representing the risen Lord. Besides the dolphin being an unclean animal, dolphins dive and rise again repeatedly, which is not the picture of Christ's death and resurrection. As for the few resemblances that remain, there are several possibilities. It could be coincidence (instead of concentrating on the ones that seem appropriate, examine all the ones that are not). It could be a satanic counterfeit.

Astrology is a religion, and Satan has always fooled people with religions that contain some element of truth. Material by the Jehovah's Witnesses cult claim that the doctrines of the trinity and a man-God were originally pagan ones. Even if their claims on these points were true, they would not detract from the truths of these doctrines as taught in the Bible. As Carl pointed out, I did not discuss anywhere near the total of the star names used by Seiss and Bullinger, but I have checked out many with what is considered the definitive work on the topic, the one by Allen. In nearly *every* case I found that Allen disagreed with Bullinger and Seiss. Perhaps in a future article I could discuss some of these. I, too, would like to see someone with the knowledge of the ancient languages (Hebrew and Chaldean, for instance) check out the claims of Seiss and Bullinger. Considering the rather sloppy work that I did document, I would be surprised if an objective study of this would verify their claims.

I agree that my statement that Psalm 19 refers to the beauty of the heavens is an inference. Also I see now that my statement may have been too restrictive on this point. If I could change anything in my article, I would change that statement. However, notice that the heavens declare 'God's glory,' not his plan of redemption. While the Psalm does not explicitly state just what property of the heavens declares that glory, I do think that something akin to its beauty is what is intended. This passage is directly related to Romans 1, which declares that men are without excuse. The proscription there is that the world reveals that there is a God, and that He is very powerful. No other information about redemption is listed there.

Both Doane and Wieland suggested that it would be a good idea for someone with knowledge of the appropriate languages to further investigate the claims made for the gospel in the stars. I agree with that suggestion. Not knowing any modern or ancient Middle Eastern languages, I am obviously not qualified to do this sort of in-depth study.

Apparently Doane has some knowledge of Arabic, or at the very least has familiarity and access to useful lexicons, so I am at some disadvantage on discussing possible meanings. Doane offered possible alternate meanings of the names of 'Zuben al Shemali', Zuben al Genubi', and 'Deneb' that could support the meanings supplied by Bullinger and Seiss. However I note that while Doane is very cautious in his assertions and acknowledges alternate meanings, this was not the approach of Bullinger and Seiss. Those authors blithely asserted their meanings without caution. That is poor scholarship in my estimation. This sloppy work really becomes suspect when the truly egregious examples are examined. These would include the mishandling of Crux and the star names 'Svalican' and 'Rotanev', as discussed in my article.

I find it interesting that neither Wieland nor Doane challenged my theological comments, such as the fact that not even the demons knew of God's plan of redemption. I think that approach is the most sobering in this discussion. In the conclusion of my paper I listed several biblical problems with the gospel in the stars. As of yet no one has challenged those. All the factual errors that we have discussed pale in comparison to these.

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Instrumentalism, mathematics and science

Stephen Ferguson's paper[1] gives the impression that mathematical objects are an impenetrable mystery, or at least something that requires many years of philosophical learning even to qualify to talk about. It's a profound mystery then that mathematicians manage to do mathematics, and that for that matter mathematics teachers manage to teach mathematics, quite oblivious to the apparent philosophical conundrums.

The same mystery applies with science. Philosophical disputes rage[2] but science and science teaching, like their mathematical cousins, carry on regardless. So what's the catch?

My paper[3] provides, I would assert, the solution to the mystery. Scientific and mathematical knowledge are *instrumental.* This means that the objects of science and mathematics (e.g. atoms and numbers) are instruments for doing things to the world, not pre-existing objects (like rocks or people). In other words, atoms or numbers are the same sorts of things as spades, microscopes or maps. They are *artefacts,* not facts. They are invented (like the electric light bulb), not discovered (like the Great South Land).

