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Fictions, Inference, and Realism

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Abstract: It is often assumed without argument that fictionalism in the philosophy of science contradicts scientific realism. This paper is a critical analysis of this assumption. The kind of fictionalism that is at present discussed in philosophy of science is characterised, and distinguished from fictionalism in other areas. A distinction is then drawn between forms of fictional representation, and two competing accounts of fiction in science are discussed. I then outline explicitly what I take to be the argument for the incompatibility of scientific realism with fictionalism. I argue that some of its premises are unwarranted, and are moreover questionable from a fictionalist perspective. The conclusion is that fictionalism is neutral in the realism-antirealism debate, pulling neither in favour nor against scientific realism.

1. Models and fictions in recent philosophy of science

There has been an intense interest in fictionalism in recent philosophy of science, as witnessed by a large number of symposia, workshops and conferences organised on the topic. It seems closely linked to the booming interest on the practice of modelling in the last two decades. Among the most relevant collections one finds the volume compiled by Margaret Morrison and Mary Morgan (1999) on the mediating role of models. On this view models turn to be neither true to theory, nor just a faithful repository of data, but are thoroughly infused by idealisation and other features of the imagination more generally. The role of models in guiding reasoning as opposed to merely stating truths about their target systems, is also explored in the series of books edited by Lorenzo Magnani out of the Pavia conferences on model based reasoning in science (e.g. L. Magnani 1999). A more theoretical or philosophical treatment of idealisation in

modelling is presented in the essays collected by Martin Jones and Nancy Cartwright (2005).

These collective efforts are not the result of new developments in metaphysics or ontology but rather arise from attempts to understand the practice of modelling in the sciences. Thus fictionalism in philosophy of science emerges as the culmination of the detailed scholarship of the last couple of decades on modelling practices in the sciences. We should therefore not assume at the outset that this brand of fictionalism is merely a derivative of the fictionalism discussed in other areas of philosophy, such as metaphysics, the philosophy of language, mathematics, or aesthetics. In particular the brand of fictionalism nowadays discussed in philosophy of science has specific links with the techniques of idealisation, modelling and the imagination that philosophers of science have uncovered in the sciences. A thorough understanding of this brand of fictionalism requires a corresponding philosophical reflection upon such techniques.

2. Fictionalism and philosophy

In metaphysics and philosophy of language, fictionalism is typically contrasted with realism – as a thesis regarding the ontological status of those entities putatively referred to in fiction and fictional discourse. Roughly, realists claim that those objects have some mode of existence besides or alongside the concrete objects of ordinary experience typically studied in the empirical sciences. By contrast fictionalists claim that there is no reason to suppose that such objects exist, and in particular that fictional discourse is perfectly meaningful and legitimate without any need to postulate any particular ontology. Fictionalism is thus meant to relieve us from heavy ontological commitments while essentially preserving all our linguistic practices. Not surprisingly the main arguments in favour of fictionalism in metaphysics are intimately related to considerations of ontological parsimony. [1]

Another area of philosophical research where similar distinctions have played an important role is the philosophy of mathematics. Here too we find fictionalism in the

[1] M. Kalderon 2005 is an excellent recent collection on fictionalism in metaphysics that draws all the right contrasts.

contrast class of realism, broadly understood. The debate between classical and constructive mathematics for example turns on the interpretation of the existential quantifier, and has often been seen to rest at least in part on the issue of the reality of mathematical entities. Classical mathematicians accept the principle of bivalence, and the law of excluded middle. By contrast constructionists contend that mathematics can not legitimately avail itself of either bivalence or excluded middle. As a result constructionists defend the view that the proper practice of mathematics can neither involve nor require any commitments to a pre-existent ontology of mathematical entities, or more generally truth-makers for mathematical existential statements. The truth of mathematical statements requires the construction of a proof. [2]

More contemporarily, mathematical fictionalists contend that the practice, language and results of modern classical mathematics do not require a commitment to the reality of any mathematical entities. Contemporary fictionalism does not abandon classical (bivalent) mathematics, but instead attempts to piggy back on all its results while withdrawing the ontological commitments. The strength of this form of mathematical fictionalism is supposed to lie precisely in the avoidance of the ontological commitments without demanding any revision of classical mathematics or its practice. Not surprisingly it is a very lively option in the field. [3]

