A World Without Time: The Forgotten Legacy of Gödel and Einstein

Essay Review - May 2013

Marie Gauthier

Palle Yourgrau (2006). *A World Without Time: The Forgotten Legacy of Gödel and Einstein*. New York: Basic Books.

Kurt Gödel was an Austrian American logician, mathematician and philosopher. After he moved to America, Einstein became his colleague and friend at the Institute for Advanced Study in Princeton. He also studied Einstein's theory of relativity and showed that it was consistent with time travel. Yourgrau's book analyzes these different features that relate Gödel and Einstein together, taking a philosophical outlook. As mentioned in the acknowledgments, this is not the first time Yourgrau writes a book about this topic. In 1999, he wrote *Godel Meets Einstein: Time Travel in the Godel Universe* that was "intended primarily for philosophers" whereas the book *A World Without Time: The Forgotten Legacy of Gödel and Einstein* is "accessible to normal readers" (p. vii). This is a fair statement since Yourgrau always takes care of defining new philosophical concepts that are not necessarily known by non-philosopher readers.

Yourgrau's book begins with a quote from the American physicist and mathematician Freeman Dyson "Gödel was… the only one of our colleagues who walked and talked on equal terms with Einstein" (p. 1). It could describe genuinely the relationship between these two great scientists, namely together and apart at the same time. Throughout the entire book, the author draws parallels between Einstein and Gödel's lives, covering a wild variety of topics: science, philosophy, culture, personality, private life.

But Gödel and Einstein's relationship was even more deeper than the differences and similarities between the two men drawn from these various comparisons. Referring to the book's title, the main theme should be "A World Without Time". Indeed, Gödel gave an interpretation of both special and general theory of relativity that led him to the conclusion that time was unreal. Surprisingly, less than twenty five percent of the book covers this theme. It seems that Yourgrau wanted to focus more on a different matter though, namely the "Forgotten Legacy of Gödel and Einstein". He expressed his desire to concentrate on the "sheer intellectual drama of the companionship of Gödel and Einstein-a relationship sorely neglected in the literature" (p. vii). This relationship is indeed not very popular among the literature. For instance, Einstein's biographers may not refer to it at all or may just dedicate few lines to it. But as Yourgrau points out, this "Legacy" was also pretty much ignored among philosophers. In this sense, Yaurgrou's book is an attempt to find the reasons of this neglecting and to show that Gödel's philosophy was underestimated.

Although comparison between Gödel and Einstein is not the main announced theme of the book, the latter is built on it and parallels between the two scientists can be found in each chapter of the book. The central similarity between Einstein and Gödel is perhaps the fact that they have achieved great discoveries in science that were groundbreaking. Yourgrau describes Gödel and Einstein with superlatives, Gödel is "the greatest logician of all time" (p.1) while Einstein is "the greatest scientist since Newton" (p. 31). Along with Werner Heisenberg, they were the "three men whose fundamental scientific results opened up new horizons" (p. 3) in the beginning of the twentieth century. The German theoretical physicist Heisenberg was one of the key creators of quantum mechanics and was even awarded the Nobel Prize for its creation. But Einstein and Gödel found themselves opposed to Heisenberg: "together they remained isolated and alone" (p. 4). The isolation the author speaks about has two aspects. The first one is geographical and the second one is philosophical.

Heisenberg remained in Germany while Gödel and Einstein emigrated to the United States at the end of the first half of the twentieth century. They met in 1933 during a visit to the Institute for Advanced Study in Princeton and they became friends in 1942 after Gödel

had joined the institute as a “temporary member” while Einstein was a permanent professor. Before moving to the United States, both Einstein and Gödel were hesitant mainly because of what Yourgrau calls the “Vienna Syndrome”. The effects of this syndrome were the unreasonable attachment and commitment of Austrian scientists to Vienna, “the city of charm and culture” (p. 80) and furthermore, if we consider the “German strain” of the syndrome, to Berlin. In Vienna and Berlin, Gödel and Einstein, respectively, used to living among a scientific and cultural club that they appreciated a lot. By leaving Europe, they would find themselves much more isolated in the United States. They would find ways to enjoy their American life though. They would become not only scientific colleagues but also genuine friends. They saw each other everyday, went to the institute and returned home together. Einstein even admitted that he went to his office “just to have the privilege of walking home with Kurt Gödel” (p. 94). They were outsiders but had their own eccentricities. For instance, Einstein was a Jew professor in a university where there were still Jewish quotas for its students. Gödel was a hypochondriac whose “fear of disease finally grew into a generalized fear of others” (p. 92) whereas Einstein was used to having affairs with women.