Before I show how an 'instrumentalist' view solves the mystery, let me clear up some bad press for instrumentalism that appears in Ferguson's article. He writes:

'There is a line in the philosophy of science, which argues that scientific theories do not have to be true to be useful — physics would then be no more than a game with a usable outcome, but without representational content. This is called Instrumentalism, as scientific theories are reduced to the role of instruments or tools on this view, rather than as truth-apt representations of reality. '[4]

It is true that Ferguson describes a version of instrumentalism, and in fact the one that most commentators have identified as instrumentalism, probably since the so-called 'Copenhagen interpretation of quantum mechanics' in the 1920-30s. However it is not the original version, as I was at pains to express in my paper. I recommend John Dewey's (1859-1952) classic, *The Quest for Certainty*,[5] to clear up the confusion, and give a taste of some incredibly powerful and profound philosophy.

What Stephen Ferguson writes about instrumentalism thinly conceals some critically false assumptions, which even a cursory reading of Dewey would expose. The big one is that what makes something true is a correct representation of some prior existing reality (i.e. 'truth-apt representations of reality'). Dewey went to great lengths to expose what he called 'the spectator theory of knowledge', the notion that knowledge looks on at the world, passively and dispassionately, and attempts to describe its true underlying essence or being. He gives a clear and powerful account of how this false conception of knowledge developed in human prehistory, was formalized by classical Greek philosophy, and persisted unchecked and unexposed right down to the modem era.

On Dewey's view, knowledge, and thinking in general, are active, not passive:

'Thought is not a property of something termed intellect or reason apart from nature. It is a mode of directed overt action. Ideas are anticipatory plans and designs which take effect in concrete reconstructions of antecedent conditions of existence. '[6]

As far as science is concerned, measurable quantities (mass, temperature, conductivity) are defined *operationally,* that is, by the actual operations and processes which are used to measure them. They are therefore properties of the *interaction* between overt measurement operations and prior existing phenomena, not of the phenomena *perse.* Theories (laws, models) then express observed relations between these operationally defined quantities. In turn the theories (laws, models) are used as tools for prediction, or for the development of new operations to observe new phenomena. The purpose of science then is not to describe reality but to change it, to reconstruct or transform it in a way that releases new potentialities. Hence there is a direct connection, both historically and theoretically, between science and technology.

As far as mathematics is concerned, foundational concepts such as number, spatial measure, proportion and so on are also instruments for dealing with reality, not representations of it. By foundational here I am not talking about axioms and theorems developed *post facto* by pure mathematicians and logicians, but rather about basic mathematical concepts as they developed historically. This historical context was entirely practical and operational. Mathematical concepts arose in contexts of, for example, tallying and scoring in commerce or play, or in carpentry and masonry and other practical arts. In such contexts, *'the indispensable need* writes Dewey, 'is that of ***adjusting things as means, as resources, to other things as*** *ends.*[7] He goes on:

'...the origin of counting and measuring is in economy and efficiency of such adjustments .... It is easy to find at least three types of situations in which this adjustment ...is a practical necessity. There is the case of allotment or distribution of materials; of accumulation of stores against anticipated days of need; of exchange of things in which there is a surplus for things in which there is a deficit. The fundamental mathematical conceptions of equivalence, serial order, sum and unitary parts, of correspondence and substitution, are all implicit in the operations which deal with such situations, although they become explicit and generalized only when operations are conducted symbolically in reference to one another. '[8]

The key difference between mathematics and science is found in the word 'symbolically' in the last sentence. Scientific theories correlate *actual* physical operations, whereas mathematical formalisms correlate operations expressed *symbolically.* When such operations are expressed symbolically they can be manipulated, studied and developed without reference to actual operations, although at some later date they may be referred back to the original concrete operations, or even to new operations. But irrespective of whether this reference is ever made, the basic reality of the mathematical conceptions — what they represent in other words — are real, concrete, objective operations.

This account of scientific and mathematical objects reveals, I would suggest, the other critical fallacy in Ferguson's characterization of instrumentalism, namely that if scientific (or mathematical) theories are instrumental, then they have no objective content, and science is 'no more than a game'. He might as well tell a mechanical engineer that his development of a particular machine is a game, in which he might be lucky to stumble on the right prototype, which however has no actual reference to any objective realities! Obviously machines, like scientific theories, only work when they have concrete 'truth-apt' relationships to objective realities. The chances of developing successful theories or machines without reference to the realities that are there to be worked upon, and the practical outcomes that are desired, are absolutely nil!

