive, compared to the very strong E/M field outside the nucleus. And this is simply because most of the *B*-photons were emitted *outside* the nucleus, due to gyroscopic rules of spin.

As one final proof against asymptotic freedom, let us look at the math, such as it is. It should be a matter of interest that Gross had published, only a year earlier, and using very similar math, "a proof that no renormalizable field theory that consisted of theories with arbitrary Yukawa, scalar, or Abelian gauge interactions could be asymptotically free." [Coleman and Gross, 1973.] No one had shown this proof was wrong, but nonetheless Gross could see that the need in quantum physics for asymptotic freedom was greater than the need for proofs against it. QCD wanted asymptotic freedom, and Gross planned to supply it. He would change his course in any way required in order to supply it. If Abelian gauge theories were necessarily non-asymptotically free, he would pursue non-Abelian gauge theories. But all this talk of gauge theories is misdirection, as Gross proves in his Nobel Lecture, where he supplies "the arithmetic":

The contribution to $\varepsilon$ (in some units) from a particle of charge $q$ is $-q^2/3$, arising from ordinary dielectric or (diamagnetic) screening. If the particle has spin $s$ (and thus a permanent dipole moment $\gamma s$), it contributes $(\gamma s)^2$ to $\mu$. Thus a spin-one gluon (with $\gamma$ = 2, as in Yang-Mills theory) gives a contribution to $\mu$ of $\delta\mu = (-1/3 + 2^2)q^2 = 11/3q^2$; whereas a spin one-half quark contributes $\delta\mu = -[-1/3 + (21/2)^2]q^2 = -2/3q^2$ (the extra minus arises because quarks are fermions). In any case, the upshot is that as long as there are not too many quarks the anti-screening of the gluons wins out over the screening of the quarks.[4]

Gross then tacks on the formula for the beta function of the non-Abelian gauge theory, but that is just window dressing. You can see that he has already given us the math and the explanation, with simple arithmetic!

To begin with, notice the odd language here after the math. "In any case, the upshot is. . . ." I was struck by that the first time I read it. "In any case" is not applicable here, since Gross is not supposed to be giving us an example or a suggestion, he is giving us famous math. It is highly irregular to follow a mathematical proof with "in any case," as if all this is perhaps beside the point. "The upshot is" is also odd phrasing. We find nothing else like it in this lecture. As one would expect with a Nobel Lecture, this paper is not breezy and informal. It appears that Gross is subconsciously attempting to hurry us past this math, and trying not to put too much emphasis on it. Why?

Because he has just told two whopping lies and put them in full view. He is afraid someone might notice this, but he can't help but tell the lies anyway. Both lies happen to reside in the sentence immediately preceding "In any case." The first lie is the last equation. The second lie is that the "minus sign arises because quarks are fermions." I would hurry past that, too, if I were Gross. The whole proof relies on it, and it is known historically that he and his colleagues changed the sign right at the end. At first they had the "wrong" sign, and then they changed it. This is a well-known part of the story, since Politzer claims to have gotten it right the first time (and claims special recognition for that). But we are dealing with spins and charges here, as you see. The final equations are $11/3q^2$ and $-2/3q^2$, and $q$ is explicitly defined as charge. Well, according to the standard model in 1973 and now, gluons are spin 1, charge 0. Quarks are spin ½, and the charge may be either 2/3 or -1/3. The quarks in the proton and neutron (the most common quarks) are up and down quarks, which are 2/3 and -1/3, respectively. So the fact that quarks are fermions does not decide the question. Even according their own rules, these equations are misleading. That last equation already includes the sign of the quark inside the brackets. That first term inside the bracket can be either -1/3 or 2/3, which expresses the charge of the quark. There is no need or excuse for re-expressing the charge outside the brackets. Gross implies that all fermions are negatively charged, but even disregarding the three quarks with positive charges, we have the three neutrinos with no charge, according to the standard model. Even this simple arithmetic has been pushed!

This is crucial, since that minus sign decides, by itself, the asymptotic freedom of the field. It has to be the opposite sign of the gluons, so that the anti-screening of the gluons can counteract the screening of the quarks. If both signs are the same, we have no anti-screening and no freedom. Gross himself has proved my point, in his own Nobel Lecture.

As I have said before, physicists don't know when to shut up. It was a magnificent blunder for Gross to publish this simple math, since it put the lie in high focus. It would have been much better for him to continue to hide behind the beta function and the gauge fields, which provided some cover. But his Prize made him overconfident. Like a criminal who has dug up the loot after three decades, Gross couldn't help bragging. He has unmasked himself.

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As a closer, I will draw your attention to the fact that people are now being given Nobel Prizes in physics without doing any physics. As I have proved, what Gross, Wilczek and Politzer did was bad math, not physics. Physics is supposed to be "physical," which means material and mechanical. Non-mechanical theories and mathematics are not physical. Virtual particles are not physical: if they were, there would be no need to call them "virtual." The Landau pole is not physical, since it is found by applying a mathematical margin of error to a problem, and claiming to have developed a number that can be applied to a momentum. But a momentum cannot be derived from a margin of error. That is like saying that you can manufacture a leprechaun from a bag of leap-years. It is mathematical alchemy of the most ridiculous sort.

Not only did these guys fail to do any physics, they failed to do any real math. They did only ghost-physics and ghost-math. They created a problem with ugly math, defined it with uglier math, and solved it with even uglier math. Ironically, each math created more problems than it solved. Math and science are supposed to solve problems, but ghost-math and ghost physics do the opposite. Each ghost spawns at least two more ghosts. This is great for job-creation, but terrible for anyone who desires a meaningful or physical explanation.

I suggest that the Nobel committee discontinue the prize for physics, and substitute prizes for alchemy and job-creation.

[1]Göckeler et. al., arXiv:hep-th/9712244v1

[2]See my paper on screening.

http://milesmathis.com/screen.html

[3]http://pr.caltech.edu/periodicals/CaltechNews/articles/v38/asymptotic.html

[4]REVIEWS OF MODERN PHYSICS, VOLUME 77, JULY 2005, p. 844.

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