3. Fictionalism and science

By contrast in the recent literature in the philosophy of science the terms 'fiction' and its derivatives 'fictionalism', 'fictionalising', 'fiction making', are used to refer to a prominent and some argue universal feature of modelling practice. "Fictionalism" in this context is not primarily at least a view in metaphysics or even ontology, but rather a view in methodology. More particularly it is a view about the methodology of model building in science. [4] On this view, modelling involves assumptions whose main

[2] This is of course a rough summary. The literature on intuitionism and constructive mathematics is immense – a classic is M. Dummett 2000. See also C. Chihara 1990 for an extended philosophical commentary.
[3] For two contemporary defences of mathematical fictonalism see H. Field 1980, and M. Balaguer 1998.
[4] Sometimes it is also presented as a view about the ontology of models, encapsulated in the slogan that "models are fictions". But both the slogan and the view it summarizes are controversial (see e.g. R. Giere

function is as props or vehicles for the imagination. Such fictional assumptions are both essential and ubiquitous in science. We could then summarise the view as follows:

Scientific Fictionalism (SF): The exercise of the creative imagination is indispensable in order to arrive at fertile representations of the sorts of systems studied in the natural and social sciences.

A number of caveats are in order. First of all, the exercise of the creative imagination in the sciences is not entirely unconstrained. More specifically the use and application of scientific fictions is instead governed by a number of norms and requirements that do not regulate the use of other forms of fiction, such as artistic or literary fiction. So although (SF) accepts that the practice of model building is driven by the goals of greater enlightenment and understanding promoted by the exercise of the imagination, it also accepts that there will be particular constraints on this exercise. Second, and related, the emphasis on "fertile" is important. The aim is to produce representations that possess a certain virtue – and this will be the source of some of the particular constraints upon the use of fictions in science. Thirdly, the indispensability claim is restricted to model-based science – since the claim that fictional assumptions are essential is in principle restricted to that particular form of scientific activity. So we are not here making any claims regarding either scientific theorising, or the mere registering and recording of experimental data. [5]

Regardless of caveats, an important *prima facie* consequence of (SF) is that there is no requirement that particularly fertile representations be accurate or true. And indeed idealisation, distortion, and even inconsistency are all so rife within modelling practice that misrepresentation appears to be in practice a precondition for modelling to achieve its aims. This is a fundamental insight of the literature of the last two decades, and is nowadays a commonplace in the discussions surrounding scientific representation too. [6] Let us refer to these 'idealising' or 'distorting' assumptions in modelling as fictional

2009), or at least more controversial than the form of fictionalism I discuss here. So I will not discuss them extensively here.

[5] This is not to exclude a role for fictions and fictionalising in those activities, or more generally outside modelling. J Rouse 2009 for instance, claims that fictionalising has a role in the laboratory sciences too, and in particular fictional assumptions are built into model organisms. I do not need to consider such radical views in this paper; for our purposes the restriction of fictionalism to modelling practices is certainly enough.

[6] See e.g. M. Suárez 2003, G. Contessa 2007, B. Van Fraassen 2008.

assumptions or, simply, fictions. The fictionalist is committed to the indispensability of fictions in scientific representation. The question I explore in this essay is the extent to which this commitment brings the fictionalist into conflict with scientific realism.

Scientific realism (SR) is nowadays almost always understood as a thesis concerning the aim of science. More specifically, (SR) asserts that science aims at truth. [7] It is thus perhaps unsurprising that scientific fictionalism has been seen to conflict with scientific realism: does it not follow from (SF) that science can not aim at truth? [8] In this paper I attempt to identify precisely this perceived threat to realism, making explicit the reasoning that leads to the appearance of conflict, and carrying out a proper philosophical analysis. My conclusion will be that there is no genuine threat because there is no valid argument to the contradiction of (SF) with scientific realism. On the contrary these two views may – although they need not – live happily together. [9]

4. Fictional versus fictive representation

Let me then begin by discounting an ontological distinction between two ways in which a representation may be said to involve fiction. Although the distinction is clear and cogent, it has not been judged to be relevant in the elucidation of representation in science, and similarly I claim that the debate about fictions need not appeal to this distinction. But since the claim that (SF) and (SR) contradict each other often presupposes this distinction, it will pay to make it explicit and discount it.

