Journal of Interdisciplinary Science Topics

The Many Worlds Interpretation: Can anime exist in real life?

Arbaaz Patel
Faculty of Health Sciences, McMaster University
17/04/2018

Abstract
This paper examines if the worlds depicted in anime series with their physics-defying events can exist in parallel worlds. Considering the Copenhagen Interpretation adopts the notion of wavefunction collapse, it is incompatible with the possibility of alternate universes existing. Thus, the Many Worlds Interpretation, which denies the possibility of this collapse and therefore allows other worlds to exist beyond ours, is adopted to argue that worlds parallel to ours with significantly different physical laws are highly unlikely to exist.

Introduction
There is a common misconception that the science behind the parallel universes suggests that all possibilities, including the physics-defying events shown in anime and TV-shows, can exist. Much of this misconception occurs because the Copenhagen Interpretation has been linked to the existence of parallel universes. However, if we consider the Many Worlds Interpretation, the theoretical likelihood of a world consisting of the phenomena seen in anime series (e.g. teleportation, light-speed movement, etc.) is actually improbable. Thus, we provide an answer to the question of whether or not any world like those in anime series can exist by considering the Many Worlds Interpretation.

Misconception: Copenhagen Interpretation
It is important to first clarify the distinction between the Copenhagen Interpretation and the Many Worlds Interpretation.

Under the Copenhagen Interpretation, objects do not have any definite properties until they are measured [1]. Prior to this, objects exist in a superposition (the state of existing in all possible states) of their wavefunction (ψ; the total possible states an object can take on). This particular wavefunction describes the particular configuration of the particles that allow for an object to assume its state [2]. Upon observing an object, it assumes one of the possible states in its wavefunction. That is to say, the wavefunction is collapsed [2].

Under this theory, it might be said that a multiverse (a construct in which multiple worlds exist) exists in superposition of its wavefunction. When something is measured or fails to be measured, or an action is taken or even not taken, for example, the wavefunction is collapsed for the world in which the event occurred. However, upon wavefunction collapse, all other possibilities cease to exist.

The Copenhagen Interpretation of wavefunction collapse is therefore incompatible with the idea that multiple universes exist because it does not allow for alternate possibilities to exist.

The Many Worlds Interpretation
The Many Worlds Interpretation denies the possibility of wavefunction collapse after observation, and interprets each possible event as existing in a separate non-communicating world (i.e. multiple universes exist) [3, 4]. Instead, quantum decoherence is used to explain the phenomena associated with what *seems* to be wavefunction collapse [2]. At its simplest form of interpretation, there exists a world for every possible event that *could have, has, or will* happen [3].

In brief, the multiverse exists with a universal wavefunction; that is to say, there exists only one wavefunction, entitled the *basic physical entity*, as coined by Everett [5]. For each possible event, there exists a wavefunction originating from the universal wavefunction, but bifurcates in different trajectories

which never interact. However, there is never any true collapse – a wavefunction never assumes a definite state or position – it only appears to collapse [4, 6].

Quantum decoherence provides an explanation as to why a wavefunction appears to collapse upon observation, but by no means does it claim collapsing occurs. In its most general sense, the quantum information escapes into the surroundings to assume certain phases in certain "worlds". Thus, the quantum system (i.e., the original particles comprising the wavefunction) begin to obey the rules seen in the observable world after interacting with the environment [2]. In the end, all possibilities exist in superposition in that they are all relatively entangled with the universal wavefunction but differ with respect to their coherence to the system and their assumed wavefunction [7]. That is to say, all possibilities exist simultaneously.

In simpler terms, different wavefunctions exist for different words as a result of quantum leakage from the universal wavefunction. These worlds correspond to the infinitely many alternate futures and histories, and simultaneously exist with the present day instead of merely being possibilities. Thus, the events we perceive are a result of us perceiving a "wavefunction collapse", but in actuality, there is no true collapse – it is only a decoherent form of the original wavefunction.

We may therefore consider the wavefunction of each object in a world as defined by "$|\psi|_{OBJECT}$", indicating assumption of a decoherent form, or a relativistic (but not actual) collapse. Finally, not all particles comprise objects. For those that do not, the wavefunction is denoted ϕ.