We are ready now to clear up the big mystery we started with. How do mathematics and science manage to carry on regardless, in spite of all the philosophical debates about what they are? Easy! Firstly most mathematicians and scientists have never heard of the debates. And secondly there's no actual mystery about the nature of mathematical and scientific objects anyway. They are simply tools or instruments, either actual or symbolic, for doing things in the world. The progression of science and mathematics is no more a philosophical mystery than the progression of the practical arts and technology. This is because, so says instrumentalism (the 'original' version), they are basically all the same sort of thing anyway.

As to the specific position on mathematics put forward by Ferguson in his paper, he is right to reject David Malcolm's notion that *'mathematics* [is] *founded on a God-given innate grasp of mathematical truths.'*[9] In terms of Dewey's critique, Malcolm's version of 'foundationalism' is just another futile attempt to see mathematical objects as somehow pre-existent. But Ferguson reveals himself as a covert foundationalist when he writes earlier in his paper:

> *'As a result ... there is no privileged access to mathematics; we cannot assume that just because it is an abstract subject matter, that our contact with the realm of mathematics is the same contact as God would have; I repeat, there is no privileged access to mathematics.'*[10]

The clear assumption is that there is a pre-existing *'realm of mathematics"* — some real foundations already existing out there somewhere — which we are striving ever imperfectly to apprehend. On an instrumentalist view, this is as absurd as suggesting that there is a pre-existing realm of combustion engines, or tin openers, that engineers and inventors are striving to apprehend!

Ferguson goes on to state that:

> *'Mathematics is an essentially linguistic practice, and post-Babel, we have no reason to think that our language latches on to reality in the way we intuitively think it does.'*[9]

His argument here, that mathematics is, because of the Fall and the events at Babel, irreducibly linguistically mediated, is hard to sustain. Firstly, as all mathematicians know, maths is the same in all languages: it is linguistically invariant. Secondly, just because it speaks in symbols, it is not then somehow relative and corrigible. It will always be incomplete, because we will never know what new operations are going to be invented for it to represent. But it will never be linguistically relative — its symbols will always have their objective reference to the concrete operations they originated in.

The underlying agenda is to find a way to show that mathematics has been specifically affected in some adverse way by the Fall. I believe that Ferguson's thesis on this is off-target, and that the original agenda is misdirected anyway. Mathematics may be incomplete, in the sense of always being a work *in progress,* but it is not fallen.

In my paper I attempted to describe what I saw as the real problem to do with our understanding of science and mathematics. I argued that the historic *mis*interpretation of science and mathematics, as in some way describing the real, true, underlying essence of reality, has played a major role in the marginalization of Christian revelation as a truth-provider in the past three or four hundred years. The only sense then, on this view, in which science and mathematics can be seen as fallen, is in our radical *mis*understanding of what they are telling us about the world. I am sincerely hoping, that when the instrumental nature of scientific and mathematical knowledge are finally clearly understood, Christian revelation — the Word of God in all its fullness — will be restored to its central place in our culture.

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References

1. Ferguson, S., 1998. Humanism, foundationalism and modern mathematics, *CEN Tech. J.,* 12(1):107-114.
2. Pagano, A.R., 1998. Letter to the editor. *CEN Tech. J.,* 12(l):35-6.
3. McGinley, F., 1998. An instrumentalist critique of evolution. *CEN Tech. J., 12* (1):121-126.
4. Ferguson, Ref. 1, p. 109.
5. Dewey, J., 1930. *The Quest for Certainty: A Study of the Relation of Knowledge and Action,* Allen and Unwin, London.
6. Dewey, Ref. 5, Chapter 1. Note that genuine worship of the one true God, as chronicled in the Old Testament, needs to be excluded from the way of thinking and acting Dewey describes in the first paragraph of this Chapter. The fact that he himself did not exclude it is one important defect in his work, but it does not detract from the overall validity of his thesis. Indeed, Christian religious thinking became well and truly caught up in 'the quest for certainty' during the Middle Ages, and much theology since has been adversely affected by it.
7. Dewey, Ref. 5, p. 160. Emphasis in original.
8. Dewey, Ref. 5, pp. 149-50.
9. Ferguson Ref. 1, p. 113.
10. Ferguson Ref. 1, p. 112.