They were not only outsiders regarding their private life, but also and above all, they were outsiders regarding their scientific and philosophical outlooks. In order to give a proper description of them, Yourgrau describes carefully the philosophical, scientific, sociological and cultural context of the first half of the twentieth century. At the time, two main philosophies of science were facing each other: logical positivism and realism. On one side, logical positivism is a theory mostly influenced by the Austrian physicist and philosopher Ernst Mach’s empiricism that bases all knowledge on sensory experience. This was the leading philosophy of both Berlin circle and Vienna circle that were associations of philosophers, contemporaries to Gödel and Einstein, formed in the 1920s. On the other side, realism is the belief that reality exists independently of observers. In his early works, Einstein was inspired by Mach’s empiricism. In his 1905 paper about special relativity, he redefined the concept of time based on empirical facts such as the synchronization of clocks. At the same time, Einstein had different views on Mach’s philosophy of science. His 1905 article about Brownian motion is based on the hypothesis of the existence of atoms and molecules. Mach was opposed to this assumption since such particles are not empirically observable. Einstein then took more and more distance from positivism and turned to realism. Contrary to Heisenberg and in accordance with Gödel, he believed that there was a mathematical intuition -different from Kant’s limited conception of intuition- that could provide truths about reality.

Meanwhile, mathematics suffered from a crisis for the search for its proper foundations. Yourgrau gives a detailed picture of this foundational crisis. He mentions the German mathematician Georg Cantor and his proof that there is “an infinity of infinities” (p. 45) or the Russel’s paradox (the set of all sets that are not members of themselves is member of itself if and only if it is not a member of itself). The German mathematician David Hilbert provided a response to this crisis. As a formalist, he claimed that mathematics was only a language and he proposed to give all mathematical theories one single formalism built on a finite set of axioms. Such formalism should be consistent, that is should not contain any contradiction and it should be complete, that is “all true statements expressible within the system (under a suitable interpretation) should be derivable from the axioms” (p. 53). Gödel showed that most of the goals of Hilbert’s program were impossible to achieve. In 1931, he proved his two incompleteness theorems: “the complete set of mathematical truths will never be captured by any finite or recursive list of axioms that is fully formal” (p. 3) and such

a system can't demonstrate its own consistency. Yourgrau dedicates a substantial part of his book in the chapter 4 about Gödel's proof. He warns the reader not to get intimidated by the toughness of the details. We also would like to add that the reader should be aware of some confusion that can be found in this chapter. Indeed, Yourgrau doesn't give proper and clear definitions of some advanced mathematical concepts, such as omega-consistency for example (p. 67). Anyway, the given description of Gödel's proof still helps the attentive reader to "get the gist of Gödel's argument" (p. 59). Gödel's incompleteness theorems can even be considered more philosophical than mathematical. The major point raised by Yourgrau is to understand the philosophy of it, more precisely "discovering the limits of formal methods in capturing intuitive concepts" (p. 76). It was a break with tradition and Gödel "may have been a spy in the house of logic, a revolutionary, an intellectual bomb" (p. 69). Gödel's incompleteness theorems can be compared to Einstein's theory of relativity. Both of these scientific achievements brought unexpected results and were not fully understood by Einstein and Gödel's contemporaries. Both have had their opponents: Einstein and antirelativists, Gödel and formalists. But eventually, both theories became appreciated and largely used and they made their creators famous. The comparison can go even further, embracing a philosophical outlook. Indeed, both theories advocate "the freedom of the creative imagination" (p. 55) allowed by mathematical thinking. It seems quite natural regarding Gödel's incompleteness theorems. Regarding the General Theory of Relativity (GTR), it was also mathematical creativity, more precisely the use of the Riemannian geometry and tensor calculus, that led Einstein to his field equations after many struggles.

Then, Einstein and Gödel were "Scientists as Philosophers" (p. 100), doing more and more philosophical-oriented work. They were both skeptical toward quantum theory mainly because of its philosophical consequences. The same way Gödel argued about Hilbert's program and its incompleteness, Einstein tried to show that quantum mechanics was incomplete in the EPR paper published in 1935. According to quantum mechanics, there exists no objective physical reality other than that which is revealed through measurement. That was above Einstein and Gödel's realist ideology. The two companions were not involved in large research program and they became most absorbed by their own work, "lost in clouds of abstruse mathematics and philosophy" (p.96). Einstein was trying to find a unified field theory that could make the bridge between relativity and quantum theories. Gödel also had the same kind of quest. Cantor had shown that infinity could have different sizes, Gödel then was wondering what was the size of this infinity, i.e. he wanted to determine the cardinality of the continuum (for the author "counting the number of points on a line" (p. 96)). Despite their early successes, Einstein and Gödel spent their final years in lost causes. Yourgrau offers a simplistic explanation to this turning point in their career. He mentions two important elements that goes with a great scientific discovery: "One must have an insight into which problems are ripe for resolution, and one must then have the craft-or invent it- to solve the problem one has had the audacity to recognize as solvable" (p. 151). Einstein and Gödel simply didn't recognize that their problems were unsolvable.

