

Lloyd Davies Philosophy Prize (Oriental College, Oxford) 2020 :

Is it rational to believe in the existence of viruses but not to believe in the existence of dark matter?

To believe in something is to accept something as true, feel sure of the truth of it¹. Rationality, on the other hand, is the quality of being based on or in accordance with reason or logic¹. Therefore, believing rationally is using reason or logic to accept the existence of something. For example, using reason, and logic for that matter, we could consider the belief in a scientific theory rational once it is supported by good evidence. What could be considered good evidence is if the theory has been confirmed² by a strong number of instances and that it still hasn't been refuted by any counter-instance over time. As, under those circumstances, we have good evidence for the theory and no evidence against. This reasoning applies only to refutable theories. Indeed, the belief in an irrefutable theory could have instances confirming it and could still be not rational as an irrefutable theory cannot, by definition, be refuted by any counter-instance. In the same idea, like argued by Karl Popper in *The Logic of Scientific Discovery*, for a theory to be labelled scientific, it must be refutable. This, however, doesn't make every refutable theory scientific, but makes every non-refutable theory non-scientific. On the other hand, under a psychological approach: "Rational Beliefs are tentative, and flexible. They are logical [and] consistent with reality"³. Indeed, for a belief to be rational, in addition to being logical and reasonable, it must also be tentative and flexible. In other words, we must be ready to change our minds once we provided with new information. For example, if an experiment or observation contradicts the theory (for example the orbits of Uranus and Mercury that contradicted Newton's depiction of gravity), we must be ready to adopt a new and more accurate theory (such as Einstein's theory of general relativity that explained the orbit of Mercury). Moreover, we could also make an ad hoc hypothesis⁴, such as the existence of a planet beyond Uranus explaining its orbit, Neptune.

Having established what is rational belief, and how one can believe rationally in a scientific theory, can we rationally believe in the existence of viruses without believing in the existence of dark matter? We will start by establishing different principles that will allow us to understand the rationality of belief in scientific theory, then we will determine if believing in viruses can be considered rational, and then we will assess whether these conditions also apply to dark matter.

¹ definitions by Lexico, Oxford dictionary

² If an instance confirms a theory, under philosophical terms, it simply means that the instance is in line with the theory.

³ Quote from : A Practitioner's Guide to Rational-Emotive Behavior Therapy, Raymond A. DiGiuseppe, Referenced on Oxford's Clinical psychology Website

⁴ An ad hoc hypothesis is a hypothesis designed to prevent a theory from being falsified, often when encountering anomalies going against the theory's predictions.

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Firstly, Let's establish principles in order to understand the rationality of belief in scientific theories.

As displayed in the introduction, a theory not in line with the following principle is not scientific :

A1 : In order for a theory to be labelled scientific it must be refutable, like argued by Karl Popper. (However, this does not mean that every refutable theory is scientific. Rather, it means that any non-refutable theory is non-scientific).

The A1 principle is essential to the A2 principle as A2 can only be applied to refutable theories.

Additionally, a belief in a scientific theory has to be in line with A2 in order to be considered rational :

A2 : In order for the belief in a scientific theory to be rational it must have been confirmed by several instances over time and not have been refuted by counter-instances. Moreover, if a theory has been refuted by any counter-instance, then it can be considered irrational to believe in it.

Let us now focus on the third and final principle that we will rely on in this essay. This principle concerns ad hoc hypotheses and the rationality of the belief in them :

A3 : In science, when making ad hoc hypotheses and before getting any conclusive experimental data , we cannot know whether the ad hoc hypothesis is the right approach to the problem or whether the theory on which the ad hoc hypothesis was based needs to be revised. Therefore, it is not more rational to believe in the ad hoc hypothesis than to believe that the entire theory on which the ad hoc hypothesis is based should be revised when we do not have conclusive experimental data pointing towards either one of those options.

For example : the ad hoc hypothesis of Urbain Le Verrier on the orbit of Uranus (the theory that there is a planet beyond Uranus, Neptune, that explains Uranus's orbit) turned out to be true. Whereas his theory explaining the orbit of Mercury (that there was a planet closer to the sun than Mercury) turned out to be wrong and the problem of Mercury's orbit has been solved years later by revising the theory on which this ad hoc hypothesis was based on, Newton's depiction of gravity, when Einstein published his theory of general relativity.

Secondly, having established those principles, let's now determine whether the belief in the existence of viruses can be considered rational. In order to do so, we must describe how viruses were discovered.

The story of the discovery of viruses began in the late 1800's when the German agricultural chemist Adolf Mayer and the Russian botanist Dmitri Ivanovsky were conducting research on tobacco mosaic disease. Through experiences, Adolf Mayer concluded that the disease was infectious as he could spread the disease spraying sap from infected plants onto healthy plants. Moreover, Dmitri Ivanovsky, inferred that the disease must be caused by a tremendously small organism, smaller than bacteria, as the sap was still infectious after passing through a filter designed to retain bacteria. The first observation of the tobacco mosaic virus was finally made by Wendell Meredith Stanley, a Nobel Prize-winning American biochemist and virologist.

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Having indicated how viruses were discovered, let us now focus on the rationality of the belief in viruses.