From an ontological point of view, there is a clear difference between a representation of a non-existing entity, and an incorrect representation of a real entity. Both are misrepresentations in the sense alluded in the previous section – but the reason why each of them fails to accurately represent its target is very different. As an illustration of

[7] B. Van Fraassen 1980, p. 7.
[8] Scientific realists and antirealists alike have recently voiced the suspicion. Among the former: M. Morrison 2009, P. Teller 2009, and R. Giere 2009. Among the latter: A. Fine 2009, echoed by T. Knuuttila 2009 and my own Suárez 2009, among others. In this paper I do not presuppose any view whatever regarding realism.
[9] My aim in this paper is not to defend realism, but fictionalism. I shall claim that there is no argument against (SF) from scientific realism. In this regard (SF) is fundamentally distinct from its cousins in metaphysics and philosophy of mathematics: Unlike these, (SF) is acceptable independently of one's views in the realism-antirealism debate.

the difference, consider James Clerk Maxwell's mechanical "vortex" models of the ether; these models fail to represent their target simply because their intended target does not exist. The primary failure is not one of accuracy, but existence. By contrast, consider most idealised models in current science: however inaccurate these models are in different respects and to some degree, their targets are, supposedly, real existing objects. Thus the Newtonian model of the solar system is inaccurate – it does not describe correctly the precession of the perihelion of mercury, among other phenomena. But this is not to deny that the solar system exists and is real, nor is it to deny that the model is a representation of it.

Let us introduce some terminology to mark the distinction. Let us refer to the former case as fictional representation and the latter as fictive representation, as follows:

Fictional representation: X represents an imaginary entity Y

Fictive representation: X inaccurately represents a real entity Y

The defender of (SF), who is committed to the indispensability of the imagination in modelling, can happily accept that all scientific representation is necessarily either fictional or fictive (or both!). The scientific realist by contrast seems hard pressed to be able to accept this. For the realist science aims at truth, so it must at least in principle be the case some scientific representations are neither fictional nor fictive. [10]

5. The incompatibility between scientific realism and fictionalism

[10] This is not to say that the defender of (SF) is committed to the view that all representation is fictional – i.e. committed to there failing to even exist a target in the real world for scientific models to represent. Similarly, scientific realists need not be committed to the view that no scientific representation is fictional – i.e. that no genuine representation fails to have a target in the real world. Thus defenders of (SF) can – and normally will – accept that the solar system is real and the Newtonian model is a genuine, albeit inaccurate, representation of this real system. And scientific realists can – and normally will – accept that Maxwell's vortex models of the ether are representations of an entity that Maxwell himself could not have foreseen not to exist. Thus, as mentioned in the main text, the fictional / fictive representation distinction, however cogent, does not cut very deep in this debate. The disagreement, if any, is not about ontology, but about methodology and the aim of science.

This is where the contradiction seems to lie: The thought that all representation is fictional or fictive seems prima facie to conflict with realist intuitions. Such an argument is implicit in recent writings of philosophers on this topic, and we may refer to it as the incompatibility argument (IC). It aims to show that fictionalism is incompatible with scientific realism. But let us try to make both the intuitions and the argument more precise. More specifically let us try to derive the contradiction from an argument with just the right fictionalist premises.

We already have unearthed two fictionalist premises. The first is that all representation is fictive or fictional since modelling always involves the exercise of the imagination: at least some of its assumptions are fictional. The second takes it that fictions, as the product of the exercise of the imagination, are hence unconcerned with truth. Both follow from (SF) as I have expressed it, although they could be motivated on different grounds too. [11] I shall be more specific regarding the second premise – for reasons that will become clearer later on – and will stipulate that the cognitive function of fiction is independent of its truth value or degree of accuracy. The antirealist conclusion (science does not aim at truth or accuracy) follows from these two premises only under a conditional third premise. To be more precise the conditional premise (iii) stipulates that if fictions are ubiquitous and their cognitive function is independent of their truth-value, then science does not aim at truth (not through its models at any rate). Let us refer to this as the conditional premise; and let us explicitly write down the argument in full.

IC: The Incompatibility Argument

i) All scientific representation involves fiction, i.e. it is either fictional or fictive.

ii) A fiction's cognitive function in inquiry is independent of its truth-value (or degree of accuracy).

iii) If i) and ii) then science does not aim at truth.