Yourgrau does not only consider the scientific side of Einstein and Gödel's lives during this period, he also tries to depict their private lives. This could be summed up by the reductive term "isolation". He gives a rather dark picture of Einstein's last years by a long enumeration of negative facts about his family. For example, the author states that Einstein's first son, "Hans Albert, always distant, remained so after he too emigrated to America" (p. 149). We may ask ourselves about the truth of this statement. Actually, one of Einstein's biographers,

Walter Isaacson, provides a very different view of Einstein's late relationship with his son: "He had, in particular, made in peace with Hans Albert" (Isaacson, p. 537).

As mentioned at the beginning, Einstein and Gödel's relationship was deeper than the whole set of comparisons that Yourgrau spread across his book. In 1944, Gödel wrote an essay in a volume in honor of Einstein's seventieth birthday, *Albert Einstein: Philosopher-Scientist* by Paul Arthur Schilpp. The first sentence of this essay transcript Gödel's deep interest in the new notion of time given by Einstein: "One of the most interesting aspects of relativity theory for the philosophical-minded consists in the fact that it gave new and surprising insights into the nature of time" (Schilpp, p. 557). Gödel "would complete the philosophical journey Einstein had begun in the theory of relativity" (p. 112). He began by considering the relativity of simultaneity introduced by special relativity theory, i.e. that simultaneity of two spatially separated events is not absolute but depends on the reference frame. Thus, talking about the present state of the entire universe doesn't make any sense anymore. The temporal component of relativistic Einstein-Minkowski space-time "t" cannot be identified with the intuitive time. Therefore, special relativity is inconsistent with the reality of intuitive time. But special relativity is restricted to inertial frames of reference. Gödel turned to GTR who provided more relevant consideration about cosmology. Rotating universes were particular solutions to Einstein equation. In particular, one of the properties of not expanding rotating universes is the existence of closed timelike curves allowing a form of time travel in a highly accelerated spaceship traveling along this closed path. In such universes, our intuitive idea that the time "flows" is completely discarded. Was Gödel's universe enough realistic to be taken into consideration? Einstein recognized the value of Gödel's essay: "Kurt Gödel's essay constitutes, in my opinion, an important contribution to the general theory of relativity, especially to the analysis of the concept of time" (p. 115). But according to Yourgrau, Einstein was not willing to give a physical meaning to such extreme mathematical consequences of general relativity. "Gödel would be a pathfinder, then, along two directions: a mathematical approach to the philosophy of time, and a philosophical assessment of the mathematics of relativity. Einstein himself had been reluctant to engage in the latter" (p. 111). He remained attached to make every element in his physical theories correspond with an element in reality. To do so, one should "grasp the difference between geometry as a formal science of deduction and geometry as an empirical account of physical space" (p. 145), what Einstein respectively called "purely axiomatic geometry" and "practical geometry" (Einstein, 1921). For instance, in his special theory of relativity, the geometrical structure of space-time "has the limiting velocity of electromagnetic signals built into its very definition" (p. 146). Besides, the mathematician Minkowski also used the velocity of light as a foundation to define his four dimensional geometry of space-time: "Then c would be an upper limit for all substantial velocities and that is precisely the deeper meaning of the quantity c" (Minkowski p. 41). But one have to admit that time travel is much more difficult to imagine than a finite velocity of light. Nevertheless, maybe Yourgrau is too radical assuring that Einstein was not that much concerned about philosophical meaning of GTR and its mathematics. At Oxford in 1933, Einstein delivered the Herbert Spencer Lecture "On the Method of Theoretical Physics" that included some insights about the role of mathematics in physics: "It is my conviction that pure mathematical construction enables us to discover the concepts and the laws connecting them which give us the key to the understanding of the phenomena of Nature" (Einstein, 1933, p. 167). The latter sentence echoes with one that Gödel wrote: "the

mathematical and empirical parts are in harmony and the real world is also beautiful" (p. 184). It suggests that mathematics not only "dress up" the world but it also gives an inner substantial beauty to it. Contrary to the rest of the book that is full of comparison between Einstein and Gödel, there is no detailed comparison between Einstein and Gödel. According to Yourgrau, while Einstein was preoccupied with his unified field theory and politics, Gödel was much more engaged in the philosophical literature. Yourgrau does not only draw a portrait of Einstein and Gödel's relationship, he also expresses his deep regret concerning the fact that Gödel's philosophical insights didn't find a proper audience and were underestimated.

References

Einstein, A. (1921). *Geometrie und Erfahrung*. Berlin: Springer.

Einstein, A. (1933). "On the Method of Theoretical Physics". *In*: *Philosophy of Science*, Vol. 1, No. 2, (April 1934), pp. 163-169.

Gödel, K. (1944). "A Remark About The Relationship Between Relativity Theory and Idealistic Philosophy". *In:* Schilpp, P.A. *Albert Einstein: Philosopher-Scientist*. La Salle: Open Court Pub Co (3rd edition), pp. 557-562.

Isaacson, W. (2007). *Einstein: His Life and Universe*. New York: Simon & Schuster Paperbacks.

Minkowski, H. (1908). "Space and Time". *In:* Petkov, V. *Space and Time: Minkowski's Papers on Relativity*. Montreal: Minkowski Institute Press, pp. 37-53.