Stephen Ferguson replies:

Fergus McGinley makes a number of clear, well presented and interesting points in his letter, taking up a point which I made concerning instrumentalism and philosophy of science, reprising some of the main points of his earlier paper.[1] He contends that what I said about instrumentalism applies only to part of what can be called instrumentalism. He also raises some interesting questions about the relationship between science and philosophy of science, or mathematics and philosophy of mathematics, to which I would like to respond. First let me clarify what I think is at stake with instrumentalism.

Instrumentalism — or at least one strand of it — goes back to Pierre Duhem (1861-1916), a French physicist, who argued that what is of prime importance in science is not the theories or the hypotheses which we make, but the data which we collect.[2] As there can be no 'crucial experiments' which will confirm one and falsify another of a pair of rival theories (because supporting or auxiliary hypotheses can always be dropped or amended), scientific theories are not what science is about; they are instruments with which we frame future observations. According to Duhem, only the statements of science which are about the phenomena — about that which is observable — should be taken at literal face value.

It is usually recognised that Dewey's work (which McGinley cites), while importantly different from Duhem's, is related, and is subject to the same major criticism: namely that the distinction between the two types of statement, theoretical and non-theoretical, requires some sort of explanation. How are we to tell, given a candidate statement, how to understand its semantic content? More crudely, how are we to work out what it means? If we think that theoretical statements of science are not to be understood as truth functional, then the underlying semantics will be different from those statements — the non-theoretical ones — which are genuinely truth-apt representations (e.g. 'Copper sulphate solution is blue'). What distinguishes these two semantic categories? There is no general difference in the logical structure of such statements: there is no way to separate them purely on the basis of the properties of the language involved. Instead the difference has to be cashed out epistemologically. The statements of science which have truth evaluable content are those, according to the instrumentalist, which are observable, or perhaps, whose truth value can be decided on the basis of observation. But while the semantic distinction between, on one hand, truth evaluable non-theoretical statements, and theoretical statements on the other, is a sharp distinction, the mirror epistemic one is not. What is observable is not an absolute matter: it changes every time someone invents a new telescope, or microscope, or discovers a new staining technique to investigate cell bodies hitherto unobservable (e.g. Golgi's pioneering work). As the semantic and epistemological boundaries are drawn in different ways, they cannot mark the same divide, and the Instrumentalist is left with no coherent account of the supposed difference in the semantics of theoretical terms.

There are three ways to respond to this. The first is to argue that we never, even in the observational case, make statements which involve truth qua representation. At best we can hope for some notion of utility cashed out as:

> *'truth is an idealisation of rational acceptability. We should speak as if there were such things as epistemically ideal conditions, and we call a statement 'true' if it would be justified under such conditions.'*[3]

Or, as Bas van Fraasen has tried to argue, the key is not in looking at crucial experiments, rather what is at stake is the ways in which any theory generalises beyond an empirical core.[4] While all theories ought to be considered truth evaluable, and intended to be taken literally, they are all false, because they always mistakenly generalise beyond the available evidence. This empirical submodel of the full model of the theory, is where the emphasis should be. Van Fraasen has argued that what is important in choosing one theory over another, when both are empirically adequate — they have equivalent empirical submodels — is the relative theoretical virtues of the theories. Theoretical virtues include ease of calculation, simplicity of computer simulations, or even something as simple as the number of variables involved in the 'laws' that arise from the theory. This line has been taken by many modern instrumentalists, but it has a number of problems and drawbacks.[5]

The third main response is to accept that science aims, and usually succeeds, in giving rise to genuine descriptive statements, which like other descriptive statements of our language, are truth evaluable, and aim to represent reality. If anything passes for an accepted theory in philosophy today, it is Gottlob Frege's (1848-1925) theory of language:

> *'A singular term (word, sign, sign combination, expression) expresses its sense, stands for or designates its reference. By means of a sign we express its sense and designate its reference.'*[6]

I am against the idea that we never have any grasp on truth or falsity in our everyday dealings with the world. To think otherwise would not only make truth and falsity elusive notions, but I also consider there are fundamental problems with the pragmatist's reinterpretation of truth as the limit to epistemic enquiry. We could never know the truth because we could never know we had reached the limits of enquiry. Similarly, the problems with van Frassen's position lead me to take an orthodox Fregean position. In particular, and returning to the subject which started my interest in this, numerals are singular terms. Numerical identity statements are true descriptive statements, and so numbers — the reference of numerical singular terms — are objects.