[11] Conversely (SF) possesses further implications, but I shall not discuss them here since they are irrelevant to my purposes in this paper.

iv) Science does not aim at truth: Scientific realism is false

Most philosophers of science who have written on the topic recently seem to implicitly accept the IC argument. They seem to assume that IC forces a choice between the fictionalist premise (i) and scientific realism, which is explicitly denied in iv). Realists have then been inclined to reject i) and thereby reject (SF) along with it; while fictionalists have been inclined to accept iv) thus rejecting scientific realism.

But is a choice really required? The IC argument is valid as stated – but is it sound and cogent? Let us subject the incompatibility argument to careful analysis. Since premise i) is disputed by realists, we must leave it aside for the time being, and concentrate instead on the other two premises: the thesis that the function of fictions is independent of truth value, and the conditional premise that allows us to derive the conclusion from the premises. What is their status?

6. **Fictions in Science: The truth-conditional account**

The defender of (SF) takes it that fiction is ubiquitous in science: all scientific representation is fictional or fictive. But how exactly shall we characterise fiction? What are the identifying marks of fiction in science? The question is vexing and can receive several different answers. This paper adopts a functional characterisation of fiction, to be developed in the next section. In this section a still common yet incorrect alternative, the truth-conditional account, is critically discussed and rejected.

The truth-conditional account takes it that the defining property of fiction is falsehood. [12] More specifically, on this account, for an assumption in a model to work as a fiction, this assumption must i) be truth-apt, i.e. must possess a truth value; ii) it must be false;

[12] This account presupposes a linguistic formulation of the assumptions within scientific models, and might seem to sit uneasily with a semantic conception of theories, the nowadays more popular view, according to which theories are collections of models *and* are not linguistic. But the truth-conditional account could be safely replaced with an application-conditional account that is compatible with the semantic conception and has identical consequences for the questions explored here.

and iii) users of the assumption (the 'modellers') must be aware of both the truth-aptness and the falsehood of the assumption. In other words, the modellers must have access to, or knowledge of the truth conditions of the assumption – at least to the extent required for their correctly judging it to be false.

This account of fiction agrees with much that has written on the topic over the years but it is on reflection inappropriate. Two sorts of considerations can be brought to bear against the truth-conditional account. First, there are intrinsic considerations related to the fact that the three conditions above are not all necessary, nor are they jointly sufficient. Second, there are considerations discussed in other fields, particularly aesthetics and the philosophy of art, which suggest that falsehood is both insufficient and inadequate as a requirement on fiction more generally.

Let us look at sufficiency first. Are all assumptions in a model that satisfy i)-iii) fictions? Since (SF) promotes the ubiquity of fictions in scientific modelling, it could be supposed that a fictionalist would need to answer positively. But this would be a mistake, akin to an invalid transposition of quantifiers from 'all modelling involves fictionalising' to 'all that modelling involves is fictionalising'. Not every assumption in a model is fictional; and maybe among those assumptions that are not fictional there are some that are false and known to be so. Certainly it does not follow from (SF) that i)-iii) are jointly sufficient for an assumption to be a fiction. [13]

How about necessity? Can there be fictional assumptions in a model which violate either i), ii), or iii)? Let me just focus on ii) and iii) here: I shall try to show they can not both be necessary conditions on scientific fiction. [14] The statement that all fiction is necessarily false entails that the fictional character of an assumption is a trans-historical matter (assuming of course that truth is trans-historical). For instance, the assumption that electric currents are generated by displacements in the ether is nowadays considered false. But it would not have been judged to be false in late 19th century physics. So, whether an assumption works as fiction in a model is, on this view, something that can

[13] Particularly in cutting-edge areas of science the use of false assumptions might not answer to any exercise of the imagination at all, nor any pragmatic considerations, but might result out of bare necessity – there are simply no other assumptions that we could possibly bring to bear to the problem. The application of effective field theories might be a case; inflationary cosmology might be another.
[14] This is not to say that I consider i) unproblematic. The question whether fictions are necessarily truth apt is interesting, but it is beyond the scope of this paper.

be, if anything, only ascertained retrospectively. But combined with iii), this condition requires the user of a fictional assumption to be aware of its truth value – in particular the user must know that the assumption is false. It follows that those assumptions we take to have been fictional throughout the history of science (e.g. the ether, phlogiston, etc.) have not actually been fictions at all. And this is unacceptable if we take the historical record at face value. Hence ii) and iii) can not both be necessary conditions on scientific fiction. At least one of these conditions is violated by the fictions that have operated effectively silently throughout the history of science. (I say 'silently': it is a different matter altogether when it comes to those fictional assumptions that were knowingly taken to be fictions such as, possibly, the plum pudding model of the atom, frictionless planes, etc.).