Thus, the defined wavefunction of a "world" is the sum total of the decoherent wavefunctions of particles in each object multiplied by the decoherent wavefunction of all particles which do not comprise objects [8]. In simpler terms, because each object has a decoherent wavefunction, the sum total of the decoherent wavefunctions of all objects in one particular world constitutes the overall wavefunction of that world. This is analogous to the idea that the total mass of an object is the sum total of the individual masses of its components. In mathematical terms, this is represented as:

$$|\psi|_{WORLD} = |\psi|_{OBJECT_1} + |\psi|_{OBJECT_2} + |\psi|_{OBJECT_3} \dots \times |\phi| \quad (1)$$

Thus, the multiverse universal wavefunction (where "$|\psi|$" does not apply since the universal wavefunction is coherent) is defined, as [8]:

$$\psi_{MULTIVERSE} = |\psi|_{WORLD_1} + |\psi|_{WORLD_2} + |\psi|_{WORLD_3} \dots \quad (2)$$

This defines the basis of the Many Worlds Interpretation and the existence of parallel worlds which comprise the multiverse.

The Existence of an Anime-like World

The misconception is that an anime-like world could be defined by equation 1, and could exist in a multiverse as defined in equation 2. However, Everett's postulate assumes that the laws of physics across parallel worlds should remain generally obedient to what is currently observed. In other words, a world in which the laws of physics are inconsistent with those that are currently accepted is highly improbable to exist [9]. Furthermore, Tegmark considers the wavefunctions provided by equation 1 and 2 in a statistical light, where he notes that anything inconsistent with the laws of physics will never happen as a result of statistical improbability [9]. Finally, Tipler concludes that extremely absurd events, as observed in many anime series, assume non-existent wavefunctions, thus the probability of a world existing in which such events occur is zero [10]. Thus, it would seem that the worlds depicted by anime series are unlikely to exist as the laws of physics are quite stretched (e.g. in Naruto, characters display supernatural abilities).

Conclusion

According to the Many Worlds Interpretation, a world in which the laws of physics are drastically different from what we know to is highly improbable to exist. As a result, because the phenomena seen in most anime seem to drastically disobey the laws of physics as we currently know them in one way or another, it is highly unlikely that worlds like those portrayed in anime series exist.

References

[1] Melkikh, A.V. (2013) *Quantum field theory solves the problem of the collapse of the wave function*, arXiv preprint arXiv:1311.0205.

[2] Tegmark, M. & Wheeler, J.A. (2001) *100 years of quantum mysteries*, Scientific American, 284, pp 68-75.

[3] DeWitt, B.S. & Graham, N. (2015) *The many worlds interpretation of quantum mechanics*, Princeton University Press.

[4] Albert, D. & Loewer, B. (1998) *Interpreting the many worlds interpretatio*n. Synthese, 77, pp 195-213. DOI: 10.1007/BF00869434

[5] Everett, H. (1973) *The Theory of the Universal Wave Function.* Long thesis as published, UCI Libraries. Available at: http://hdl.handle.net/10575/1302 [Accessed 17th April 2018]

[6] Bacciagaluppi, G. (2012) *The role of decoherence in quantum mechanics.* Stanford Encyclopedia of Philosophy. Available at: https://plato.stanford.edu/entries/qm-decoherence/ [Accessed 17th April 2018]

[7] Tegmark, M. (1999) *The interpretation of quantum mechanics: Many worlds or many words?* Fortschritte der Physik (Progress of Physics), 46 (6-8), pp 855-862. DOI: 10.1002/(SICI)1521-3978(199811)46:6/8<855::AID-PROP855>3.0.CO;2-Q

[8] Vaidman, L. (2009) *Many-worlds interpretation of quantum mechanics* in Compendium of Quantum Physics. Editors: Springer, Berlin, Heidelberg, pp 363-367. ISBN 978-3-540-70626-7

[9] Tegmark, M. (1997) *The Universes of Max Tegmark*. Available at: http://space.mit.edu/home/tegmark/crazy.html [Accessed 1st February 2018]

[10] White Gardenia (2016) *white gardenia - interview w/ frank tipler (discussion on richard dawkins stephen hawking more..* YouTube. Available at: https://www.youtube.com/watch?v=kMkp1kZN5n4&t=26s [Accessed 4th March 2018].