When applying the A1 and A2 principles to the belief in the existence of viruses (the A3 doesn't apply as it is not an ad hoc hypothesis), the information given in the paragraph on the discovery of viruses lets us admit that :

B1 : Dmitri Ivanovsky's theory that the tobacco mosaic disease was caused by organism smaller than bacteria (that Martinus Beijerinck later called viruses) was a refutable theory, as if any experiment would have shown that the disease was caused by another source, for example if the filter used happened to be defective, then the theory would have been refuted. (B1 checks the requirements of A1)

B2 : His theory has been confirmed by many instances over time, for example by Wendell Meredith Stanley's observations of tobacco mosaic viruses using electron microscope, and it has yet to be refuted by any counter-instance. (B2 checks the requirements of A2)

We can therefore conclude that it is rational to believe in the existence of viruses as both the theory and the experiments are in line with A1 and A2.

Thirdly, now that we have established why the belief in the existence of viruses can be considered rational, let us focus on dark matter.

Observations of spiral galaxies made by American astronomer Vera Rubin in the 1960's and 1970's, led us to realize that the motion of galaxies was not occurring the way it should according to their masses. Indeed, according to Kepler's laws, the closer gas clouds and stars are to the center of the galaxy, the faster they should rotate. But, what the observations tells us is that when going far from the center of the galaxy, the velocity of gas clouds and stars increases in some galaxies. Moreover, in other galaxies, their velocity flattens and becomes constant, but it never decreases. Furthermore, at the speed at which stars are rotating inside of the galaxy, they shouldn't be able to remain inside of the galaxy, because of the centrifugal force.

Therefore, Vera Rubin concluded that there might be some matter that we cannot see, namely "dark matter" that impacts the motion of stars inside the galaxies. Her theory was in line with the one of Swiss astronomer Fritz Zwicky, who inferred that there might be more matter than meets the eye while observing the speed of galaxies in galaxy clusters. Indeed, at the speed at which they are moving they shouldn't be able to remain in the cluster.

The dark matter theory is widely accepted among astrophysicists and astronomers. Nevertheless, it is not the only viable hypotheses to explain those anomalies. As a matter of fact, the hypothesis that there is invisible matter that affects the gravitational pull of galaxies is made using Einstein's depiction of gravity. However, several physicists, like Erik Verlinde, believe that in order to understand the anomalies supposedly caused by dark matter, we could revise our understanding of gravity and make a new theory of gravity. If making a new theory of gravity was the true answer to the problem, it would not mean that Einstein's theory of general relativity was wrong, it would

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simply mean that it was not complete. It would improve Einstein's theory just like Einstein's theory improved Newton's theory.

Having now indicated the reasons that make some scientists believe in the existence of dark matter, let's now focus on the rationality of the belief in the existence of dark matter.

Applying the A1, A2 and A3 principles on the theory of the existence of dark matter on A1, A2 and A3 principles gives us :

C1 : The theory on the existence of dark matter is refutable, as if we were to find that these anomalies were due to another factor, for example our lack of understanding of gravity, it would be refuted. (C1 checks the requirements for A1)

C2 : There isn't any instances confirming the dark matter theory nor counter-instances refuting it. It is therefore not rational nor irrational to believe in it. (C2 doesn't check the rationality, nor the irrationality criteria of A2)

C3 : As the dark matter theory is based on current understanding of gravity and keeps in from being falsified, it could be considered an ad hoc hypothesis. Moreover, as of now, there has been no experimental data confirming nor refuting the dark matter theory. Therefore, by applying A3, we can conclude that the belief in dark matter is not more rational than the non-belief in dark matter. (Under the A3 principle)

In addition, if one was not to believe in the existence of dark matter, then one would need to explain the anomalies observed by the hypothesis that they are due to our lack of understanding of gravity. Applying A1, A2, A3 principles to this hypothesis gives us :

D1 : The theory that the anomalies observed are due to our lack of understanding of gravity is refutable as if we were to actually find dark matter and discover that they caused the anomalies, this theory would be refuted. (D1 checks the requirements of A1)

D2 : There isn't any instances confirming that our lack of understanding of gravity explains the anomalies observed, nor counter-instances refuting it. It is therefore not rational nor irrational to believe in it. (D2 doesn't check the rationality, nor the irrationality criteria of A2)

D3 : The theory that the anomalies observed are due to our lack of understanding of gravity implies that, to explain the anomalies, we need to revise our current understanding of gravity. As of now, there has been no experimental data confirming nor refuting the theory. Therefore, by applying A3, we can conclude that the belief in this theory is not more rational than the belief in the dark matter theory.

It is therefore as rational to believe in the existence of dark matter as to believe that the anomalies that some scientists think are caused by dark matter are due to our lack of understanding of gravity, i.e. not to believe in dark matter.

In conclusion, Believing rationally is using reason or logic to accept the existence of something. Using reason and logic, in order to determine whether it is rational to believe in the existence of viruses and not believe in the existence of dark matter, we have established 3 principles : A1, A2 and A3 . We then explained how viruses were discovered and concluded that the belief in the existence of viruses was rational. Indeed, the statements B1 et B2, deduced from the information given by the theory and experiences on viruses matched the conditions of the principles. Subsequently, we focused on the rationality of the belief in dark matter. We explained how the dark matter theory came to be, because of anomalies inside the galaxies and between galaxies. Afterwards, we demonstrated that it was as rational to believe in dark matter as to believe that the anomalies are due to our lack of understanding of gravity, according to the principles.

It can therefore be rational to believe in the existence of viruses without believing in the existence of dark matter, as it is as rational to believe in dark matter as to believe that the anomalies observed in galaxies are due to our lack of understanding of gravity.

Whether or not we believe in the existence of dark matter, this reflection indicates how much we do not know and makes us wonder what's behind the veil hiding the true nature of the universe, and perhaps of reality.

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