Hence i)-iii) are neither necessary nor jointly sufficient for fictions. In addition, one can find alternative arguments in other areas of philosophy suggesting that falsehood is the wrong kind of criterion to apply to fiction more generally. The fictional character of a story, for instance, does not seem to depend on there being no interpretation of the story that makes it true. What's more: it is possible, however unlikely, that the story be true of our actual world, even under the standard interpretation. [15] Consequently most accounts of fictions in the arts do not nowadays assume that fiction is false, but characterise it in independent ways. [16] I shall follow suit in the next section.

7. Fictions in science: The functional inferential characterisation

A more appropriate characterisation of fictions in science refers to their function in inquiry. More precisely we may adopt a deflationary attitude towards the nature of fiction by assuming that there are no defining properties of a fictional assumption. Instead we identify fictional assumptions in virtue of family resemblances that hold between the roles they play in inquiry. Such identification is fallible – it does not amount to a definition, but at best a characterisation. Following Vaihinger I shall

[15] David Lewis credits Saul Kripke with this insight (D. Lewis 1978, p. 39) in relation with the Sherlock Holmes stories. Lewis's account gets around the problem of the possible enactment of the fictional story in the actual world by requiring that the story be told as known fact in the actual world. One need not accept a Lewisian account of fiction in order to share the view that a fictional story may as a matter of fact be true.

[16] Walton's make belief account is a good example (K. Walton 1990).

assume the function of fictions in science is related in this manner to the maxim of expediency. [17]

However expediency must be defined with respect to some aim. In line with an inferential conception of representation more generally, I will take it that the key function of fictions is to provide inferential expediency. A fictional assumption allows quick and efficient inference within the framework of a model. In other words, fictions provide inferential shortcuts in models; and the fact that this is the main or only reason for their use, distinguishes them as fictional. [18]

Let me expand on this characterisation by very briefly referring to two examples. One is the Maxwellian mechanical model of the ether in the mid to late 19th century. The other is the contemporary model of stellar structure that one finds in astrophysics. In both cases assumptions are made that are functioning fictionally because their truth or falsity is irrelevant to their role. In Maxwell's case this is arguably the function of the 'vortexes' in the ether. In the stellar structure model this is the role of the assumptions of isolation, standard composition and shape, and thermal equilibrium. In different modelling contexts these assumptions allow for a different set of inferences to be drawn. Some of these inferences are to empirically testable conclusions (electrical current displacements, including the speed of light in Maxwell's case; the Hertzsprung Russell law in the stellar structure case).

We do not need to consider the details of these models closely here. The important point is this: the function of a fictional assumption in a model is to provide, in conjunction with further background assumptions and knowledge, conditional statements. Scientist can then employ these statements to reason from properties of the model to empirical consequences of the target systems. Thus the assumption of vortexes in the ether

[17] See (H. Vaihinger 1924, p. 99). This is not to say that Vaihinger was completely clear in his characterisation of fictions in science. In particular he failed to distinguish the truth-conditional and the functional characterisations, and tended to run together the thought that the truth-value of fiction is irrelevant and the thought that fictions are false. From a functional point of view, the exegesis of the conflation is straightforward: there is no easier way to show that the function of an assumption does not depend on its truth than by showing it to be false yet successful in carrying out its function. But this is of course just a matter of rhetoric. If the function really is independent of truth value then fictions can be true or false regardless. The point is that the functional characterisation is primary and the truth-conditional is at best a happy by-product.

[18] This is the view defended in M. Suárez 2009, which also includes a discussion of the two examples mentioned in the main text.

models, for example, allows us to predict stellar aberration phenomena. From the knowledge of star distances and motion via the model's assumptions – including the fictional vortexes – we are led to the empirical prediction of the changes of relative positions of different stars in the sky throughout the year. Given our knowledge of the physics of matter and radiation and the properties standard in the interstellar medium, the idealising assumptions behind the stellar structure models similarly allow us to derive predictions of correlations of apparent brightness effective temperature on the surface of the star, conditional on some knowledge of distance and age of the star. And so on.