McGinley suggests that I presented this as some obscure and particularly deep matter, to be pondered over only by philosophers. While I do not think this is the case, I do think that many of the philosophical questions about mathematics and science rest on a proper grasp of technical details in the philosophy of language. This sometimes takes the debate into areas of complexity, the necessity of which is not always immediately apparent.

Why should it matter anyway, whether statements of science or mathematics are truth evaluable or not? Trying to answer this question goes deep into exploring the relationship between the subject, call it X, be that mathematics, physics, or science in general, and the philosophy of X.

In a previous paper,[7] I attacked foundationalism as the guilty component to many philosophical positions which fail to cohere with biblical thought. Foundationalism is the approach to knowledge that crucially expresses itself in the work of Descartes, and is taken up in the work of all foundationalists since. Foundationalism says that to know something involves knowing how you know it. Before we can claim scientific knowledge, we must — according to the foundationalist — give a philosophical explanation of the reliability of the methods and practices which we use to gain that knowledge. This has recently been labelled 'philosophy first', and is one clear way of answering questions about the relationship say, between science and philosophy of science. It says that philosophy of science comes first, settles the important questions, and raises the issues which scientists should then investigate.

While this view was prominent one hundred years ago, few professional philosophers accept it today. It is generally recognised that we stand too close to our standards of evidence-evaluation to be able to then evaluate those standards in turn. We cannot, contra the foundationalist, justify justification, unless we step somehow outside of our own cognitive processes. On this non-foundationalist view, neither philosophy nor science and mathematics come out tops. Each is informed by its interaction with the other. Neither takes conceptual priority, and each has a substantial part to play in our understanding of God's Creation — the world around us.

This rejection of foundationalism is related to, but separate from, a view that I hold, which says that we have no innate grasp of numbers, something I tried to argue for in my previous paper. McGinley argues that I am a covert foundationalist because I talk of a realm of mathematical objects. Typically, mathematical platonists, or realists as they are also called (those who think there are real, but non-physical mathematical objects) hold that these objects are discovered and exist independently of us. I disagree. I think that our knowledge of mathematics is tied to our knowledge of language and to the extent that language, at its very best, can be objective, so is mathematics.

The irresistible metaphor is that pure abstract objects, conceived as by the Fregean:

> '*... are no more than shadows cast by the syntax of our discourse. And the aptness of the metaphor is merely enhanced by the reflection that shadows are, after their own fashion, real* '[8]

In sum, I think there is much to be gained from taking instrumentalism seriously — both in what McGinley calls its 'Copenhagen' sense, and as an interpretation of pragmatism — but in the end I do not think it provides a full account of science or mathematics. Other non-foundational approaches are available. In particular, the interpretation of the modern Fregeans, that numbers are objects — shadows of syntax — and that statements of mathematics and science are genuinely truth-apt.

References

1. McGinley, F., 1998. An instrumentalist critique of evolution. *CEN Tech. J.,* 12(1):121-126.
2. For example, see Duhem, P., 1969. *To Save the Phenomena,* Chicago University Press, Chicago.
3. Putnam, H., 1981. Reason, *Truth and History,* Cambridge University Press, Cambridge, p. 55.
4. See for example, van Fraasen, B., 1980. *The Scientific Image.* Oxford University Press, Oxford.
5. See for example, Psillos, S., 1996. On van Fraasen's critique of abductive reasoning. *Philosophical Quarterly,* 46:31-47, and Psillos, S., 1997. How not to defend constructive empiricism. *Philosophical Quarterly,* 47:369-72.
6. Frege, G., 1892. *Sense and Reference,* reprinted in Harnish Basic Topics in the Philosophy of Language, Harvester, New York, p. 4.
7. Ferguson, S., 1998. Humanism, foundationalism and modern mathematics. *CEN Tech. J.,* 12(1): 107-114.
8. Wright, C, 1992. *Truth and Objectivity,* Harvard University Press, Harvard, p. 182.

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Did mountains really rise?

In a recent article Charles Taylor argues that Psalm 104:8 says that mountains rose and valleys sank.[1] A major point in his argument is that