To put it in a nutshell, fictional assumptions may be identified functionally by their inferential roles. Given a particular context of inquiry these assumptions, jointly with background knowledge and further assumptions in the model, entail conditionals with fictional properties in the antecedent and measurable properties in the consequent. We may refer to these as the fictional conditionals entailed by the model in a given context of inquiry.

Fictional Conditionals: **Given B_1 & B_2 & […]: If F_1 & F_2 & […] then M_1 & M_2 & […]**, where {B_1, B_2, etc} are non-fictional background assumptions, {F_1, F_2, etc} are model assumptions, containing at least some fictional ones, while {M_1, M_2, etc} are measurable properties of the target systems. [19]

On the functional view of scientific fiction, the point of fiction making is to provide us with those fictional conditionals which best facilitate the inference from background knowledge to measurable consequences. Hence the use of fictions in science is justified by the maxim of *expediency in inference*.[20] This inferential and functional

[19] The application to our two examples is as follows. In the ether model case: Given rectilinear finite-speed starlight: If a star moves with respect to the ether in such and such a ways & earth moves with respect to the ether so and so then – relative positions in sky change seasonally so and so (stellar aberration). And in the stellar interior model case: Given star distance D & star age A: If temperature at core is T_1 & gas volume at star birth is V & […] then – brightness now is B & effective temperature is T_E.

[20] It would be nice of course if this inferential characterisation of fictions turned out to be more general, or even universal – and some very sympathetic audiences have suggested this to me. I confess that I find it difficult to see how it could seriously apply outside science. It is hard to find any other area of human activity where fiction making is driven by the maxim of inferential expediency. (Compare e.g. literary fiction which seems to me to divert often maximally from any form of expediency). I prefer to think that the inferential characterisation provides a way to precisely distinguish *scientific* from non-scientific uses of fiction.

characterisation of scientific fictions is supported by Vaihinger's original insights, by a large number of case studies, and by the unavailability of any other credible account of scientific fiction. But it moreover backs up premise ii) in the incompatibility argument (IC). For the inferential role of fictional assumptions presupposes absolutely nothing regarding their truth value. (In other words the inferential function is performed just as well by a set of fictional assumptions $\{F_{1T}, F_{2T}, \text{etc}\}$ that turn out to be all true, by a set of false fictional assumptions $\{F_{1F}, F_{2F}, \text{etc}\}$, or by any other 'mixed' set of true and false assumptions). Hence we have independent reasons to adopt this inferential and functional characterisation of fiction in this paper. If only for the sake of argument, this characterisation appropriately grounds the first two premises in the (IC) argument, thus providing the most favourable setting for the claim that (SR) and (SF) contradict each other – precisely the claim that we aim here to criticise.

8. Truth-driven inquiry and fictionalising in science

We have now found good grounds for accepting that the fictionalist must be committed to both premises i) and ii) in the incompatibility argument (IC). So we must now turn our attention to the conditional premise iii). Suppose that we find grounds for iii) too. This would show the (IC) argument is both valid and sound. The scientific realist would then want to use the (IC) argument to provide a reductio of fictionalism. The fictionalist by contrast would employ (IC) as a powerful argument against scientific realism. In either case, conflict is ensured. But is the incompatibility argument cogent? It seems clear now that the answer to this question turns on a premise that has not before been made explicit and has received very little attention even implicitly, namely the conditional middle premise iii). This is the premise that allows the argument to move from the fictionalist-grounded premises i) and ii) to the antirealist conclusion. The defender of the incompatibility argument (IC) must assume that the fictional assumptions that (SF) postulates as a necessary part of all scientific models cannot be reconciled with the aim to seek out truth according to (SR). This is the intuition that needs backing up in order to defend premise iii).

Notice however, that there is much of interest that we have discovered along the way. In particular in our attempt to clinch premise ii) for the fictionalist we have developed a

new understanding of scientific fiction. This new understanding takes a deflationary attitude to the nature of fiction in science, and provides a family resemblance characterisation instead. The resemblance is in their function in inquiry only: Fictions in science promote a form of expediency in inference. Contrary to what one may have thought, truth value, and in particular falsehood, is *not* a defining feature of fiction in science.

This has interesting consequences for the (IC) argument. For it turns out that the notion of fiction that grounds premise ii) provides no grounds whatever for the conditional premise iii). And conversely: the notion of fiction that would ground the conditional premise – and which probably is in the mind of most of its proponents – can not ground premise ii).

Let us make this claim more precise. The conditional premise (iii) requires fiction to always necessarily involve falsehood – or at least the absence of truth. For only then can one can safely go from "all scientific representation involves fiction, and a fiction's cognitive function in inquiry is independent of its truth-value" to "science does not aim at truth". In other words premise iii) is true under the truth conditional account of fiction. But this is not the account that grounds and justifies premise ii) from a fictionalist point of view. So the account of fiction that makes true the conditional premise iii) also happens to make premise ii) doubtful. Under the truth conditional account of fiction the (IC) argument is not cogent because premise ii) is unwarranted.

However, the truth-conditional account was critically analysed and discarded for independent reasons in section 6 anyway. An alternative functional and inferential characterisation was developed in section 7, and we saw that it appropriately grounds premise ii). So let us now focus on the inferential characterisation of fiction. On this view the function of fiction is to promote inferential expediency by providing the modeller with a number of fruitful fictional conditionals, which allow for inference to relevant measurable properties or quantities. But we have already noted that inferential expediency in no way requires the fictional assumptions to be false. On the contrary, the fictional properties mentioned in the antecedent $\{F_{1T}, F_{2T}, \text{etc}\}$ may *all* turn out to be

true! [21] In other words the inferential characterisation of fictions grounds premise (ii) in the (IC) argument but at the expense of the conditional premise (iii), which is now left lacking in justification.

Hence (IC) fails to be cogent *whatever understanding of fiction in science is adopted*, as long as it is consistently applied throughout. The only way to push (IC) through to its conclusion is by surreptitiously changing the meaning of 'fiction' half-way through the reasoning, in moving from premise ii) to premise iii). The appearance of conflict thus reveals inadequate attention by philosophers so far to the nuances of fictions and their role in science, and a failure to make explicit the argument for conflict.

9. **Conclusions**

It is a common place in many areas of philosophy that realism and fictionalism are contrary positions. In metaphysics and philosophy of mathematics for example, fictionalism has emerged as a powerful alternative to the extant realist views. In both areas the conflict between these two views seems clear. So it is not entirely surprising that their homonyms have also been thought to similarly come into conflict in the philosophy of science. However, the thought may just result from faulty association.

In this paper I have provided an updated and appropriate expression for the view that may be called scientific fictionalism (SF). I have contrasted two different accounts of fiction and defended a functional characterisation in terms of inferential expediency. I have then analysed the supposed conflict between (SF) and scientific realism and have found no good argument to this conclusion. On the contrary it does not seem possible to derive antirealist conclusions from the appropriate fictionalist premises. This not to say that scientific realism is true, and of course it is not to say that scientific fictionalism (SF) must be committed to it. Although these views have not been shown to be in

[21] There are no grounds to suspect this is the case in the two examples that I provided. In Maxwell's case the fictional assumptions are false. But in the stellar structure models case, some of the assumptions (isolation, and initial composition) can be seen to be innocuous idealisations: although not strictly true, their departure from truth is minimal. The literature on idealisation is of course immense, but there is no room to canvas the full range of idealisations here. (See e.g. M. Jones and N. Cartwright 2005 for some discussion). But the brief argument above already supports the view that whether the fictions in a model are idealisations or not is irrelevant to their inferential function as fictions. If so a study of the varieties of idealisation will not have a significant impact upon the thesis defended in this paper.

conflict, and they could in principle live together happily, it is of course logically possible that independent arguments will lead us to reject either. And indeed diverse considerations can be, and have been, brought to bear in favour of one of these views over the other. For example there are many well known and powerful arguments against scientific realism, [22] but not so far against fictionalism – certainly not against the form (SF) defended here. Thus the fact that there is no clash between these two views does not entail that there are no rational grounds to adjudicate and evaluate them on their own merits. However, this work still remains to be done. Fictionalism will not be defeated by a mere expression of faith in scientific realism.

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